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

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Executive Summary

Some of the most important disagreements about how aggressively to respond to the threat of climate change turn on the choice of the discount rate. A high discount rate implies relatively modest and slow reductions; a low discount rate implies immediate and dramatic action. The debate between the two sides reflects a disagreement between the positivists, who argue for a market rate, and the ethicists, who urge that the positivist approach violates the duty of the present to the future. We argue that the positivists are largely right, and that the question of discounting should be separated from the question of the ethical duties of the present. Discounting is a means of taking account of opportunity costs, and a refusal to discount may well hurt, rather than help, future generations. Nonetheless, it is also possible that cost-benefit analysis with discounting will impose excessive harms on future generations. If so, the proper response is to make investments that will help those generations, not to refuse to discount. We also explore several questions on which the ethicists' legitimate objections require qualification of the positivists' arguments, justifying a low discount rate for climate change policy.

Keywords: discounting, future generations, climate change, intergenerational neutrality

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I. 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, and issues of national sovereignty, distributive justice, corrective justice, and development. Despite a consensus on many issues, specialists intensely disagree about some of 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]

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 a slow but steady change in the energy supply system is preferable. As a result, Nordhaus argues in favor of a relatively low carbon tax. What is the

[1] A good overview can be found in JOHN HOUGHTON, Global Warming: The Complete Briefing (3d ed. 2004).

[2] The most prominent example is Massachusetts v. EPA, 549 U.S. 497 (2007).

[3] NICHOLAS STERN, The Economics of Climate Change, The Stern Review (Cambridge University Press. 2007); WILLIAM D. NORDHAUS, A Question of Balance (Yale University Press. 2008). Partha Dasgupta, begins with a similar comparison of Stern and Nordhaus. See PARTHA DASGUPTA, *Discounting Climate Change*, 36 Journal of Risk and Uncertainty (forthcoming 2008).

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 that occur 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.

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[4] The appropriate discount rate has become an issue in several cases. For a dated but helpful overview, see COMMENT, *Judicial Review of Discount Rates Used in Cost-Benefit Analysis*, 65 University of Chicago Law Review 1333 (1998).

[5]The major difference in the two models, other than the discount rate, is Stern's greater attention to worst case scenarios and risk. Nordhaus runs sensitivity analyses in his model to obtain a sense of how changes in parameters affect the results, but 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 50 years but discounts the benefits over several hundred years. We focus here on the disagreement over discount rates and ignore here Stern's unusual application of discounting. See JOHN WEYANT, P., *A Critique of the Stern Review's Mitigation Cost Analyses and Integrated Assessment*, 2 Review of Environmental Economics and Policy 77 (2008).for a discussion of Stern's calculations of the costs of reducing emissions. 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.

We also note that there are many other disagreements about methodologies for setting climate policy, such as whether cost-benefit analysis is appropriate for a problem of this scale and how to account for small possibilities of very bad outcomes. We do not address these issues here.

[6] NICHOLAS STERN, *The economics of climate change*, 98 American Economic Review 1 (2008). Nordhaus and others respond in WILLIAM D. NORDHAUS, *A Review of the Stern Review on the Economics of Climate Change*, 45

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 discounting argue that discounting is necessary to ensure consistent comparisons of resources spent in different time periods. Critics of discounting begin with a principle of intergenerational neutrality. They insist that people in the current generation should not be treated as more valuable than people in the next generation; they object that discounting ensures that future generations 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 the arguments, we break down the

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Journal of Economic Literature 686 (2007); Martin L. WEITZMAN, *A review of the Stern Review on the Economics of Climate Change*, 45 Journal of Economic Literature 703 (2007).

[7] For a small sampling, see 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 (Robert C Lind ed., 1982); ROBERT C .LIND, *Analysis for Intergenerational Discounting*, *in* Discounting and Intergenerational Equity, (Paul R Portney & John P. Weyant eds., 1999); MARTIN WEITZMAN, *A Review of the Stern Review*, 45 Journal of Economic Literature 703 (2007); MARTIN WEITZMAN, *Why the Far-Distant Future Should be Discounted at Its Lowest Possible Rate*, 36 Journal of Environmental Economics and Management (1998). THOMAS STERNER & U. MARTIN PERSSON, An Even Sterner Review: Introducing Relative Prices into the Discounting Debate (Resources for the Future 2007); NORDHAUS, *A Review of the Stern Review on the Economics of Climate Change*. KENNETH J. ARROW, *Intertemporal Equity, Discounting and Economic Efficiency*, *in* Climate Change 1995: Economic and Social Dimensions of Climate Change, (James P Bruce, et al. eds., 1995); KENNETH J. ARROW, *Discounting, Morality and Gaming*, *in* Discounting and Intergenerational Equity, (Paul R Portney & John P. Weyant eds., 1999); LOUIS KAPLOW, *Discounting Dollars, Discounting Lives: Intergenerational Distributive Justice and Efficiency*, 74 The University of Chicago Law Review79 (2007); DEXTER SAMIDA & DAVID WEISBACH, *Paretian Intergenerational Discounting*, 74 The University of Chicago Law Review 145(2007); PARTHA DASGUPTA, et al., *Intergenerational Equity, Social Discount Rates, and Global Warming*, *in* Discounting and Intergenerational Equity, (Paul R Portney & John P. Weyant eds., 1999); GEOFFREY HEAL, *Intertemporal Welfare Economics and the Environment*, *in* The Handbook of Environmental Economics, (K-G Maler & J.R. Vincent eds., 2005); CASS

basic positions into two camps: the positivists 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 that 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 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 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, treating the welfare of people who live in the future as far less important than the welfare of people who live in the present.

SUNSTEIN & ARDEN ROWELL, *On Discounting Regulatory Benefits: Risk, Money, and Intergenerational Equity*, 74 The University of Chicago Law Review 171(2007); Partha DASGUPTA, et al., *Intergenerational Equity, Social Discount Rates, and Global Warming, in* KENNETH J. ARROW, *Discounting and Public Investment Criteria*, *in* Water Research, (A.V. Kneese & S.C. Smith eds., 1966); John BROOME, *Discounting the Future*, 23 Philosophy & Public Affairs 128 (1994); Robert C. LIND, *Intergenerational Equity, Discounting, and the Role of Cost-Benefit Analysis in Evaluating Global Climate Policy*, 23 Energy Policy379 (1995); Thomas C. SCHELLING, *Intergenerational Discounting*, 23 Energy Policy __(1995);Ari RABL, *Discounting of long-term costs: What would future generations prefer us to do?*, 17 Ecological Economics137 (1996); Thomas C. SCHELLING, *Intergenerational and international discounting*, 20 Risk Analysis 833 (2000); Geoffrey HEAL, *Discounting: A review of the basic economics*, 74 University of Chicago Law Review 59 (2007).

[8]To our knowledge, these terms are our own. A chapter of the 1996 IPCC report in climate change uses similar terms, referring to the basic positions as descriptive and prescriptive. KENNETH ARROW, J., et al., *Intertemporal Equity, Discounting, and Economic Efficiency*, *in* Climate Change 1995: Economic and Social Dimensions of Climate Change, Contribution of Working Group III to the Second Assessment Report of the Intergovernmental Panel on Climate Change, (J.P. Bruce & Haites E.F. eds., 1996).

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 goal 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[9] from climate change, 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 essentially separate from the issue addressed by the positivists. The positivists are considering the choice of projects for any given decision about how much each generation should get -- but they do not address at all how much each generation should get. 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 ways, including simply by saving more, these two concerns can be separated. The best way for the current generation to

[9] See MARTIN WEITZMAN, Structural Uncertainty and the Value of a Statistical Life in the Economics of Catastrophic Climate Change (2007) (*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.

help posterity might be through reducing emissions; but it might be through other methods, including approaches that make posterity richer and better able to adapt.[10]

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-returning project wastes resources. To be sure, if we save more for the future, the market rate of return will go down, 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, we accept the principle of intergenerational neutrality.[11] 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

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

[11] For one understanding and defense of that principle, see JOHN RAWLS, A Theory of Justice (Harvard University Press 2d ed. 1999). For applications to risk regulation, see CASS R. SUNSTEIN, Worst-Case Scenarios (Harvard University Press. 2007).

generations, by depriving them of the benefits of current investments. Our conclusion, then, is that discounting is appropriate and ethically justified – and that 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 two major positions, 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 II reviews the basic mathematics of discounting and explores why it makes sense in the normal context of a person making investment decisions. Part III considers the arguments for and against extending this logic to the intergenerational context presented by climate change. Part IV discusses our proposed resolution of the problem. Part IV also considers objections, including the argument that discounting means valuing the lives or 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.

II. Why Discount?

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 come at different times. To prevent significant harms, we have to 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.[12] The first is that carbon dioxide and other greenhouse gases have very long lives in the atmosphere.[13] Emissions today will increase concentrations of greenhouse gases long into the future. They cannot 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 stop emissions of greenhouse gases immediately, prior emissions would continue to have effects 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 people through the reduced changes 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 you have $100 and are presented with a $100 investment that will produce $110 in two years. You can choose to spend the $100 today or make the investment and spend $110 in two years. You should not simply choose $110 on the grounds that $110 is larger than $100; that would be ridiculous. Instead, you should use discounting to compare the two choices.

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[12] For a summary with citations, see RICHARD A. POSNER, Catastrophe: Risk and Response (Oxford University Press 2004).

[13] 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 IPCC (Cambridge University Press. 2007). Frequently Asked Question 10.3, pp 824-25. According to the IPCC, under current conditions, more than half of the CO_2 emitted is currently removed from t5he atmosphere within a century but about 20% remains in the atmosphere for many millennia. The rate of removal will slow down as land and ocean sinks are used up.

To see why, suppose that you have an alternative choice: putting the money in a bank account, which will pay you interest at 6%. If you put the $100 in the bank instead of making the investment, you would have $112.12 after two years. Therefore, you should not make the investment. Doing so would leave you worse off than the alternative. The 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 $1/(1+r)^n$ 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 was the alternative return available by putting the money in the bank. With our numbers, the opportunity cost was higher than the return on the investment. If the bank paid interest at 4%, the opportunity cost would be lower -- and, in this case, the investment would make sense.

A key to this analysis is that you had alternative means of shifting resources across time, in our example a bank account. Given the bank account, you could choose $100 today or $112.12 in two years, but in no event should you choose $110 in two years. If you were Robinson Crusoe and had no other choice of investments -- no way of shifting resources across time periods by borrowing or by saving -- the opportunity cost of the investment would be zero and you would simply have to decide whether you preferred $110 in two years to $100 today. You might still prefer $100 today because you have to eat, but you would no longer look to the opportunity cost to decide. We will come back to this point at the end of the essay. The ethicists are, in a sense, claiming that the world is like Robinson Crusoe with respect to climate change: we have to

decide how much to have in each period without reference to opportunity costs. The positivists are claiming that we have the option of the market, so we must take opportunity costs into account.

B. Future Generations and the Arc of Time

A key question is whether this same logic can be applied over very long time periods (perhaps 200 years or more) and when the costs and benefits are spread across generations rather than a single individual. Discounting no longer is simply about an individual spreading consumption over a 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 are facing the loss of $1 trillion dollars in one hundred 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 time well within climate change policy considerations -- at a 7% discount rate, we would be willing to spend only about $1.3 million, 0.00013% of the future cost, to prevent it. With 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, they 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. Stern discounted future costs and benefits at 1.4% while Nordhaus discounted them at 5.5%.[14] 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 see climate change as a far larger 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.[15]

While we highlight these two recent books as example, 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 International 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 were 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 is valued at 32.[16]

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[14] Nicholas STERN, The Economics of Climate Change (2007); William NORDHAUS, A Question of Balance (2008).

[15] See NORDHAUS, supra note __; CHRIS HOPE, *The Marginal Impact of CO_2 from PAGE2002: An Integrated Assessment Model Incorporating the IPCC's Five Reasons for Concern*, 6 Integrated Assessment19 (2006).

[16] CHANGE INTERGOVERNMENTAL PANEL ON CLIMATE, Climate Change 2007 -- Impacts, Adaptation and Vulnerability, Contribution of Working Group II to the Fourth Assessment Report of the IPCC (UNFCCC ed., Cambridge University Press. 2007) p. 823. Weitzman, supra note, emphasizes another factor, which we note but do not explore here: low-probability risks of catastrophe.

The debate on discounting goes back to 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."[17] Roy Harrod argued that discounting is "a polite expression for rapacity and the conquest of reason by passion."[18] Tjalling Koopmans argued, however, that a failure to discount effectively means that the current generation must starve itself to benefit the future. Suppose that ethically, 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.[19] Numerous other authors have studied the issue over the years.[20]

III. Ethicists and Positivists

There are two major positions with respect to the proper discount rate. We will describe these as the ethicists' and the positivists' approaches. 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 the approach

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[17] FRANK RAMSEY, *A Mathematical Theory of Savings*, 38 Economic Journal 543 (1928).

[18] ROY HARROD, Towards a Dynamic Economics (Macmillan 1948).

[19] Tjalling C. KOOPMANS, On the Concept of Optimal Economic Growth 28 Pontificae Academiae Scientiarum Scripta Varia 225(1965).

[20] See note __ for a partial list of references.

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

In the end, we will 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 fail our 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.[21] Suppose that we were going to invest $100 billion to reduce carbon emissions, producing a benefit in 100 years of $400 billion. 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 give the future $400 billion dollars by investing about $2 billion at the market rate, keeping the remaining $98 million 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.

[21]Classic references include ARROW, *Intertemporal Equity, Discounting and Economic Efficiency*, note _; ARROW, *iscountingsupre note __;* KENNETH J. ARROW & ROBERT C. LIND, *Uncertainty and the Evaluation of Public Investment Decisions*, 60 American Economic Review 364(1970). DAVID BRADFORD, *Constraints on Government Investment Opportunities and the Choice of the Discount Rate*, 65 American Economic Review887 (1975). S. A. MARGLIN, *The Opportunity Costs of Public Investment*, 77 Quarterly Journal of Economics 274-289, (1963). LIND, *Primer* , supra note.

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 has 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 the investment to the return available elsewhere (the bank). The long time period 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 throws away resources, which is not good for future generations. In our example, instead of investing the $100 billion in the project that had a 1.4% return, we could invest, say, $5 billion in the market and give the future generation about $1 trillion. Everyone would be better off: the current generation would have $95 billion more than otherwise, and the future 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, say, $5 million.[22] 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 put aside today grows with the discount rate. Therefore, the positivists' position, they argue, firmly respects the principle of intergenerational neutrality, and claims to be

[22] This number is in the ballpark of current figures. See Cass R. Sunstein, Valuing Life: A Plea for Disaggregation, 54 Duke L.J. 385 (2004) (listing a figure of $6.1 million).

defensible on ethical grounds. The claim is that future generations are helped, not hurt, by discounting, because it ensures that resources will be invested for their benefit.

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 in computing the opportunity cost. One important issue turns on how to adjust for taxes and similar items, which cause a divergence between the rates of return investors see (the after-tax rate of return) and the rate of return that benefits society (the full, pre-tax rate of return because the investor gets the after-tax amount and the government gets the taxes). Another problem is that there are many market rates of interest. Treasuries pay a different rate from corporates; short-term bonds pay a different rate from long-term bonds; stocks and bonds have different returns. Also, discount rates can vary over time. While important, these issues are largely technical and need not detain us here.[23]

2. *Uncertainty*. A seemingly technical issue, very much worth our attention, involves the effect of uncertainty on discount rates. Suppose that we are considering a project that produces a return of one million dollars 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 evaluating 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 need to take the discounted value of the million

[23] 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.

dollars in each of the two circumstances and average these numbers. If the discount rate is 10%, the present value is about $8,500. If the discount rate is only 2%, the present value is $372,000. The average value is $190,000. This average, $190,000, is the number we should use for our estimate of the present value of the project. The implied discount rate (i.e., the discount rate that gives a present value of one million as $190,000) is 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.[24] 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, it should be legally vulnerable on the ground 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 meaning that the logic of the positivists recommends a high discount rate. Indeed, given that climate change itself might, if bad, lower the rate of return on investments dramatically, the discount rate recommended by the positivists might be very low. This is true even if very bad climate consequences are unlikely because the averaging effect just illustrated means that bad outcomes, even if unlikely, dominate the analysis.

[24]M. L. WEITZMAN, *Why the far-distant future should be discounted at its lowest possible rate*, 36 Journal of Environmental Economics and Management 201 (1998).

3. *The richer future*. Positivists also have to be sure that they attach the correct values to items in the future.[25] For example, if future people are richer than people 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 it provides will be scarcer and its relative value increased. Estimating the correct values of 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 are at risk of using the wrong valuations and calculating the costs and benefits of climate change abatement incorrectly.

C. The Ethicists' Position

The ethicists argue that the only way to determine the correct discount rate is to go back to first principles of ethical reasoning.[26] 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 risk 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 is unethical. Discounting cannot justify 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 also that these effects will be very difficult to counteract: reducing emissions may be

[25] STERNER & PERSSON, supra note

[26] Examples include STERN, *The economics of climate change, supra note*. HEAL, *Intertemporal Welfare supra note _;* DASGUPTA, et al., *Intergenerational Equity, supra note __*

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 into which one finds oneself is irrelevant from the moral point of view; the current generation violates its moral obligations if it enriches itself while subjecting future generations to catastrophic harm.[27] 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 vs. social rates of return.* The ethicists argue that the rate of return on an investment seen by individuals – the so-called private rate of return – is not the same as the benefit society gets from an investment – the social rate of return. There could be many reasons for this, but unless markets are perfectly competitive, a condition that is unlikely to hold, the two

[27] See the discussion of the just savings principle in RAWLS, supra note.

will not be equal. Observed interest rates reflect only private rates of return and, therefore, they are not a good guide 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. It may, for example, be the case that if individuals get a 1.4% benefit that the additional benefits to society from an investment make it worthwhile. Looking only to the market rate, 5.5%, would mean that we reject projects that overall are worthwhile. Absent very stringent conditions, such as the economists' 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 are considering their lifetime consumption – how much to consume today compared to their retirement – and possibly the consumption of their children or 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 interests rates are not a good guide 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 the problem. It 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 try to determine the appropriate discount rate, the ethicists imagine society conducting a 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" is this net increase in consumption. So if we must give up one unit today and society would demand $1 + \rho$ in the future to offset this loss, ρ, the Greek letter rho, 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 in this process. That is, in symbols, society wants find:

$$Max\ [W(C_0) + W(C_1)/(1+\delta) + W(C_2)/(1+\delta)^2 \ldots]$$

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, the Greek letter eta. In particular, the welfare of a given generation, W, is set equal to $C^{(1-\eta)}/(1-\eta)$.

This is largely chosen for convenience rather than based on any empirical or ethical support – this functional form happens to be easy to work with mathematically.[28]

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 – that rate which we should use for evaluating projects such as climate change abatement. The term ċ is the rate of growth of the economy. It tells us what the consumption in each period, the C's in the formula, will be. Eta reflects how much we care about inequality. That is, suppose that growth rates are high, so that the future is very much richer than today. Eta tells us that an increment to their consumption matters less because they are richer. The higher eta is, the more we demand the future get to give up a unit of consumption today. We can think of it as an inequality parameter.

The second term is δ, 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.

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[28]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. STERN, *The economics of climate change*. Although the use of this functional form has a long history in public economics, it remains a specialized assumption. See, ANTHONY B. ATKINSON, *Measurement of Inequality*, 2 Journal of Economic Theory 244 (1970).

Most of the discussion has been about δ. The ethicists almost uniformly take the position that it is unethical to allow δ to be positive because this would mean giving less weight to a future person simply because he lives in the future. If all people count equally, δ must be zero.

Eta is also important. It reflects views about inequality, both across generations and within any given generation. Higher etas 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 with the current generation as across time, the more we want to redistribute now (i.e., we are more egalitarian), the higher the discount rate should be (we should less want to engage in climate change abatement 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 (we hope) 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 are 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 if the future is richer, we should less want to increase their consumption. 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 looks like 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%. 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 now be 2.7%, closer to but still below the rate of return on other investments, although he has not recomputed the resulting policy recommendations.[29] Nordhaus would set $\delta = 1.5$, $\eta = 2$, and a growth rate of 2%, to derive a discount rate equal to 5.5%. 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.

IV. The Ethics of Discounting

A. Our Central Claim

In this section, 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 of return throws away resources; (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 gets – 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 should be. The positivists'

[29] STERN, *The economics of climate change*, supra note.

use of the market rate of discount to choose projects says nothing about whether we are fulfilling our obligations to the future.

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, call it $100. (Imagine putting as many zeroes at the end as needed, and we recognize that some people think that the goods at stake are incommensurable, a point to which we shall return.) 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, maintaining distributional neutrality. The only question in this case is whether spending the $10 on this project produces a better return than spending the $10 elsewhere. The correct procedure for deciding whether to engage in this project is to measure the opportunity costs, which, as we showed above, is equivalent to discounting. [30]

Now suppose that we find out that our legacy to the future is inadequate because of newly discovered environmental harms from our actions. Suppose, for example, we discover that it is only $70 instead of $100. We must now reevaluate whether we are leaving enough. If we believe that, given this information, the correct amount to leave to the future is $95, we must increase our legacy.[31] 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

[30] If it turns out that the project is desirable – that current projects have lower rates of return, there is an issue about how to divide the surplus. Any division makes both generations better off.

[31] 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 thought. It is as if we lost money. It is likely that all generations 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.

leaves $25 for the future, we should not engage in projects that cost more.[32] 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 using discounting at the market rate to choose projects. Project choice and ethical obligations to the future are, to a large extent, separate.

Seen 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 that 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 jump to 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

[32] This is a simplification of the idea of distribution neutral investment choice discussed in detail in KAPLOW, *supra note* __; SAMIDA & WEISBACH, *supra note* __.

correct legacy for the future. The exact implied savings rate is contested because the calculation involves estimates of technological change and other factors, but the ethicist seem to be demand behavior of 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' arguments are 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 it is, it 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 say 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.[33]

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

[33] 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 because 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% used by Stern. Given large differences in the private rate of return and the social rate 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 government projects. The models run by the ethicists and the resulting recommendations, however, never include these exogenous restrictions.

impoverish the future or to reduce greatly its welfare (as climate change threatens to do). If this is true, discounting is not a reason for allowing this to happen. It is simply a method of choosing projects that fulfill our obligation to prevent this from happening. A recommendation for modest climate change abatement, such as that made by Nordhaus, may also need to be accompanied by 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 it counts as such a project.

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 rate. The ethicists will object that our claimed separation between the market rate of return and our ethical obligations to the future is not correct. The reason is that if we were to save more, market rates would go down. 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.[34] Similarly, as mentioned above, the ethicists might argue that the market rate of return is a choice variable, not an exogenous input when we are dealing with large projects. The separation of the

[34] A more subtle and less powerful objection is that even if overall savings rates stay the same, interest rates may change 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 $100, market rates of return may change. This concern seems second order and interest rates could go up as well as down. See KAPLOW note __ for a discussion.

market rate of return and the choice of projects that we are suggesting does not make sense if the market rate of return is determined by the choice of projects.

While we agree that there is a likely connection between the overall savings rate or very large projects and the market rate of return, the ethicists' conclusion does not follow. If the market rate of return is, say, 5.5 percent and the ethicists argue that at the correct savings rate, the rate of return should be 1.4 percent, we should not immediately jump to projects with such low rates of return because eventually, if we increase savings enough, market rates of return might get this low. Large adjustments 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, interest rates will equal the one determined by the ethicists' intuitions. 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 model that has been supplanted by vastly more sophisticated models.[35] Even the most sophisticated and 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 decision procedure is to consider, more directly, the nature of our ethical obligations to the future. If the obligation is to leave more to the future than we previously thought (say because of newly discovered risks from climate change), we need to decide how to do that. The

[35] ROBERT J. BARROW & XAVIER SALA-I-MARTIN, Economic Growth (McGraw-Hill. 1995).

first choice of projects as we begin this adjustment should be those with the highest rate of return. This means discounting at the market rate. As market returns adjust (by going down 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 problems of the positivists' position.

The ethicists derive a discount rate to be used by a social planner independent of the rates demanded by individuals. That is, they start off with the basic premise that social rates of return and private rates of return are different and that the government should choose projects using the social rate of return. The problem with framing the question is this way is that individuals control most of the wealth in society. This means that whatever their preferences about savings, even if wrong, they can offset whatever the government does. Suppose, for example, that individuals, taken as collective, want 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 seeing 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 making the choice that is posed. Instead, the government is merely choosing 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 much debated and it is unlikely to be fully true.[36] Individuals may under our numbers, reduce their legacy to only $70 or $80 or even $90. Nevertheless, there is a basic futility problem with the ethicist's approach. The question they pose, by imagining that the government makes the basic choices about total investment, ignores the basic (and well-founded) constraints on the government.

The positivists also have feasibility problems. The problem is that it may not be possible to transfer resources across hundreds of years to compensate the future victims 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.

This argument has been made most convincingly by Robert Lind.[37] He argues that we simply do not have direct methods of shifting resources across long periods of time, so indirect methods, the choice of projects such as climate change abatement have unavoidable distributional consequences. He imagines a proposal to transfer resources to the distant future through an investment with a 0 percent rate of return at a time when money or other projects earn a 10 percent 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

[36] For a review, see K. SMETTERS, *Ricardian equivalence: long-run Leviathan*, 73 Journal of Public Economics 395 (1999).

[37] LIND, *A Primer on the Major Issues Relating to the Discount Rate for Evaluating National Energy Options*, note __; LIND, *Analysis for Intergenerational Discounting*, *note* __.

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."[38]

The extent to which this is correct is an empirical and institutional question rather than a purely ethical question. 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 percent and the project at issue had a zero rate of return, it is hard to imagine that there were not other projects that, while perhaps not yielding the full 10 percent, had a higher rate of return than zero.

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 set aside funds will have a greater future value than funds invested in reducing emissions, they would have to pass through many generations before being received by their target. Any of those intervening generations could prevent the transfer 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

[38] LIND, *Analysis for Intergenerational Discounting*, *note __*.

fossil fuels. It is hard, without much more institutional detail, to understand why various projects would differentially have the problem of intervening generations, which is what is needed for the claim to have force. We cannot rule this possibility out, 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 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 not realistic. At the same time, as we learn more about climate change, it is becoming apparent that our legacy to the future may be far less than we hoped. New understandings about climate change increase our need to save, whether through investments in abatement or otherwise. 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 and let the market aggregate preferences to the future with this new information incorporated.

3. Incommensurable Goods: lives v. money. A final argument that we cannot separate our ethical obligations and project choice is that climate change produces particular harms to the future that cannot be offset by other projects that help 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 offset by simply saving more. Dean Richard Revesz makes such an argument.[39] He contends that the primary reason for discounting monetary benefits do 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

[39] Richard L. REVESZ, *Environmental Regulation, Cost-Benefit Analysis, and the Discounting of Human Lives*, 99 Columbia Law Review 941 (1999).

lost twenty or two hundred years in the future cannot be "recovered" by investing some sum in the present.

Revesz is right to say 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.[40] The issues raised by the monetary valuation of lives is no different when used for standard cost-benefit analysis within a single time period and 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 need to discount the dollars allocated to the future life because money put 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 that would value the future life more than the present life. To be sure, translating lives into money is not easy and raises a host of thorny question,[41] but it is not an issue for discounting in particular; objections to the methodologies for valuing lives are orthogonal to the discounting debate.[42]

An alternative version of the incommensurability argument, associated with Derek Parfit, is that even if discounting combined with changes in overall savings rates can get the allocation of resources correct across generations taken as a whole, harms to particular individuals cannot

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[40] See, e.g., W. Kip Viscusi, Fatal Tradeoffs (Oxford University Press 1994).

[41] For discussion, see CASS R. SUNSTEIN, *Valuing Lives: A Plea for Disaggregation*, 54 Duke Law Journal 385(2004).

[42]For a detailed discussion of this point, see SUNSTEIN & ROWELL, *On Discounting Regulatory Benefits: Risk, Money, and Intergenerational Equity*, supra note __.

be offset by this procedure.[43] 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, this 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 is begun, all individuals may be subject to the same risk and taken as whole the project may seem sensible. Ex post, however, particular individuals will suffer harm, 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.[44] It presents nothing new when the project occurs over more than one time period.

V. Climate Change and Respecting the Future

In one sense, the debate over climate change is over; a consensus has emerged not only on the existence of global warming,[45] but also on the proposition that the world would benefit, on balance, from a suitably designed agreement to control emissions.[46] But as yet, there is no consensus on what the agreement should require. One of the largest debates involves the aggressiveness of emissions cuts. That debate turns, in large part, on the appropriate discount rate.[47]

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[43] DEREK PARFIT, Reasons and Persons (Oxford University Press 1984).

[44] Viscusi, Fatal Tradeoffs, supra note __; Sunstein, Valuing Lives, supra note __.

[45] See, e.g., Houghton, supra note.

[46] See, e.g., Nordhaus, supra note.

[47] Another important issue involves the weight to be given to catastrophic outcomes. See Weitzman, Structural Uncertainty, supra note __

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 have also contended that on the most fundamental question, the positivists are largely right: 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 value of the environment. Any other approach risks choosing projects with low rates of return, leaving resources on the table.

Discounting, however, should be seen only as a method of choosing projects, not as a method of determining our ethical obligations to the future. We have endorsed a principle of intergenerational neutrality, and if, because of climate change, our legacy to our descendents is far lower than we thought, we have a moral obligation to adjust. The proper response is to leave them more, not to choose projects by refusing to discount.