Forthcoming, 98 Columbia Law Review __ (1999)
Draft of February 17, 1999

Environmental Regulation, Cost-Benefit Analysis, and the Discounting of Human Lives

Richard L. Revesz*

The loss of human life resulting from environmental contaminants generally does not occur contemporaneously with the exposure to these contaminants. Some environmental problems produce harms with a latency period whereas others affect future generations. One of the most vexing questions raised by the cost-benefit analysis of environmental regulation is whether discounting, to reflect the passage of time between the exposure and the harm, is appropriate in these two scenarios.

The valuations of human life used in regulatory analyses are from threats of instantaneous death in workplace settings. Discounting, to reflect that in the case of latent harms the years lost occur later in a person's lifetime is appropriate in these circumstances. Upward adjustments of the value of life need to be undertaken, however, to account for the dread and involuntary nature of environmental carcinogens as well as for higher income levels of the victims. By not performing these adjustments, the regulatory process may be undervaluing lives by as much as a factor of six.

In contrast, in the case of harms to future generations, discounting is ethically unjustified. It is simply a means of privileging the interests of the current generation.

Discounting raises analytically distinct issues in the cases of latent harms and harms to future generations. In the case of latent harms, one needs to make intra-personal, intertemporal comparisons of utility, whereas in the case of harms to future

---

*Professor of Law, New York University School of Law. I benefitted greatly from the comments of Barry Adler, Lucian Bebchuk, Vicki Been, David Bradford, Jules Coleman, John Donohue, Einer Elhauge, Richard Epstein, Christine Jolls, Louis Kaplow, Lewis Kornhauser, Liam Murphy, Richard Pildes, Roberta Romano, Steven Shavell, Richard Stewart, and W. Kip Viscusi. Donna McGee and Libby Rohlfing were excellent research and administrative assistants, respectively. Prior versions of this Article were presented at law faculty workshops at Harvard, the University of California at Berkeley, the University of Chicago, the University of Michigan, and Yale. The generous financial support of the Filomen D'Agostino and Max E. Greenberg Research Fund at the New York University School of Law is gratefully acknowledged.

generations one needs to define a metric against which to compare the utilities of individuals living in different generations. Thus, the appropriateness of discounting should be resolved differently in the two contexts.

Table of Contents

Introduction

The use of cost-benefit analysis has become commonplace in environmental and other health-and-safety regulation. Such analysis is now mandated by Executive Order 12,866 for all major regulations,[1] and may eventually be required by statute if Congress passes one of the various regulatory reform bills that have been pending for some time.[2] The primary benefit of many important environmental statutes, as determined by the dollar value assigned by cost-benefit analysis, is the human lives that

---

[1]Exec. Order No. 12,866, 58 Fed. Reg. 51,735 (1993). This order replaced a similar Executive Order, promulgated by President Reagan. See Exec. Order No. 12,291, 46 Fed. Reg. 13,193 (1981). Given its legal status, however, it cannot displace contrary statutory provisions.

For discussion of the practice of OMB review, see Environmental Policy Under Reagan's Executive Order: The Role of Benefit-Cost Analysis (V. Kerry Smith ed. 1984); Thomas O. McGarity, Reinventing Rationality: The Role of Regulatory Analysis in the Federal Bureaucracy (1991); Richard H. Pildes & Cass R. Sunstein, Reinventing the Regulatory State, 62 U. Chi. L. Rev. 1 (1995).

[2]Currently, a bill sponsored by Senator Carl M. Levin, Democrat of Michigan, which enjoys bipartisan cosponsorship, is pending before the Senate. S. 981, 105th Cong. (1997). It mandates the preparation of a cost-benefit analysis for major rules. See id. §623(b)(2). The bill does not preclude an agency from promulgating regulations that fail a cost-benefit test but imposes seemingly tough hurdles to such regulations. See id. §623(c)(3)(B). Legislative efforts to require that essentially all important regulations satisfy a cost-benefit test, began in earnest with the 104th Congress "Contract with America." See Cass R. Sunstein, Congress, Constitutional Moments, and the Cost-Benefit State, 48 Stan. L. Rev. 247 (1996); see infra text accompanying notes 56-58 (views of Senator Leahy on S. 343). The House passed a bill during the Congress' second month, Sunstein, supra, at 275-76, but a companion bill in the Senate failed to move forward when cloture was defeated, id. at 277-82.

are saved.[3] Thus, in determining whether a particular regulation can be justified on cost-benefit grounds, the central questions revolve around the value assigned to the lives that would be saved by the program. Probably the most vexing problem concerning these valuations has been whether to discount the value of a life saved to account for the fact that the loss does not occur contemporaneously with the exposure to certain

---

[3]For example, Richard Morgenstern explains:

> "The value of fatality risk reduction figures prominently in assessment of environmental benefits. In the case of air pollution, the reduced risk of death often accounts for the largest single component of the dollar value of environmental benefits."

Richard D. Morgenstern, Conducting an Economic Analysis: Rationale, Issues, and Requirements, in Economic Analyses at EPA: Assessing Regulatory Impact 25, 41-42 (1997); see James K. Hammitt, Stratospheric-Ozone Depletion, in Economic Analyses at EPA, supra, at 131, 151-52 (value of averted skin cancer mortality comprises 98% of the benefits of the regulations implementing the Montreal Protocol). More generally, for all health-and-safety regulations, one recent estimate is that "[a]bout 60 percent of the total benefits results from reduction in the risk of death, disease, and injury." Robert W. Hahn, Regulatory Reform: What Do the Government's Numbers Tell Us?, in Risks, Costs, and Lives Saved: Getting Better Results from Regulation 208, 219 (Robert W. Hahn ed. 1996).

Moreover, even in cases in which there are other benefits, EPA's calculation of the magnitude of the benefits focuses on human health effects. See Lisa Heinzerling, Reductionist Regulatory Reform, 8 Fordham Envtl. L.J. 459, 461-62 (1997). For examples, see Heinzerling, supra, at 495 (asbestos ban); Ronnie Levin, Lead in Drinking Water, in Economic Analyses at EPA, supra, at 205, 227 (Richard D. Morgenstern ed., 1997) (corrosion control). The same failure to quantify benefits other than those related to human health effects and mortality are also present with regard to agricultural pesticides, worker protection and primary air quality standards for ozone depletion. Louis P. True Jr., Agricultural Pesticides and Worker Protection, 303, 318 (agricultural pesticides). However misguided such a policy might be, it magnifies the importance of the discounting issues analyzed in this Article.

contaminants.

With respect to this issue, two opposing camps have developed among regulators, judges, and academics. A similar controversy has arisen in connection with other regulatory programs,[4] as well as with the provision of medical services.[5] Supporters of discounting argue that the value of human life must be treated in the same manner as the value of any other benefit or cost: because other benefits and costs are normally discounted to present value when they occur in the future, the value of life should be discounted as well.[6] In contrast, opponents of

---

[4]See Thomas O. McGarity & Sidney A. Shapiro, OSHA's Critics and Regulatory Reform, 31 Wake Forest L. Rev. 587, 629 (1996) (discussing occupational safety).

[5]Compare Emmett B. Keeler & Shan Cretin, Discounting of Life-Saving and Other Nonmonetary Effects, 29 Mgmt. Sci. 300, 303-05 (1983) (favoring discounting); I. Steven Udvarhelyi et al., Cost-Effectiveness and Cost-Benefit Analyses in the Medical Literature, 116 Annals Internal Med. 238, 239 (1992) (same); Milton C. Weinstein & William B. Stason, Foundations of Cost-Effectiveness Analysis for Health and Medical Practices, 296 New England J. Med. 716, 719-20 (1977) (same) with Michael Parsonage & Henry Neuburger, Discounting and Health Benefits, 1 Health Econ. 71 (1992) (opposing discounting) with Alan L. Hillman & Myuong S. Kim, Economic Decision Making in Healthcare, 7 PharmacoEconomics 198, 198 (1995) (rejecting automatic discounting but arguing for "thoughtful adjustments" to reflect period of latency).

For discussion of different methods for discounting the benefits of medical interventions, see Magnus Johannesson, On the Discounting of Gained Life-Years in Cost-Effectiveness Analysis, 8 Int'l J. Tech. Assessment in Health Care 359 (1992).

[6]See, e.g., U.S. Office of Management and Budget, Regulatory Program of the United States Government, April 1, 1991-March 31, 1992, at 147-48 (1991); Susan W. Putnam & John D. Graham, Chemicals Versus Microbials in Drinking Water: A Decision Sciences Perspective, J. Water Works Ass'n, March 1993, at 57,

discounting claim, generally by appeals to notions of ethics and morality,[7] that lives saved in the future are no less valuable than lives saved in the present. As a result, they argue that discounting is inappropriate.[8]

The debate, which is not confined to the United States,[9] has taken on a relatively high profile, including discussion in the

---

60; W. Kip Viscusi, Equivalent Frames of Reference for Judging Risk Regulation Policies, 3 N.Y.U. Envtl. L. Rev. 431, 436 (1995); infra note 28-55 (discussing Corrosion Proof Fittings case).

[7]See Michael B. Gerrard, Demons and Angels in Hazardous Waste Regulations: Are Justice, Efficiency, and Democracy Reconcilable?, 92 Nw. L. Rev. 706 (1998) ("[The] protection of future generations is not merely a matter for accountants. The Constitution was adopted in part to 'secure the Blessings of Liberty to ourselves and our Posterity.'"); Lisa Heinzerling, Regulatory Costs of Mythic Proportions, 107 Yale L.J. 1982, 2044 (1998) ("the decision to discount lives saved in the future involves a choice about values, as to which reasonable people may disagree"); A. Dan Tarlock, Now, Think Again About Adaptation, 9 Ariz. J. Int'l & Comp. L. 169, 173 (1992) ("Speculations about discount rates becomes a disguised debate about our ethical duties toward future generations.").

[8]See Gerrard, supra note 7, at 742-43 ("If a human life is considered to be worth $8 million, and a ten percent discount rate is chosen, then the present value of saving a life one hundred years from now is only $581. ... Neither I nor anyone else uses this kind of argument ... ."); McGarity & Shapiro, supra note 4, at 629 ("The practice of discounting future benefits to present value ... biases cost-benefit analysis against future generations. A high discount rate clearly biases the analysis against future benefits, even though 'it is not clear why the later-born should have to pay interest to induce their predecessors not to exhaust [depletable resources]'").

[9]The government of the United Kingdom, for example, has rejected the concept of discounting in connection with the health benefits of medical interventions. See Hillman & Kim, supra note 5, at 198.

popular press.[10] For example, the issuplayed a role in the Senate's scrutiny of the unsuccessful nomination of Judge Douglas Ginsburg to the Supreme Court of the United States in 1987,[11] and attracted the attention of Vice President Albert Gore during the 1992 presidential campaign.[12]

The discussion of the propriety of discounting human lives often conflates two different sets of problems.[13] In the first,

---

[10]See What Price Posterity? Economic Aspects of Environmental Policy, Economist, March 23, 1991, at 73.

[11]See John K. Horowitz & Richard T. Carson, Discounting Statistical Lives, 3 J. Risk & Uncertainty 403, 412 n.2 (1990).

[12]See Al Gore, Earth in the Balance: Ecology and the Human Spirit 190-91 (1992). Gore takes a negative view toward discounting: "The accepted formulas of conventional economic analysis contain short-sighted and arguably illogical assumptions about what is valuable in the future as opposed to the present; specifically, the standard 'discount rate' that assesses cost and benefit flows resulting from the use or development of natural resources routinely assumes that all resources belong to the present generation. ... In the words of Herman Daly, 'There is something fundamentally wrong in treating the earth as if it were a business in liquidation.'" Id.

[13]See, e.g., Magnus Johannesson & Per-Olov Johansson, The Discounting of Lives Saved in Future Generations: Some Empirical Results, 5 Health Econ. 329, 329 (1996); Heinzerling, supra note 7, at 2043-56 (not distinguishing the analysis of carcinogenic risks to the current generation and of risks to future generations); Putnam & Graham, supra note 6, at 60 (equating delays in the adoption of public health problems with burdens on future generations); see also Peter S. Burton, Intertemporal Preferences and Intergenerational Equity Considerations in Optimal Resource Harvesting, 24 J. Envtl. Econ. & Mgmt. 119, 119 (1993) ("standard discounting practices confuse two issues: (1) intertemporal discount rates of members of the society and (2) intergenerational equity considerations."); Harold P. Green, Legal Aspects of Intergenerational Equity Issues, in Equity Issues in Radioactive Waste Management 189, 192 (Roger E. Kasperson ed. 1983) (most of the statutes governing conservation

the benefits will not accrue until the future because the harm as a latency period. For example, an individual exposed to a carcinogen faces an increased probability of dying at some point in the future, perhaps twenty or thirty years later. In the second, the benefits of controls accrue primarily to future generations. Climate change caused by the presence of anthropogenic gases in the atmosphere are a prominent example of this phenomenon.

The question of how to value lives threatened by latent harms was starkly posed in a regulatory proceeding that took place in the late 1980s in connection with a partial ban on the use of asbestos promulgated by the Environmental Protection Agency (EPA).[14] The Office of Management and Budget (OMB), which is responsible for reviewing regulations to ensure their consistency with cost-benefit principles,[15] strongly urged discounting the value of human lives over the period of latency of the harm; under its then existing policy of discounting environmental benefits at a 10 percent discount rate, the value

---

of land and water resources and wildlife preservation "do not distinguish between benefits accruing in the short-term future to members of the current generation and longer-term benefits to future generations").

[14]See infra text accompanying notes 28-55 (providing more detailed analysis of the proceedings).

[15]See Exec. Order 12,866, supra note 1, §§2(b), 6(b) (responsibilities of OMB's Office of Information and Regulatory Affairs (OIRA)).

of saving a life would have been reduced to only about $22,000.[16] EPA withstood OMB's pressure and published final regulations that essentially rejected the concept of discounting. But the EPA's regulation was invalidated by the Fifth Circuit, partly for this reason.[17]

A recent article by Lisa Heinzerling shows how much rides on whether the value of human lives is discounted over a latency period.[18] She shows that many environmental and health-and-safety regulations promulgated since the 1970s have acceptable cost-benefit ratios if the value of lives is not discounted, but fail cost-benefit analysis if those values are discounted.[19]

Discounting issues play an even more critical role in connection with harms to future generations, particularly with

---

[16]See infra text accompanying notes 32-38.

[17]Corrosion Proof Fittings v. EPA, 947 F.2d 1201 (5th Cir. 1991).

[18]See Heinzerling, supra note 7.

[19]See id. at 1984-85. Heinzerling does not ultimately take a position on the propriety of discounting. See id. at 2055-56 ("more case-by-case attention needs to be given to the question of whether the future benefits of health and environmental regulation should be discounted at all, and if so, at what rate"), although in passing she makes arguments that reveal a deep animosity toward discounting. See id. at 2043-54. The legal literature contains one other sustained discussion on the discounting of environmental benefits. See Daniel A. Farber & Paul A. Hemmersbaugh, The Shadow of the Future: Discount Rates, Later Generations, and the Environment, 46 Vand. L. Rev. 268 (1992). The authors urge that, both intra- and intergenerationally, benefits should be discounted at the long-term real rate of return on riskless investments, which they take to be between one and two percent. See id. at 280, 303-04.

respect to the effects of climate change. Because of the long lag until many of the harmful effects of excessive anthropogenic gases in the atmosphere are felt, how much our society is willing to spend on measures to prevent climate change may well depend on how the question of discounting is resolved.[20]

Opponents of discounting adduce vivid statistics to illustrate what is at stake. For example, Derek Parfit notes: "At a discount rate of five percent, one death next year counts for more than a billion deaths in 500 years."[21] Even economists who do not oppose discounting acknowledge its striking effects: "[W]hen time horizons are very long, all benefits are discounted to zero using any positive discount rate, so that a death prevented in the distant future is worth nothing at the present time."[22]

---

[20]See Christopher D. Stone, Beyond Rio: "Insuring" Against Global Warming, 86 Am. J. Int'l L. 445, 476 ("any variations in policy that might be implied from defensible attitudes toward risk may well be swamped by the implications of defensible discount rates, and, indeed, on how one resolves the philosophical conundrums of valuing the welfare of future generations"); Tarlock, supra note 7, at 173 ("The selection of the discount rate determines the strategy.").

[21]Derek Parfit, Reasons and Persons 357 (1984). For other examples, see Gerrard, supra note 7, at 742-43 ("If a human life is considered to be worth $8 million and a ten percent discount rate is chosen, then the present value of saving a life one hundred years from now is only $581."); McGarity & Shapiro, supra note 4, at 629 ("At a discount rate of 10%, a dollar's worth of benefits fifty years from now is worth slightly less than a penny today.").

[22]Clifford S. Russell, "Discounting Human Life" (Or, the Anatomy of a Moral-Economic Issue, Resources, Winter 1986, at 8,

This Article seeks to shed light on what has become a shrill and unproductive debate. The polar positions on both the latency and future generations issues are analytically unsound and overlook important components of both problems. Moreover, the latent harm and future generation situations are analytically distinct: what one concludes with respect to discounting in one context says little about the appropriate treatment of discounting in the other.

Part I addresses the problem of latent harms. Because there are essentially no empirical studies of the value of lives threatened by latent harms, regulatory analyses must adapt valuations derived from threats of instantaneous death in workplace settings. This Article argues that it is necessary to discount this value, to reflect that the years lost occur later in a person's lifetime. It also argues, however, that such discounting must be accompanied by countervailing upward adjustments, to account for the involuntary nature of exposure to

---

8; see Frank S. Arnold, Economic Analysis of Environmental Policy and Regulation 193 (1995) ("When the delay between the present and the time the benefits of a regulatory action are enjoyed is very large, say hundreds of years, using virtually any positive discount rate will render the present value of the benefits almost nil."); Robert C. Lind, Reassessing the Government's Discount Rate Policy in Light of New Theory and Data in an Economy with a High Degree of Capital Mobility, 18 J. Envtl. Econ. & Mgmt. S-8, S-20 (1990). ("[T]he basic arithmetic of exponential growth applied in a cost-benefit analysis implies that, regardless of how small the cost today of preventing an environmental catastrophe that will wipe out the whole economy, it would not be worth this cost to the present generation if benefits in the future are sufficiently distant.").

environmental carcinogens, the dread such exposure causes, and the higher income levels of the victims. By not performing these adjustments, OMB may be undervaluing lives by as much as a factor of six, or even more for particularly long latency periods. Correcting this undervaluation, as this Article urges, could have an important impact on the regulatory process by allowing more stringent regulations to satisfy the requirements of cost-benefit analysis.

Part II attends to the case of harms to future generations. It shows that the use of discounting in that case is ethically unjustified. As a result, it argues that discounting approaches should not replace the principle of sustainable development, which is used in the major international environmental law agreements to measure our obligations to future generations. The discussion shows, however, that the principle of sustainable development is also problematic, and sets forth the principal elements of an attractive theory of intergenerational obligations. The practical implications can be enormous: The rejection of discounting may lead to a far more stringent response to environmental problems, such as climate change, that have long time horizons.

The Article underscores the extent to which discounting raises analytically distinct issues in the cases of latent harms and harms to future generations, even though these two scenarios have generally been treated as manifestations of the same

problem.[23] In the case of latent harms, one needs to make intra-personal, intertemporal comparisons of utility, whereas in the case of harms to future generations one needs to define a metric against which to compare the utilities of individuals living in different generations. The case of latent harms gives rise to a problem that is primarily technocratic: determining how an individual trades off the utility derived from consuming resources at different times in her life. In contrast, the case of harms to future generations raise to a difficult ethical problem. It is therefore not surprising that the appropriateness of discounting would be resolved differently in the two contexts.

The Article does not address the role that cost-benefit analysis should play in environmental regulation--a subject that has spawned a large academic literature.[24] Rather, its goal is more targeted. It assumes, consistent with current practice,[25] that an important set of environmental and health-and-safety regulations will be evaluated under principles of cost-benefit analysis, and that human lives will be valued as part of this analysis. Given these practices, it seeks to determine the best way to account for the fact that certain losses do not occur

---

[23]See supra text accompanying note 13.

[24]See Environmental Policy Under Reagan's Executive Order, supra note 1; McGarity, supra note 1; Pildes & Sunstein, supra note 1; Sunstein, supra note 2.

[25]See supra text accompanying notes 1-4.

contemporaneously with the exposure to a contaminant.

A central goal of this Article is to move the regulatory process towards a more thoughtful valuation of human lives threatened by environmental carcinogens, and away from OMB's deeply flawed technique of taking valuations from the workplace setting and reducing them by an inflated discount rate.[26] The Article also seeks to move the discussion of how to treat future generations beyond a focus on discounting, which is unlikely to provide an ethically defensible account of our obligations to future generations.

I. Latent Harms

The discussion begins in Section A by reviewing the central role that the debate over discounting played in the Corrosion Proof Fittings case and the extent to which, despite the court's resolution in that case, the issue remains unsettled in the public policy arena. Section B explains that the valuations of human life in the economics literature have been conducted almost exclusively in the context of industrial accidents, where workers face a probability of instantaneous death. In contrast, as a result of understandable methodological complications, there have been essentially no valuations of risks to life with a long latency period, such as those posed by environmental carcinogens.

[26]See infra Part I.G.

Thus, it is necessary to construct a second-best valuation of a life threatened by a contaminant with a latency period, using as a starting point the valuations from the existing empirical studies on instantaneous deaths.

Section C begins the task of constructing a second-best valuation, relying on temporal models that describe the value of life by reference to a stream of utilities that individuals receive if they are alive in particular time periods. When an individual faces a threat to life that manifests itself only after a latency period, she loses fewer life-years than when the threat is instantaneous. Moreover, on average, the loss of life-years occurs further into the future. Downward adjustments to account for these two factors are therefore appropriate.

Section D examines the plausibility of the assumptions underlying the temporal models explored in Section C. It also shows that the discounting of future utilities is conceptually different from the discounting of money flows.

Section E turns its attention to three important upward adjustments that need to be made when extrapolating from the case of instantaneous deaths to that of carcinogenic harms. These adjustments are necessary as a result of the relationship between an individual's income and the value that she places on life, the involuntary nature of exposure to environmental carcinogens, and the dread people suffer from carcinogenic risk.

Section F focuses on the choice of an appropriate discount

rate. It shows that the emerging consensus in the economics literature calls for the use of a rate of 3 percent or less and takes issue with OMB's policy of prescribing a 7 percent rate.

Section G estimates the undervaluation of life that results from OMB's approach of taking valuations from the workplace setting and, without further adjustment, mechanically reducing them by an inflated discount rate. Over a twenty year latency period, the OMB approach can lead to an underestimation by a factor of about six, with a factor of about two being attributable to the choice of discount rate.

Section H argues that discounting the value of life in the context of latent harms does not pose significant moral or ethical dilemmas that are distinct from those raised by cost-benefit analysis in general and the valuation of human life in particular. It is simply one defensible adjustment in the process of constructing a second-best valuation, using workplace valuations as a starting point. Discounting, however, cannot be the only such adjustment.

Before proceeding further, it is useful to underscore that Part I focuses on harms that an individual suffers as a result of an earlier exposure to an environmental contaminant.[27] The term "latent" could be used to describe other phenomena as well: for

[27]A similar set of issues arises where current expenditures can prevent future harms to individuals now alive, even though the harm is not a latent disease. The analysis in Part I is therefore relevant to this situation as well.

example one might think that an environmental exposure producing a harm to future generations gives rise to a latent harm as well. As used throughout this Article, however, the term "latent" is used to describe only situations in which the exposure and the harm accrue to the same individual.

A. The Debate Over Discounting

The appropriateness of discounting the value of human lives first received sustained attention in the regulatory proceeding that led to EPA's partial ban on the manufacture, importation, and processing of asbestos under the Toxic Substances Control Act (TSCA), and the challenge to this regulation in Corrosion Proof Fittings v. EPA.[28] The question was highly controversial even before EPA's publication of the notice of proposed rulemaking in 1986.[29] As required by Executive Order 12,291 (the Reagan Administration's predecessor of Executive Order 12,866),[30] EPA submitted the draft rule to OMB for review before its publication in the Federal Register. In a March 1985 letter to A. James

[28]947 F.2d 1201 (5th Cir. 1991); see Russell, supra note 22, at 9 (noting that before this proceeding, "'discounting human lives' had not yet become an issue in the public debate"). For discussion of the case, see Rita L. Wecker, Case Comment: A "Hard Look at a Soft Analysis, Corrosion Proof Fittings v. Environmental Protection Agency, 4 B.U. Pub. Int. L.J. 145 (1994).

[29]51 Fed. Reg. 3738 (1986).

[30]See supra text accompanying notes 1-4.

Barnes, EPA's acting Deputy Administrator, OMB raised questions about whether the benefits of the rule exceeded its costs.[31] In performing a cost-benefit analysis, OMB used a value per cancer case avoided of $1 million and discounted this amount at a rate of 4 percent for the length of the latency period.[32] (At the time, an OMB guidance document provided for discounting of costs and benefits at a rate of 10 percent,[33] but OMB instead used the rate contained in EPA's guidance document on cost-benefit analysis.)[34]

The following month, the propriety of discounting the value of human lives became an issue in connection with Barnes' Senate confirmation hearings:

> "I have a great deal of ethical difficulty with a concept of applying a discount factor to human life. The lives of my three children are worth every bit as much to me 10 years from now as they are now. I personally reject that notion. I have talked to [EPA Administrator] Lee Thomas about it; I know that it is not one that finds favor with him."[35]

---

[31]See Letter of Robert P. Bedell, Deputy Administrator, Office of Information and Regulatory Affairs to A. James Barnes, Acting Deputy Administrator, Environmental Protection Agency (March 27, 1985), reprinted in Peter S. Menell & Richard B. Stewart, Environmental Law and Policy 104 (1994).

[32]See id.

[33]See infra text accompanying notes 182.

[34]See Letter of Robert P. Bedell, supra note 31, reprinted in Menell & Stewart, supra note 31, at 104.

[35]See Subcomm. on Oversight and Investigations, Comm. on Energy and Commerce, U.S. House of Representatives, EPA's Asbestos Regulations: Report on a Case Study on OMB Interference

In October 1985, a subcommittee of the U.S. House of Representatives chastised OMB for its insistence on discounting the value of human lives.[36] It noted that discounting at OMB's 10 percent discount rate over a forty year latency period would reduce the $1 million value per life saved to just over $22,000.[37] Thus, on cost-benefit terms, one could not justify a current expenditure of over $22,000 to save a life forty years in the future. Even at 4 percent discount rate, the $1 million value of life would be reduced to about $208,000.[38]

The subcommittee referred to the testimony of Don Clay, Director of EPA's Office of Toxic Substances, that EPA "never ha[d] used discounting over the latency period of a chronic hazard," and that, by reducing the value of benefits to such an extent, OMB's approach would prevent EPA from regulating any carcinogen with a long latency period.[39] The subcommittee

---

in Agency Rulemaking, reprinted in Menell & Stewart, supra note 31, at 111. The Barnes comment does not deal specifically with the problem of latent harms, but it reflects a general antipathy to discounting the valuations of human life.

[36]Some members of Congress took a strident position against discounting. For example, Representative Bob Eckhart noted that "it was difficult to say whether that kind of approach was more callous or more foolish" and Representative James Florio called OMB's approach "ghoulish" See Russell, supra note 22, at 9.

[37]See Subcomm. on Oversight and Investigations, supra note 35, reprinted in Menell & Stewart, supra note 31, at 109.

[38]See id.

[39]See id., reprinted in Menell & Stewart, supra note 31, at 110; Sidney A. Shapiro & Thomas O. McGarity, Not So Paradoxical:

further reported that Clay "personally opposed the discounting of lives in the asbestos case on ethical grounds."[40] It concluded that OMB's position with respect to the discounting of the value of life was "simply an outrage" and urged EPA to "reject the use of discounting over the latency period of diseases caused by chronic hazards."[41]

EPA published the proposed rule on the asbestos ban in January 1986.[42] The proposal did not quantify the value of life or undertake any discounting of this value over the length of the latency period.[43] EPA took a different approach, however, when it promulgated the final rule in July 1989.[44] It assigned a value to human lives, but discounted it at a rate of 3 percent from the time of the promulgation of the regulation until the time of the exposure to the carcinogen.[45]

The use of asbestos products does not necessarily result in

The Rationale for Technology-Based Regulation, 1991 Duke L.J. 729 735 ("[I]n cases of toxic substance exposure, where the onset of the disease can be delayed by as much as thirty years, [discounting] effectively ignores the risk altogether.").

[40]Subcomm. on Oversight and Investigations, supra note 35, reprinted in Menell & Stewart, supra note 31, at 111.

[41]Id.

[42]51 Fed. Reg. 3738, 3747 (1986).

[43]See id. at 3748; 54 Fed. Reg. 29,460, 29,487 (1989).

[44]54 Fed. Reg. 29,460 (1989).

[45]See id. at 29,485.

immediate exposure; instead, exposure occurs when the product containing the asbestos begins to disintegrate. For example, some exposures occur when asbestos fibers are released into the air from the weathering of air conditioning products.[46] Exposure is the first step of a process that might later lead to the incidence of cancer and subsequently to a death from cancer. EPA did not discount the value of human life from the time of exposure until the carcinogenic death, as OMB had urged, or even until the first manifestation of cancer.

In its response to comments accompanying the final rule, EPA attempted to defend this decision. EPA noted that comments had been written on both sides of the discounting issue:

> "Some commenters argued that EPA, in the proposal, improperly failed to discount benefit to be derived from the rule, and in support of documents for a final rule only discounted benefits until the time of the exposure that results in the cancer rather than until the occurrence of the disease. Other commenters argued that EPA should not discount benefits, stating that discounting the benefit of saving human life is inappropriate methodology for this rulemaking."[47]

EPA's response revealed a degree of ambiguity on this question and provided at best a luke-warm defense of its course of action. It stated:

> "Arguments can be made that estimating benefits without discounting is preferable in cases like this one where the primary benefits derived is [sic] the avoidance of human cancer cases. However, arguments can also be articulated

---

[46]See id.

[47]Id. at 29,487.

supporting the discounting of benefits."[48]

EPA was more categorical in defending its view that if discounting was appropriate at all, it was appropriate only until the time of exposure:

> "Since the benefit of a regulation to control a hazardous substance occurs at the time of the reduced exposure, EPA has concluded that the appropriate period over which to discount is until the time of exposure reduction. This approach was used in this case after extensive review of applicable literature and an examination of the inherent biases and features of other approaches."[49]

This position has an important corollary for environmental problems in which the regulation leads to an immediate decrease in the exposure of individuals as is the case, for example, with airborne air pollutants. For such pollutants, no discounting of the benefits of the regulation would be performed under EPA's approach, except perhaps for discounting from the time of the preparation of the cost-benefit analysis to the implementation of the regulation.

Though EPA's explanation is not a model of clarity, one can surmise that its approach was <u>not to discount</u> for the period in which the harm was latent: the period between the exposure and the death. Instead, the discounting that was performed affected only the period <u>before</u> the harm became latent.

In October 1991, the Fifth Circuit vacated the regulation

---

[48]Id.

[49]Id.

and remanded in Corrosion Proof Fittings v. EPA,[50] in part because of EPA's treatment of the discounting issue. The Fifth Circuit took the position that discounting was necessary in order to provide for a fair comparison of costs and benefits accruing at different times:

> "Although various commentators dispute whether it is ever appropriate to discount benefits when they are measured in human lives, we note that it would skew the results to discount only costs without according similar treatment to the benefits side of the equation. ... Because EPA must discount costs to perform its evaluations properly, the EPA also should discount benefits to preserve an apples-to-apples comparison, even if this entails discounting benefits of a non-monetary nature."[51]

The Fifth Circuit went on to hold that EPA had used an improper period for discounting, and that the value of human life

---

[50]947 F.2d 1201 (5th Cir. 1991).

[51]Id. at 1218. Lisa Heinzerling criticizes the Fifth Circuit's position:

> "One worries about 'preserving an apples-to-apples comparison,' however, only if one is dealing only with apples. In the asbestos case, the costs were dollars and the benefits were lives. These costs and benefits are the same only if dollars and lives are the same."

Heinzerling, supra note 7, at 2053. Both positions overlook an aspect of the problem. The Fifth Circuit misses the fact that the intertemporal choices of individuals do not necessarily reflect discounting at the rates used by financial markets (though in fact empirical studies show no statistically significant differences). See infra Part I.F.1. In turn, Heinzerling's rhetorical device fails to acknowledge that the cost-benefit calculus in the case required the valuation of the life, and that the question whether this amount should be discounted is one that depends on how individuals compare the utilities derived from living in the present to the utilities derived from living in the future. See infra text accompanying notes 223-24.

should have been discounted to the time of injury.[52] It noted:

> "The EPA's approach implicitly assumes that the day on which the risk of injury occurs is the same day the injury actually occurs. Such an approach might be appropriate when the exposure and injury are one and the same, such as when a person is exposed to an immediately fatal poison, but is inappropriate for discounting toxins in which exposure often is followed by a substantial lag time before manifestation of injuries."[53]

The court did not specify, however, whether it considered the injury to be the first manifestation of cancer or the death from cancer. The detection of carcinogenic cells is a serious injury, but if death does not follow it is not clear why it would be appropriate to attach to this injury the full value of life, rather than the value of the resulting morbidity.[54]

Finally, the Fifth Circuit upheld EPA's choice of a 3

---

[52]See id. The court's analysis revealed confusion. It relied primarily on the following example:

> "Suppose two workers will be exposed to asbestos in 1995, with worker X subjected to a tiny amount of asbestos that will have no adverse health effects, and worker Y exposed to massive amount of asbestos that quickly will lead to an asbestos-related disease. Under the EPA's approach, which takes into account only the time of the exposure rather than the time at which any injury manifests itself, both examples would be treated the same."

Id. In fact, if worker X would never get cancer, the regulation would have no benefit with respect to this worker. With zero benefits, there would be nothing to discount. What the court might have meant is that if workers X and Y had been exposed to asbestos at the same time, and worker Y was injured before worker X, the EPA would treat both cases in the same way (and presumably the Fifth Circuit would have wanted to treat them differently).

[53]Id. at 1218.

[54]For related discussion, see infra text accompanying notes 155-57.

percent discount rate. It implicitly assumed that the correct discount rate was the real rate of interest (the nominal rate of interest minus the rate of inflation) and stated that, historically, this rate has fluctuated between 2 percent and 4 percent.[55]

Despite the court's holding, the question of discounting the value of human life has continued to be controversial. For example, the Senate Report accompanying the Comprehensive Regulatory Reform Act of 1995,[56] which would require the use of cost-benefit analysis in regulatory proceedings,[57] contains a statement by Senator Leahy railing against such discounting:

> "[C]ost/benefit analysis assumes that benefits that occur in the future have very little value. After determining the value of human life, cost/benefit analysis applies a 'discount rate' to benefits that will occur in the future. Benefits of the lives saved in the future by a regulation are reduced by 6-7 percent per year. ... This business evaluation tool does not make sense when applied to the protection of human life."[58]

The regulatory debate over the appropriateness of

---

[55]See 947 F.2d at 1218, n.19. For further discussion of discount rates, see infra Part I.F.2.

[56]S. 343, 104th Cong. (1995).

[57]Id. §624 ("no final rule ... shall be promulgated unless the agency finds that ... the potential benefits from the rule justify the potential costs of the rule"); see id. §§621-622 (dealing with the preparation of cost-benefit analyses); see supra text accompanying notes 1-4 (discussing regulatory reform).

[58]S. Rep. No. 104-90, at 153 (1995) (supplemental views of Senator Leahy).

discounting of human lives, stated in conclusory terms and virtually devoid of any sustained analysis, failed to shed light on the important issues underlying this question.[59] After providing a brief overview of the economic approach to valuing human life, the remainder of Part I seeks to fill this void.

B. Valuations of Human Life

Since the 1970s, willingness-to-pay studies have become the standard economic technique for placing a value on human life.[60]

---

[59]The only two sustained treatments of the question of discounting in the legal academic literature were those of Farber & Hemmersbaugh, supra note 19, and Heinzerling, supra note 7. See supra note 19 (discussing their positions). While the economics literature has focused on isolated nuances, it has not taken a broad look at the problem or connected the various strands that are necessary to a sophisticated analysis of the public policy choices.

[60]See W. Kip Viscusi, The Valuation of Risks to Life and Health: Guidelines for Policy Analysis, in Benefits Assessment: The State of the Art 193, 193 (Judith D. Bentkover et al. eds. 1986) [hereinafter Viscusi, Valuation]. For a more recent survey, see W. Kip Viscusi, The Value of Risks to Life and Health, 31 J. Econ. Literature 1912 (1993) [hereinafter Viscusi, Value]. The technique is generally traced to Thomas C. Schelling, The Life You Save May Be Your Own, in Problems in Public Expenditure Analysis 127 (Samuel B. Chase, Jr., ed. 1968), and E.J. Mishan, Evaluation of Life and Limb: A Theoretical Approach, 79 J. Pol. Econ. 687, 695-705 (1971).

Before the ascendancy of willingness-to-pay studies, the human capital approach was prevalent. This approach valued life in terms of lost earnings. See Viscusi, Valuation, supra, at 198. The technique is subject to the obvious criticism that earnings provide that "individual well-being goes far beyond its financial implications." Id.; see W.B. Arthur, The Economics of Risks to Life, 71 Am. Econ. Rev. 54, 54 (1981); Lewis A. Kornhauser, The Value of Life, 38 Clev. St. L. Rev. 209, 212 (1990).

By far the most common method for performing such valuations focuses on the choices that workers make in accepting risky jobs.[61] The approach begins by defining sets of jobs that require comparable skills and offer comparable non-monetary amenities, except that one exposes the worker to a higher risk than the other.[62] Presumably, a rational worker would not accept the riskier job unless she obtained sufficient compensation for the additional risk. The resulting wage differential is the compensation that the worker obtains for the additional probability of death that she faces as a result of having taken the riskier job.[63] An extrapolation, consisting of dividing the wage differential by the additional probability of death, is then performed to determine the value of life.[64]

---

[61]See Viscusi, Valuation, supra note 60, at 200.

[62]See Viscusi, Valuation, supra note 60, at 199-200.

[63]Such workers might also face a higher probability of nonfatal risks. Some studies estimate the portion of the wage differential that is attributable to such nonfatal risks. The residual wage differential is then attributed to fatal risks. See Viscusi, Value, supra note 60, at 1919. Some studies, however, do not separate the wage differential into these two components. See id.

[64]For criticism of the approach, see McGarity, supra note 1, at 147-48; J. Paul Leigh, Compensating Wages, Value of a Statistical Life, and Inter-Industry Differentials, 28 J. Envtl. Econ. & Mgmt. 83 (1995); Steven Kelman, Cost-Benefit Analysis and Environmental, Safety, and Health Regulation: Ethical and Philosophical Considerations, in Cost-Benefit Analysis and Environmental Regulations: Politics, Ethics, and Methods 137, 143-45 (Daniel Swartzman et al. eds. 1982); McGarity & Shapiro, supra note 4, at 628-29.

An alternative methodology consists of surveying individuals

Willingness-to-pay studies of the value of human life have been conducted almost exclusively in the context of industrial accidents, where the worker faces a risk of being either fatally injured by a piece of machinery and dying instantaneously, or surviving unscathed.[65] In any time period, there is a probability that a fatal accident will occur. This probability is ascertained from industrial safety statistics.[66]

One could use the same approach to determine the willingness-to-pay to be free from risks with long latency

---

and asking them how much they would be willing to pay for a particular risk reduction. See Viscusi, Valuation, supra, at 204-05. The disadvantage of this contingent valuation method is that the responses are to hypothetical situations and have no economic consequences. See V. Kerry Smith & William H. Desvousges, An Empirical Analysis of the Economic Value of Risk Changes, 95 J. Pol. Econ. 89, 93 (1987).

[65]See Maureen L. Cropper & Frances G. Sussman, Valuing Future Risks to Life, 19 J. Envtl. Econ. & Mgmt. 160, 160 (1990) ("The empirical literature on valuing risks to life has focused almost exclusively on valuing mortality risks that occur today--the risk of accidental death a worker faces during the coming year or the risk of dying this month in a car accident."); Horowitz & Carson, supra note 11, at 405 ("Virtually all empirical work on the value of risk reductions has considered risks that occur entirely in the present ..."); Shapiro & McGarity, supra note 39, at 734 ("most wage premium studies ... are based on safety hazards, not health risks"). Of course, to the extent that there is a probability of a non-fatal accident, the resulting morbidity risk could also be measured using a willingness-to-pay approach.

[66]See Leigh, supra note 64, at 86-87; Viscusi, Valuation, supra note 60, at 200. Of course, in some cases, industrial accidents result in long-term disability rather than death.

periods.[67] As long as workers understood the additional probability of, say, dying of cancer from a riskier job, and knew the length of latency period, they could figure out how much additional compensation to demand in order to accept the job with the higher risk. From this wage differential, one would extrapolate to determine the value of the life. The fact that the harm would accrue only in the future would be reflected in the wage differential. For example, other things being equal, an individual with a comparatively high discount rate would demand a comparatively low wage differential. We would then have measured exactly what we wanted to see, and there would be no need to perform any discounting.

It is likely that such studies have not been conducted for three principal reasons. First, the industrial statistics on deaths resulting from latent harms are not as extensive as those for instantaneous accidents. The federal government became extensively involved in the regulation of workplace and environmental safety only in the 1970s (and prior state efforts

[67]One ongoing attempt to derive a willingness-to-pay valuation of human lives threatened by carcinogens is reflected in John R. Lott, Jr. & Richard L. Manning, How Changing Liability Rules Compensated Workers Twice for Occupational Hazards?: Earnings Premiums and Cancer Risks (June 28, 1998) (manuscript on file with the Columbia Law Review). For a contingent valuation study inquiring how individuals value risk reductions from hazardous waste sites, see Smith & Desvousges, supra note 64.

in these areas were relatively modest).[68] For example, if the federal government began to compile statistics on the risk of various workplace settings in the mid-1970s, it would have immediately had a data set on instantaneous accidents. In contrast, for carcinogenic risks with a twenty-year latency period, comparable statistics on such risks would not be available until the mid-1990s, unless retrospective studies could be performed. Moreover, while accidents on the job are relatively easy to track, statistics on mortalities associated with latent harms require much more difficult tracking of the health status of individuals after they leave their jobs. Further, while the cause of on-the-job accidents typically is relatively easy to identify, the causal link between occupational exposure and future harms from carcinogens can be difficult to establish.

Second, in order for willingness-to-pay studies to yield meaningful results, individuals must be able to properly understand the nature of the risk; otherwise, they cannot determine what sum of money properly compensates them for the risk. Some commentators doubt that our cognitive capacities are sufficiently developed to perform such valuations in the case of

[68]Both the Occupational Safety and Health Administration (OSHA) and EPA were established in 1970. See Sidney Shapiro & Thomas O. McGarity, Reorienting OSHA: Regulatory Alternatives and Legislative Reform, 6 Yale J. Reg. 1 n.1, 2 n.9 (1989).

future harms.[69]

Third, this problem is compounded by the fact that exposure to carcinogens may have a differential impact depending on an individual's characteristics, including, for example, whether she smokes. In order to decide how to respond to a wage premium, individuals would need to understand not only the "pure" carcinogenic risk of the job, but also the magnitude of any synergistic interactions that might result from such characteristics.

In summary, the task of directly performing a willingness-to-pay study of the value of life in the case of latent harms is fraught with difficulties, perhaps insurmountable ones. Instead, to obtain such a valuation, resort to a second-best approach is necessary.

C. Discounting as a Second-Best Approach

As a result of the difficulty of obtaining a direct willingness to pay measure of the value of a life threatened by a latent carcinogenic harm, economists have devoted considerable attention to defining a relationship between the value of a life lost today and the value of a life lost years from now. Such temporal models, also known as life-cycle models, study the

[69]See Cropper & Sussman, supra note 65, at 166 n.8. Moreover, certain risks may be poorly understood even by experts. See Smith & Desvousges, supra note 64, at 109.

distribution of an individual's utility throughout her life.[70]

The discussion that follows focuses, for illustrative purposes, on three different valuations: first, the life of a 40-year old that is lost today, for example, from an industrial accident; second, the life of a 60-year old, also lost today; and, third, the life of an individual who is currently 40 years but dies in twenty years as a result of exposure today to a carcinogen with a twenty-year latency period.[71] For this discussion, $V_{j,k}$ denotes the value attached to the life of an individual exposed to a harm at age j who dies at age k. Thus, the values of the three lives described above can be expressed as $V_{40,40}$, $V_{60,60}$, and $V_{40,60}$, respectively. To keep the discussion simple, it assumes that these individuals, if not exposed to the industrial or carcinogenic risk, would die of natural causes at age 80.[72]

---

[70]See Sherwin Rosen, The Quantity and Quality of Life: A Conceptual Framework, in George Tolley, Donald Kenkel & Robert Fabian, Valuing Health for Policy: An Economic Approach 221 (1994).

[71]One commentator estimates that "the average age of the workplace accident fatality is 41" whereas "the average age of the workplace cancer victim is likely to be 55, 65, or even higher." John M. Mendeloff, The Dilemma of Toxic Substance Regulation: How Overregulation Causes Underregulation at OSHA 48 (1988).

[72]Additional complications are introduced when the length of the person's life is uncertain. See Rosen, supra note 70, at 236-45. No important insights are lost, however, as a result of this simplification. In practice, of course, an individual who would have died of cancer at the end of the latency period may die earlier of other causes. See Lester B. Lave, The Strategy of

The three valuations differ in two important ways.[73] First, the forty-year old dying immediately loses 40 years of life whereas the sixty-year old dying immediately and the forty-year old dying in twenty years lose only twenty years of life.[74] Second, the individual exposed to the carcinogen does not lose these twenty years of life immediately, but twenty years later.[75] Let u_l denote the utility that an individual derives in year l from living that year. So, for example, for the forty-year old exposed today to the latent harm, u_{60} is the utility that the individual would derive in twenty years from living in the year following her sixtieth birthday. In contrast, for the sixty-year old killed today in an industrial accident u_{60} is the utility that the individual would have derived this year if the accident had not occurred.

If these utilities were simply monetary payments as opposed to the well-being that comes from living, they could easily be compared with one another by discounting the future stream of benefits by a means of a discount rate. Discounting reflects the

---

Social Regulation: Decision Frameworks for Policy 43 (1981).

[73]See Maureen L. Cropper & Paul R. Portney, Discounting and the Evaluation of Lifesaving Programs, 3 J. Risk & Uncertainty 369, 376 (1990).

[74]A more complicated situation arises when an individual is exposed to a carcinogen over a long period of time and the harm resulting from the exposure is cumulative.

[75]See Cropper & Sussman, supra note 65, at 172-73.

fact that it is more desirable to get a payment sooner rather than later. It is important to stress that this preference is not a function of the existence of inflation. In comparing monetary flows occurring at different times, the effects of inflation can be adjusted by converting all amounts to constant dollars. But even in an inflation-free world, it is best to get a given amount of money as soon as possible. Having the money sooner gives one the option of either spending it immediately or saving it for later, whereas getting it later (absent borrowing) rules out immediate spending. The rate used to discount amounts in constant dollars is typically known as a "real" discount rate.[76]

Given a discount rate of r, the present value of a payment P that is paid t years from now is $[1/(1+r)^t]P$.[77] I am not suggesting at this point that discounting to present value the utility that an individual derives from living for a year is equivalent to discounting a monetary payment, and will return to this issue later.[78] Instead, I am showing the relationship among

---

[76]See W. Kip Viscusi, Discounting Health Effects for Medical Decisions, in Valuing Health Care: Costs, Benefits, and Effectiveness of Pharmaceuticals and Other Medical Technologies 125, 129 (Frank A. Sloan ed. (1995)). In contrast, a nominal rate is used to discount current dollars. The real rate is the nominal rate minus the rate of inflation.

[77]See Edith Stokey & Richard Zeckhauser, A Primer for Policy Analysis 163 (1978).

[78]See infra Part I.F.1.

the values of the three different lives if such discounting were appropriate.

Then,

$$V_{40,40} = u_{40} + [1/(1 + r)]u_{41} + \ldots + [1/(1 + r)^{38}]u_{78} + [1/(1 + r)^{39}]u_{79}$$

The loss for the forty-year old killed by the industrial accident is the utility of living in the year following the individual's fortieth birthday, plus the utility of living one year later discounted for one year, plus the utilities of living in all subsequent years until age 80 (when the individual would have died anyway), with each utility discounted for the number of years elapsed since the present.

In turn,

$$V_{60,60} = u_{60} + [1/(1 + r)]u_{61} + \ldots + [1/(1 + r)^{18}]u_{78} + [1/(1 + r)^{19}]u_{79}$$

Here, the loss takes the same form, except that the first year of loss of utility is the year following the individual's sixtieth birthday.

Finally,

$$V_{40,60} = [1/(1+r)^{20}]u_{60} + [1/(1 + r)^{21}]u_{61} + \ldots + [1/(1 + r)^{38}]u_{78} + [1/(1 + r)^{39}]u_{79}$$

Only years following the individual's sixtieth birthday are lost, and these losses are discounted by the number of years from the present.

The relationship between $V_{60,60}$ and $V_{40,60}$ should now become

apparent. The latter value is simply the former discounted by twenty years.[79] In other words, both individuals lose the same years of their lives--those following their sixtieth birthdays, but the latter individual loses them twenty years later than the former. Thus,

$V_{40,60} = [1/(1+r)^{20}]V_{60,60}$

Under this approach, the value that should be attached to the life of a forty-year old who is exposed to a carcinogen with a twenty year latency period and who dies at age 60 is equal to the value of the life of a sixty-year old who dies instantaneously in an industrial accident, with the latter value discounted for the twenty years that elapse before the carcinogenic victim dies.

So far, in fact, the discussion suggests that the OMB approach actually overestimates the value of the loss resulting from exposure to latent risks. The OMB procedure takes $V_{40,40}$ and discounts it back to present value to account for the latency period.[80] In fact, the correct approach would be to discount $V_{60,60}$ instead,[81] which is lower than $V_{40,40}$ because of the twenty

---

[79]See Cropper & Sussman, supra note 65, at 165-66.

[80]See supra text accompanying notes 71 (hypothesizing that the worker exposed to the risk of instantaneous death is forty-year old).

[81]See Cropper & Portney, supra note 73, at 378 & n.12.

fewer years of life loss.[82] As explained later, however, this overvaluation is outweighed by the substantial undervaluation that results from other elements of OMB's approach.[83]

D. Plausibility of the Model

The model presented in the previous section relies on two important assumptions. First, it assumes that an individual's utility function can be expressed as a sum of utilities over the various periods comprising one's lifetime. Thus, one's enjoyment of life in one period is not affected by the resources available for consumption in prior periods,[84] but only on the resources in that period.[85] Under the model, an individual's utility in one period is not affected by the resources available for consumption in prior periods.[86] So, for example, whether an individual was

---

[82]See Cropper & Sussman, supra note 65, at 172 ("This fact ... is often ignored in risk-benefit analyses.").

[83]See infra Part I.G.

[84]See Robert F. Bordley, Making Social Trade-Offs Among Lives, Disabilities, and Cost, 9 J. Risk & Uncertainty 135, 138 (1994).

[85]See Cropper & Portney, supra note 73, at 371-72; Rosen, supra note 70, at 222-23.

[86]A similar issue arises in the literature on QALYS, or quality-adjusted life years, which are a means for adjusting the utility that an individual gets in a period by the quality of her health in that period. So, for example, an individual derives greater utility from a year in which her health is excellent than in one in which she is disabled. See Richard Zeckhauser & Donald Shepard, Where Now for Saving Lives, Law & Contemp. Probs., Autumn 1976, at 5, 12. In the context of QALYS, separability

able to afford a quality education in a prior period does not affect the utility that she derives from a given level of consumption in subsequent periods. This assumption is clearly debatable. Indeed, John Broome, in a related context, terms the assumption "dubious,"[87] though he acknowledges that it is commonly made in economic analysis.[88]

Moreover, an individual facing death from cancer may focus on the fact of the death and on its cause, without paying particular attention to the death's timing. One's willingness-to-pay to avoid the risk may then be relatively unaffected by the length of the latency period. A number of studies show that individuals of different ages exhibit different willingnesses-to-pay to avoid instantaneous deaths, suggesting, consistent with the model, that their valuations are indeed affected by the number of life-years that they would lose.[89] It is possible, however, that such behavior would not extend to carcinogenic risks as a result of the dread associated with such deaths.[90] As

---

implies that the utility that a person derives from the quality of her life a particular year is independent of the qualities of her life in past years. See John Broome, QALYS, 50 J. Pub. Econ. 149, 151-52 (1993).

[87]See Broome, supra note 86, at 151-52. Broome applies this label to a separability model in the context of QALYS. See supra note 86.

[88]Bordley, supra note 84, at 138.

[89]See infra Part I.F.1.

[90]See infra Part I.E.3.

a result of the paucity of studies of the willingness-to-pay to avoid carcinogenic risks,[91] it is not possible to make empirically grounded claims concerning this hypothesis.

Second, the model uses a constant discount rate.[92] So, for example, the same rate would be used to discount the utility of living twenty years in the future as would be used to discount the utility of living next year. As Donald Shepard and Richard Zeckhauser put it, the model assumes that "an individual's utility over lifespans of different length can be represented as a weighted sum of period utilities, the weights declining geometrically with time."[93] Shepard and Zeckhauser label this assumption "heroic."[94]

If, for example, I did not currently value at all the utility of living beyond the year 2010, I would be applying an infinite discount rate to the utilities that I would derive if in fact I were alive beyond that year. The present discounted value of those utilities would be zero. There is no mechanism by which

---

[91]See supra text accompanying notes 65-69.

[92]See Bordley, supra note 84, at 138; Michael J. Moore & W. Kip Viscusi, Discounting Environmental Health Risks: New Evidence and Policy Implications, 18 J. Envtl. Econ. & Mgmt. S-51, S-54 (1990); Rosen, supra note 70, at 224.

[93]Donald S. Shepard & Richard J. Zeckhauser, Survival Versus Consumption, 30 Mgmt. Sci. 423, 424 (1984).

[94]See id. at 424; Joseph Lipscomb, Time Preferences for Health in Cost-Effectiveness Analysis, 27 Med. Care S233, S237 (1989) (asking whether individuals evaluate multiperiod health outcomes "in accordance with constant-rate discounting").

I could transfer any life-years beyond the year 2010 to someone with a lower discount rate, in return for a higher present utility. In contrast, in the case of financial flows, if I undervalued relative to the market the stream of payments that I would receive on my Treasury bond after the year 2010, I could increase my utility by selling that stream of payments at the market price.[95]

There is little attempt in the literature to validate the constant discounting feature of the model through experiment or observation.[96] One study of the implicit discount rates reflected in individuals' contingent valuation of the disutilities of various illnesses led the authors to question whether the conventional discounting model properly describes individual preferences.[97]

---

[95]See W. Kip Viscusi & Michael J. Moore, Rates of Time Preference and Valuations of the Duration of Life, 38 J. Pub. Econ. 297, 297-98 (1989) ("Although money is readily transferable across time, health status is not."). Part I.F.1, infra, explains more generally why discounting health risks is analytically different from discounting financial flows.

[96]There have been attempts to estimate the rate at which individuals discount their utilities, but they have been conducted on the basis of constant discounting models. See Moore & Viscusi, supra note 92, at S-54. There also are empirical estimates of how discount rates depend on the period over which the discounting is performed, but these studies are intergenerational, or at the very least interpersonal. See infra Part II.B.

[97]See Donald A. Redelmeier & Daniel N. Heller, Time Preferences in Medical Decision Making and Cost-Effectiveness Analysis, 13 Med. Decision Making 212, 216 (1993); see id. at 214-15 (finding that rates for temporally proximate events were

These problems with the assumptions underlying the temporal models for the valuation of lives threatened by environmental carcinogens should not lead to the conclusion that the models are inappropriate. At present, such models are the state of the art in economic analysis. It is therefore proper to continue to use them, absent a further refinement or an empirical falsification. But as the regulatory process seeks to construct appropriate second-best valuations for lives threatened by environmental carcinogens, it must pay further attention to the plausibility of the assumptions underlying temporal models.

E. Necessary Adjustments

It is time now to scrutinize with more care some of the assumptions made implicitly in the model described in Part I.C. Such scrutiny reveals, for several reasons, that one cannot simply take an estimate of the value of life from an industrial accident (whether $V_{40,40}$ or $V_{60,60}$),[98] discount it, and obtain a plausible estimate of the value of life from exposure to an environmental carcinogen with a latency period.[99] Many adjustments need to be made for the estimate to be at all meaningful. These adjustments all lead to assigning a higher

---

larger than for more distant events); infra Part II.B (same finding in intergenerational models).

[98]See supra text accompanying notes 36-38.

[99]See Cropper & Portney, supra note 73, at 377.

value to the life lost.

This section examines the principal adjustments that need to be performed. It focuses primarily on differences between the valuations for instantaneous and latent harms that have been the subject of empirical examination.

1. Impact of Income on the Valuations of Life

In the temporal model presented in Part I.C, the utility that an individual derives in a particular year is a function of the level of resources available for consumption that year. Economists have estimated that the elasticity of the value of life with respect to earnings (the percentage change in the value of life for a one percent change in earnings) is approximately one. Thus, for example, a ten-percent increase in income would lead to a ten-percent increase in the value of life.[100] The impact of income on the valuation of life calls into question several of the implicit assumptions made in Part I.C.

a. Increases in Income Over Time

That model assumes implicitly that the valuation of a particular year of life, say the year following one's sixty-fifth birthday, is independent of the age of the individual making the

[100]See Viscusi, supra note 76, at 130; Shepard & Zeckhauser, supra note 93, at 437, n.18. But see Glenn Blomquist, Value of Life Saving: Implications of Consumption Activity, 87 J. Pol. Econ. 540, 555 (1979) (finding lower elasticity).

valuation. Thus, for example, u_{65}, the utility of living in the year following one's sixty-fifth birthday, is the same for both a forty-year old and a sixty-year old. The only difference related to the valuation is that the forty-year old discounts this utility for the twenty five years that it will take until this utility is realized, whereas the sixty-year old discounts the utility for only five years.

A correction needs to be made, however, if income adjusted for inflation rises over time. In comparing $V_{40,60}$ with $V_{60,60}$, one must account for the fact that by the time that the forty-year old is sixty, her income, in real terms, will be higher than the sixty-year old's income is today.

If income rises in real terms over time, the relationship between $V_{40,60}$ and $V_{60,60}$ becomes different than that posited in Part I.C.[101] Let g be the yearly increase in the individual's real income. Then

$$V_{40,60} = [(1 + g)/(1 + r)]^{20}V_{60,60}$$

Thus, $V_{60,60}$ now needs to be subjected to two adjustments.[102] First, it is increased by a factor of $(1 + g)^{20}$ to account for the fact that the years of lost life will occur twenty years later for the forty-year old, and that for each of the years of life lost, the utility lost twnety years from now to the

---

[101]See supra text accompanying notes 78-80.

[102]Viscusi, supra note 76, at 130; see Richard Zeckhauser, Procedures for Valuing Lives, 23 Pub. Pol'y 419, 437 (1975).

individual who is currently forty years old will be $(1 + g)^{20}$ greater than for the individual who is currently sixty years old. Second, it is decreased by a factor of $[1/(1+r)]^{20}$ to discount to present value the utilities that the current forty-year old would enjoy twenty years later. To a first approximation,[103] the relationship between $V_{40,60}$ and $V_{60,60}$ simplifies as follows:

$$V_{40,60} = [1/(1 + r - g)]^{20}V_{60,60}$$

For example, if the real discount rate is 3 percent but income is rising at a yearly rate of 1 percent in real terms, then the effective rate at which $V_{60,60}$ would be discounted to arrive at $V_{40,40}$ would be 2 percent. Moreover, if r and g were equal, then $V_{40,60}$ and $V_{60,60}$ would be equal as well.[104] The increase in the valuation of $V_{40,60}$ to account for rising real incomes would exactly counteract the decrease resulting from the time lag in the enjoyment of utilities.

Table I presents the changes between 1982 and 1996 in mean and median incomes for workers fifteen years and over. The

---

[103]Viscusi, supra note 76, at 130; see William D. Nordhaus, to Slow or Not to Slow: The Economics of the Greenhouse Effect, 101 Econ. J. 920, 925-26 (1991).

[104]Farber & Hemmersbaugh, supra note 19, state that "the discount rate even for economic benefits cannot significantly exceed the expected long-term rate of economic growth; otherwise, we would discount even the destruction of most future Gross Domestic Product to a low present value over periods of only decades." Id. at 296. The authors appear to be making a pragmatic argument for keeping the effective discount rate low. There is, however, no plausible normative argument for linking the two rates in this manner.

figures are presented in constant 1996 dollars.[105]

Table I: Median and Mean Earnings of Workers 15 Years Old and Over (in Constant 1996 Dollars)		
	Median Earnings	Mean Earnings
1996	20,716	27,366
1995	20,541	26,870
1994	19,858	26,668
1993	19,566	26,107
1992	19,521	25,124
1991	19,752	25,110
1990	20,092	25,446
1989	20,667	26,293
1988	20,475	25,755
1987	20,182	25,401
1986	19,564	25,078
1985	18,787	24,169
1984	18,336	23,428
1983	18,275	23,064
1982	18,135	22,760

The table reveals that median and mean income grew at compound rates of 0.95 percent and 1.01 percent per year, respectively.[106]

---

[105]The source is U.S. Census Bureau, Historical Income Tables--Persons, Table P-44 (visited June 22, 1998) <http://www.census.gov/hhes/income/histinc/p44.html>.

[106]Over the longer run, the rate has been higher. See William R. Cline, The Economics of Global Warming 251 (1992) (estimating that "real per capita income in the United States has grown at about 1.7 percent annually over the past century").

b. Age-Dependent Nature of the Valuation

A different issue is raised by life-cycle changes in levels of income. For example, Donald Shepard and Richard Zeckhauser analyze the valuations of a typical individual who enters the work force at age twenty, sees steadily rising income up to age 50, then experiences a small decrease in income until age 65, and loses all income as a result of retirement at age 65.[107] The economics literature assumes that people value their lives as a function of their current income (and resulting consumption), not on the basis of projections of future income.[108] Richard Zeckhauser has labeled this phenomenon as "temporal myopia."[109]

Shifts in an individual's income across time would not make a difference to the valuations of life if borrowing were available to equalize the amounts available for consumption. Typically, however, there are serious roadblocks to borrowing based on the expectation of higher incomes in the future.[110] And,

---

[107]See Shepard & Zeckhauser, supra note 93, at 432-36; Donald S. Shepard & Richard J. Zeckhauser, Life-Cycle Consumption and Willingness to Pay for Increased Survival, in The Value of Life and Safety 95, 120-27 (M.W. Jones-Lee ed. 1982) [hereinafter Shepard & Zeckhauser, Life-Cycle Consumption].

[108]See Zeckhauser, supra note 102, at 437.

[109]Zeckhauser, supra note 102, at 438.

[110]In general, one's credit suitability for loans is evaluated on the basis of one's present income. There are some exceptions, however, such as student loans to finance post-secondary education.

to the extent that such borrowing is possible, for example through credit cards, the interest rates are prohibitively high.[111]

Shepard and Zeckhauser calculate the impact of age on a person's valuation of life for two different scenarios, to which they attach "Robinson Crusoe" and "Perfect Markets" labels. In both cases, the individual supports her consumption from her own income and wealth, and has no heirs or dependents. In the Perfect Markets scenario, the individual can borrow in the capital markets, in order to support a higher level of consumption earlier in life, and can purchase annuities to insure against variability in her lifespan. In contrast, in the Robinson Crusoe scenario, access to these two markets is unavailable.

The authors show that in the Robinson Crusoe model an individual's valuation of life reaches its peak at age forty. A forty-year old values her life 2.5 times as highly as a 20 year old (that is, returning to the notation previously used, $V_{40,40} = 2.5V_{20,20}$). At first glance, this result might appear counterintuitive. After all, the twenty-year old loses twenty more years of life than the forty-year old. The reason that the

[111]There is potentially a logical inconsistency in believing that individuals cannot process the fact that they will have higher incomes in the future in order to value their lives accordingly, but positing that individuals will borrow money in the expectation of higher income in the future.

forty-year old's valuation is higher, however, is that her income is more than three times higher, and this effect more than counteracts the shorter remaining life.[112]

In turn, in the Robinson Crusoe world, the forty-year old values her life almost twice as highly as a sixty-year old ($V_{40,40} = 1.98V_{60,60}$).[113] Two different effects are at play here. Most obviously, the sixty-year old has fewer years to live. But another factor is depressing the sixty-year old's valuation of her life. Beyond age forty, income continues to rise until age fifty, but consumption begins to fall. The reason is that at age forty, the individual begins to save for retirement and therefore has fewer resources available for current consumption. Indeed, even though income at age sixty is comparable to income at age forty, consumption is about 25 percent lower.[114]

The situation is more straightforward under the Perfect Markets scenario. There, the valuation of life is highest at age 20, and then falls continuously through the life cycle. In this model, the forty-year old's valuation is about two-thirds higher than the sixty-year old's.[115] Here, the difference between $V_{40,40}$

---

[112]See Shepard & Zeckhauser, Life-Cycle Consumption, supra note 107, at 121.

[113]See Shepard & Zeckhauser, supra note 93, at 434.

[114]See Shepard & Zeckhauser, Life-Cycle Consumption, supra note 107, at 121.

[115]See Shepard & Zeckhauser, supra note 93, at 434.

and $V_{60,60}$ is attributable exclusively to the different number of years of remaining life.

To the extent that the assumptions underlying the Robinson Crusoe model are at least partly realistic,[116] one needs to worry about the procedure described in Part I.C in which the sixty-year old's willingness-to-pay to avoid an immediate death, $V_{60,60}$, was used as a proxy (and then discounted) for a forty-year old's willingness to pay to avoid a death twenty years later, $V_{40,60}$. Given the levels of income and savings analyzed by Shepard and Zeckhauser, using $V_{60,60}$ as a proxy for $V_{40,60}$, as was done in Section I.B, will result in an undervaluation of the willingness to pay to avoid death of about 25 percent (as a result of the lower level of consumption at age 60).[117]

This undervaluation, however, may have decreased over time. Shepard and Zeckhauser relied on data from the late 1970s.[118] Certain legal changes since that decade, particularly the end of mandatory retirement and the strengthening of protections against age discrimination, are likely to have affected the impact of age on income. In particular, it is possible that the peak income is received later in life and that the assumption that individuals receive no income after the age of sixty five is now unrealistic.

---

[116]Shepard & Zeckhauser, supra note 93, at 435 (noting that "the real world lies somewhere in between" the two models).

[117]See supra text accompanying note 114.

[118]See Shepard & Zeckhauser, supra note 93, at 433.

These changes would result in increasing the ratio of the sixty-year old's consumption relative to the forty-year old and thereby diminishing the difference in the valuations of $V_{40,40}$ and $V_{60,60}$ in a Robinson Crusoe economy.

In summary, the discussion in this subsection is presented only to illustrate the underlying methodological issues that must be resolved to obtain a plausible estimate of the value of life. More work needs to be done to determine the plausibility of the Robinson Crusoe model and the effects of changes in workplace patterns and legal protections since the 1970s.

c. Distribution of Income Across Occupations

Individuals who take risky jobs generally have lower-than-average income.[119] Thus, there is a problem in extrapolating from the willingness-to-pay studies conducted in high-risk occupations to the broader population affected by environmental carcinogens.

One threshold issue concerns the definition of the population affected by the different environmental programs. In principle, for every environmental regulation, one could attempt to determine the identity, age profiles, and economic characteristics of the affected population. One could then

[119]See Viscusi, Value, supra note 60, at 1942-43 ("the populations of exposed workers ... generally have lower incomes than the individuals being protected by broadly based risk regulation").

construct program specific valuations of life that took into account the distribution of ages and incomes of the affected population, as well of the latency period of the carcinogen subject to the regulation.

There are good reasons for why one might not want to undertake such an evaluation. First, the informational requirements are likely to be daunting. For every environmental program, in addition to estimating the number of affected individuals, one would need to determine their demographic and economic characteristics.[120]

Second, an effect of particularized valuations based on levels of income would be to justify, on cost-benefit grounds, more stringent regulation when the affected population is wealthier. Such a policy would be inconsistent with the central tenet of the increasingly influential environmental justice movement, which calls for environmental regulation to be no less (if not more) responsive to the needs of communities that are disproportionately poor, or disproportionately populated by people of color than to the needs of wealthy, white communities.[121]

---

[120]EPA should, however, vary its valuations of life on the basis of the age profile of the affected population, to account for the different numbers of life-years at stake in various regulatory programs.

[121]For discussion of environmental justice, see Vicki Been,Coming to the Nuisance or Going to the Barrios? A Longitudinal Analysis of Environmental Justice Claims, 24 Ecology

As a result, it is reasonable for EPA to use uniform valuations of life across environmental programs. These valuations would be based on representative characteristics of the population of the United States.[122] Thus, to the extent that the subjects of the empirical studies involving industrial accidents have relatively low incomes, an upward adjustment in their valuations of life must be performed before translating these figures to the environmental context.

The U.S. Census provides median and mean earnings for all workers and for various occupational categories.[123] The category including operators, fabricators, and laborers might be a good

---

L.Q. 1 (1997); Vicki Been, Locally Undesirable Land Uses in Minority Neighborhoods: Disproportionate Siting or Market Dynamics?, 103 Yale L.J. 1383 (1994); Robert D. Bullard, Anatomy of Environmental Racism and the Environmental Justice Movement, in Confronting Environmental Racism: Voices from the Grassroots 15 (Robert D. Bullard ed. 1993); Richard J. Lazarus, Pursuing 'Environmental Justice': The Distributional Effects of Environmental Protection, 87 Nw. U.L. Rev. 787 (1993).

[122]An ethical objection to such particularization would be an attack on cost-benefit analysis in general and to the use of a willingness-to-pay methodology for valuing lives in particular. See Guido Calabresi & Philip Bobbitt, Tragic Choices: The Conflicts Society Confronts in the Allocation of Tragically Scarce Resources 32 (1978) (referring to "the external costs--moralism and the affront to values, for example--of market determinations that say or imply that the value of a life or of some precious activity integral to life is reducible to a money figure"). Nonetheless, using differential valuations of life based on income levels is likely to prove objectionable to some supporters of cost-benefit analysis, and to magnify the objections adduced by opponents of this approach.

[123]The source is U.S. Census Bureau, Historical Income Tables--Persons, Table P-36 (visited June 22, 1998) <http://www.census.gov/hhes/income/histinc/p36.html>.

proxy for workers in risky occupations who are the subjects of empirical studies concerning the value of life. In 1996, the median and mean earnings of all workers 15 years of age and over were $20,716 and $27,366, respectively.[124] The corresponding figures for operators, fabricators, and laborers were $16,883 and $19,981.[125] Thus, the overall median earning is 22.7 percent higher than the median for workers in risky occupations, and the overall mean is 37.0 percent higher.

2. Involuntary Nature of the Harm

a. Comparative Valuations of Voluntary and Involuntary Risks

There is an extensive literature suggesting that individuals assign greater value to avoiding risks that are thrust upon them involuntarily than risks that they incur voluntarily.[126] As Richard Zeckhauser points out, "this tendency would introduce a downward bias in the implicit life valuations of those who voluntarily assume risks."[127]

The risk assumed by individuals who take risky jobs and subject themselves to a non-trivial possibility of industrial

---

[124]See id.

[125]See id.

[126]See Paul Slovic, Perception of Risk, 236 Science 280 (1987).

[127]Zeckhauser, supra note 102, at 445, n.27.

accidents is generally thought of as a risk assumed voluntarily.[128] In contrast, the risk of exposure to environmental carcinogens, for example, as a result of toxic air pollution, is generally thought of as involuntary.[129]

As a result, there will be a systematic undervaluation if one takes the willingness-to-pay to avoid voluntary harms and imports that figure into the context of environmental regulation. Determining the extent of the undervaluation, however, is

---

[128]Cass Sunstein cogently explains, "the question whether a risk is run voluntarily or not is often not a categorical one but instead a matter of degree." Cass R. Sunstein, Bad Deaths, 14 J. Risk & Uncertainty 259, 272 (1997). Sunstein would place risks on a voluntariness-involuntariness continuum based on three factors: whether the worker has adequate information about the risk; whether the worker is compensated for the risk; and whether the compensation package does not appear unfair, even if voluntarily chosen by the parties, as a result of background inequality between the employer and employee. See id.; Shapiro & McGarity, supra note 39, at 734 ("Unfortunately, low-paid workers in hazardous industries where there are no (or weak) unions may act more out of desperation than choice.").

[129]See Maureen L. Cropper & Uma Subramanian, Public Choice Between Lifesaving Programs 6 (World Bank Policy Research Working Paper 1497, 1995). Of course, if an individual is exposed to a toxic air pollutant, she could move somewhere else. Sunstein would nonetheless classify the risk as involuntary because the individuals are not in a contractual relationship with the producer of the risk and cannot avoid the risk except at great cost, in this case by moving to another area. See Sunstein, supra note 128, at 271.

Moreover, in many cases, individuals may lack sufficient information about environmental risks to make informed choices. Even if they had such information, risks that are uniformly distributed throughout the country could obviously not be avoided by moving elsewhere. For further discussion of the difference between voluntary and involuntary risks, see Richard H. Pildes & Cass R. Sunstein, Democrats and Technocrats, Journees d'Etudes Juridiques Jean Dabin __, __ (forthcoming 1998).

complicated.

The economics profession strongly favors "revealed preference" valuations, under which the value assigned to a good can be observed through a market transaction. Willingness-to-pay studies of wage differentials needed to compensate individuals for accepting a risk of death are a prominent example of a revealed preference technique.[130] Revealed preference approaches are poorly suited for determining the valuation of involuntary harms because they are based on the existence of market transactions, and such transactions are generally seen as voluntary.[131]

Thus, in order to estimate how the valuations of involuntary and voluntary risks differ, one needs to resort to a different approach. In recent years, a great deal of attention has been devoted to the implicit valuations of human life derived from

---

[130]See supra text accompanying notes 60-62.

[131]Even studies of how the price of a house in an area with high concentrations of this pollutant compares to the price of an otherwise similar house in an area with better air quality do not capture the value of involuntary risk. While such hedonic price studies are a commonly used revealed preference tool for economic valuations, see Ronald G. Cummings, Louis Anthony Cox, Jr., & A. Myrick Freeman III, General Methods for Benefits Assessment, in Benefits Assessment, supra note 60, at 171-76, the participants in these housing markets are individuals attempting to decide where to live. They are making a choice about whether to live in one area rather than another. As a result, it would be a stretch to regard their "choice" as involuntary. Rather, the involuntary label is better used for individuals who have lived in an area for a long time, have strong personal ties to the area, and lack the resources to move.

dividing the total cost of an environmental program by the number of lives saved. The result, for environmental programs that do not have significant other benefits, is the implicit value that the regulatory program has assigned to each life. The range of implicit valuations for regulatory programs is enormous, from around $100,000 per life to a number in the billions of dollars.[132] To reach any worthwhile conclusions from these implicit valuations, one would need to make the heroic assumption that social expenditures in fact are reflective of public preferences.

Thus, a more promising alternative is to directly question individuals about the relative value that they attach to avoiding voluntary and involuntary harms.[133] In the most comprehensive

---

[132]An extensive list of such references is provided in Heinzerling, supra note 7, at 1983 n. 1, 2. The genesis for these studies is a table prepared in the 1980s by John Morrall, an OMB official. See John F. Morrall III, A Review of the Record, Regulation, Nov./Dec. 1986, at 25, 30 table 4. Heinzerling notes, however, that the regulations with numbers at the high end were never promulgated. Moreover, she argues that the remaining differences would be less stark if Morrall had not discounted the benefits of environmental regulation or reduced the estimates of risk prepared by the agencies. See Heinzerling, supra note 7, at 1984-85.

[133]Their has been strong criticism to valuations based on survey responses. See Richard B. Stewart, Liability for Natural Resource Injury: Beyond Tort, in Analyzing Superfund: Economics, Science, and Law 219, 234-38 (Richard L. Revesz & Richard B. Stewart eds. 1995). Nonetheless, a panel of distinguished economists, co-chaired by Nobel Prize winners Kenneth Arrow and Robert Solow, which had been empaneled by the National Oceanic an Atmospheric Administration (NOAA) gave qualified endorsement to the use of contingent valuation techniques. See 58 Fed. Reg. 4601, 4610 (1993). Clearly, revealed preference valuations would

study of this type, Maureen Cropper and Uma Subramanian conducted a nationwide telephone survey of 1,000 households, asking interviewees to compare an environmental program and a public health program designed to address a particular risk, such as respiratory illness or cancer.[134] The interviewees were first told that the two programs would cost the same amount of money and save the same number of lives, and were asked to determine which program was best for society.[135] Then, they were told that the program that they had found less attractive would in fact save x times more lives than its counterpart. The authors computed the number of lives saved by each program that made the median respondent indifferent between the two programs.

The interviewees were also told to describe some qualitative characteristics for the risk addressed by each of the programs, and, for each characteristic to place the risk on a ten-point scale. One of these characteristics was the ease with which the risk could be avoided,[136] which is a measure of the risk's voluntariness.[137] In each case, the public health risk was deemed

---

be preferable, but, as indicated above, such valuations cannot be used for involuntary harms. See supra text accompanying notes 130-31.

[134]See Cropper & Subramanian, supra note 129, at 2.

[135]See id. at 16-18.

[136]See id. at 3-7.

[137]The remaining characteristics were the extent to which the affected population was to blame for the risk, the seriousness of

to be more voluntary than the environmental risk.[138]

For the purposes of this Article, the most relevant pair examined by the researchers was radon control in homes and a pesticide ban on fruit. Radon control, like workplace hazards, is a paradigmatic voluntary risk: an individual can avoid the risk by making a monetary sacrifice. In contrast, pesticide control, like other environmental risks, generally cannot be addressed effectively absent some level of social coordination. For this reason, the risk should be regarded as involuntary.[139]

The respondents were asked to assess, on a ten point scale, the ease with which the respective risks could be avoided. The mean ratio of the ease with which the radon risk could be avoided to the ease with which the pesticide risk could be avoided was 1.31.[140] When respondents were told that the two programs would save the same number of lives (and cost the same), seventy-two percent chose the pesticide ban and only twenty-eight percent

---

the risk, and whether the risks affected respondents personally. In addition to these four risk characteristics, the respondents were also asked to assess four program characteristics: the efficacy of the program, the appropriateness of government intervention, the fairness of the funding mechanism, and the time before the program begins to save lives. See id. at 39.

[138]See id. at 40.

[139]A labeling program, designating food to be free of pesticide could work effectively if the claims were in fact truthful and adequate information was conveyed to prospective buyers. But social coordination would be necessary to set up the labeling program and to police its integrity.

[140]See id. at 40.

opted for the radon control.[141] The median respondent was indifferent between saving 100 lives by means of the pesticide ban and 213 lives through radon control.[142] Thus, the median respondent implicitly found the life saved imperiled by the involuntary risk to be twice as "valuable."

More generally, the authors found, across the six pairs of risks that they studied, a consistent, statistically significant preference for addressing the less voluntary risk.[143] Moreover, a significant minority of respondents--between 20 and 30 percent--always preferred addressing the involuntary risk, regardless of how many more lives would be saved by transferring the resources to addressing the voluntary risk.[144]

b. Unrepresentativeness of the Population Exposed to Workplace Risks

Another type of adjustment needs to be made when using valuations of life in workplace settings as a second-best measure of the appropriate value of life for environmental programs. Individuals who take relatively risky jobs have a comparatively

[141]See id. at 41.

[142]See id. at 48.

[143]See id. at 24, 41.

[144]See id. at 4-5.

low willingness-to-pay to avoid the risk.[145] Indeed, individuals with higher valuations would demand greater wage differentials to take a riskier job over an otherwise comparable job that was less risky. The employers, however, would not need to pay this higher premium if they could fill their jobs with workers who had lower valuations.

This concept can be illustrated by reference to an auction. The employer with the risky jobs offers a low wage premium and sees how many workers are willing to take the positions. If it does not fill all the vacancies, it offers a somewhat higher premium, and continues this process until it is able to fill all the jobs. Any workers who place a higher value on avoiding the risk end up not getting the job.

As a result, the willingness-to-pay valuations derived from the study of risky jobs are not the valuations of the mean or median member or society. Instead, they are the valuations of a relatively small subgroup with a disproportionate tolerance for risk.

In contrast, environmental risks in general affect a far broader sector of society. Moreover, because they are

---

[145]See McGarity, supra note 1, at 146-47; Kelman, supra note 64, at 144; Viscusi, Value, supra note 60, at 1928.

This effect is discussed even though it has not been the focus of empirical study, see supra text accompanying notes 98-99, because it flows in part from the difference between the voluntary nature of workplace harms and the involuntary nature of environmental harms.

involuntary, there is no easy mechanism for individuals to self-select for such risks based on their lower-than-average valuations of risk.[146] Thus, an appropriate correction needs to be made when extrapolating from the workplace to the environmental arena. No empirical literature, however, sheds light on the magnitude of this correction.

3. Dread Nature of the Harm

There is also an important difference in the nature of deaths resulting from industrial accidents on the one hand and from environmental exposures to carcinogens on the other. The former occur instantaneously and without warning. The latter often occur following a long and agonizing ordeal. As Cass Sunstein pithily notes: "All deaths are bad. But some deaths seem worse than others."[147]

A far greater level of social expenditures is devoted to combating toxic risks like cancer than risks of instantaneous deaths. A recent, admirably comprehensive study by Tammy Tengs and a number of co-authors compares the cost-effectiveness of

[146]Some self-selection can take place with respect to reasonably local risks, such as those that result from proximity to hazardous waste sites. With respect to more regional risks, such as regional air pollution, however, such self-selection is far more difficult.

[147]See Sunstein, supra note 128, at 259.

various risk reduction regulations.[148] The authors first determine the cost per life saved by dividing the direct costs of the regulation by the number of lives saved. Then, they divide this cost per life saved by the average number of years of life saved when a premature death is averted to obtain the cost per life-year saved.[149]

The comparison of costs per life-year saved reveals enormous disparities. The median medical and toxin control measures cost $19,000 and $2,800,000 per life-year, respectively; the overall median is $42,000 per life-year.[150] The authors also found a wide disparity in occupational interventions depending on the nature of the death. The median occupational intervention designed to avert a fatal injury costs $68,000 per life-year, whereas the median occupational intervention involving the control of toxins costs $1,400,000--more than twenty times as much.[151]

But as in the case of the comparison between voluntary harms and involuntary harms, one cannot draw strong conclusions from these disparities because public expenditures may well not reflect people's preferences.[152] Instead, a more direct measure

---

[148]See Tammy O. Tengs, Five-Hundred Life-Saving Interventions and Their Cost-Effectiveness, 15 Risk Analysis 369 (1995).

[149]See id. at 370.

[150]See id. at 371.

[151]See id. at 371.

[152]See supra text accompanying notes 131-33.

of the difference in valuations is preferable.

A study by George Tolley, Donald Kenkel, and Robert Fabian, attempts to quantify the values attached to the avoidance of unforeseen, instantaneous deaths on the one hand and carcinogenic deaths on the other.[153] For each of these risks, the authors define a low estimate, a medium estimate, and a high estimate, and present their figures in 1991 dollars. For unforeseen, instantaneous deaths, the respective estimates, derived from a survey of willingness-to-pay studies, are $1 million, $2 million, and $5 million, respectively.[154]

Because, as indicated earlier, there are no willingness-to-pay studies estimating the value of life lost from a disease with a long latency period,[155] the procedure used by the authors for estimating the value of carcinogenic deaths is more complicated. As their starting point, the authors use the estimates for instantaneous deaths. Then, for their low estimate, they add a component for the value of the morbidity period preceding the death.[156] This value is derived primarily from contingent

---

[153]George Tolley, Donald Kenkel & Robert Fabian, State-of-the Art Health Values, in Tolley, Kenkel & Fabian, supra note 70, at 323, 339-44.

[154]See id. at 339-40.

[155]See supra text accompanying notes 64-66.

[156]But cf. Sunstein, supra note 128, at 269 (an extended period before death can contain benefits, since it allows grief and adjustment).

valuation rather than revealed preference approaches.[157]

As the authors note, this estimate is conservative for two reasons. First, it understates the value of morbidity preceding mortality because conditions that eventually become fatal are more serious than nonfatal, chronic conditions. Second, it does not account for the dread aspects of carcinogenic deaths.[158] The authors account for these two components in their medium and high estimates, relying primarily on a survey of how individuals compare deaths from cancer to deaths from other causes,[159] and on contingent valuations of periods of severe limitations of activity preceding death. The authors' low, medium, and high estimates of the value attached to a life threatened by cancer are $1.5 million, $4 million, and $9.5 million, respectively. Thus, the medium valuation of life in the case of carcinogenic exposure is twice as high as the corresponding valuation for an unforeseen, instantaneous death.[160]

---

[157]See Tolley, Kenkel & Fabian, supra note 70, at 329-32, 340; supra note 133.

[158]See Tolley, Kenkel & Fabian, supra note 70, at 340.

[159]Id. at 340-41; see Michael W. Jones-Lee, Max Hammerton & Peter R. Philips, The Value of Safety: Results of a National Sample Survey, Econ. J., March 1985, at 49, 58-60. For a more recent study finding a higher willingness-to-pay to avoid carcinogenic harms, see Ian Savage, An Empirical Investigation into the Effect of Psychological Perceptions on the Willingness-to-Pay to Reduce Risk, 6 J. Risk & Uncertainty 75, 77, 85 (1993).

[160]For intuitions supporting a higher valuation for dreaded harms, see Mendeloff, supra note 71, at 48; Shapiro & McGarity, supra note 39, at 734, n.29.

F. Choice of a Discount Rate

Parts of the preceding discussion have already hinted as to why the choice of the discount rate used in connection with the valuation of lives is more complicated than merely picking the discount rate used for monetary flows.[161] I can invest $100 today at a 3.5 percent interest rate and have about $200 in 20 years. I cannot invest the utility that I derive from living a year at present and obtain, twenty years later, the utility that I would then derive from living two years.[162] Similarly, I can sell the right to get a payment of $200 in 20 years for a present payment of about $100. I cannot engage in a comparable transaction with respect to the utility that I would derive from living in twenty years. As W. Kip Viscusi notes, "one cannot trade health ... across time ... . If we value our health at forty-five but not at twenty-five, then we cannot simply shift health status across

[161]See supra note 51; infra Part I.F.1; Lave, supra note 72, at 44 ("Discounting future health effects at the standard rate makes sense only if there is a fixed transformation rate between dollars and health."); John Mendeloff, Measuring Elusive Benefits: On the Value of Health, 8 J. Health Pol., Pol'y & Law 554, 568 (1983) ("discount rate for health effects should largely be based upon individuals' time preferences"). But see Victor R. Fuchs & Richard Zeckhauser, Valuing Health--A "Priceless" Commodity, Am. Econ. Rev. Papers & Proc. 263, 264 (1987) (suggesting that life years should be discounted in the same manner as cash flows).

[162]See Farber & Hemmersbaugh, supra note 19, at 287.

time in the same way that we would shift monetary resources."[163]

This section undertakes two separate tasks. First, it reviews empirical evidence suggesting that, despite the conceptual difference between the two, there is no statistically significant difference between the discount rate that individuals apply to future health risks and the discount rate that financial markets apply to flows of money. Second, it criticizes OMB's approach with respect to discounting, especially as applied to future health risks, showing that OMB employs a rate that is inappropriately high.

1. Discounting Health Risks v. Discounting Financial Flows

Thoughtful analysts have recognized that the discount rates applied to financial flows cannot be applied mechanically to the discounting of the utility that comes from living in the future.[164] The most extensive empirical work in this area is that of Michael Moore and W. Kip Viscusi, who seek to determine whether the rates of discount for health risks differ from the

[163]Viscusi, supra note 76, at 131-32.

[164]See John A. Cairns, Valuing Future Benefits, 3 Health Econ. 221, 221 (1994) ("Little is known about individual time preferences with respect to future health, and in particular whether they differ from preferences with respect to future wealth."); Putnam & Graham, supra note 6, at 60 ("Instead of choosing a standard discount rate ... the rate should be based on the ... preferences of citizens.").

financial rates of time preference.[165]

In their most recent article on the subject, Moore and Viscusi estimate the implicit discount rate exhibited by workers facing a probability of instantaneous death as a result of job risks.[166] They employ a temporal model that assumes that all life years are valued equally,[167] and attempt to determine the relationship between wage premiums and job risks as a function of the remaining years of workers' lives (and other relevant characteristics).[168]

For example, consider two workers who have the same life expectancy and are otherwise also identical, but who demand different wage premiums for undertaking a risky occupation. The worker with the higher valuation (who therefore demands the higher wage premium) has a lower discount rate and therefore values more highly than her counterpart the years that she will lose in the future. Alternatively, if two workers who have different life expectancies but are otherwise identical were to

---

[165]See Moore & Viscusi, supra note 92, at S-61 ("One should be cognizant of the ultimate objective of our study, which is to ascertain whether systematic differences exist between rates of time preference for health and financial rates of return.").

[166]See Moore & Viscusi, supra note 92.

[167]See id. at S-53.

[168]See id. at S-57. These studies follow a revealed preference approach, which consists of observing the prices at which market transactions take place. See supra text accompanying notes 130-31.

demand equal wage premiums, the worker with the shorter life expectancy will be exhibiting a lower discount rate: she will be valuing the future years more highly than the other individual.

On the basis of an empirical study of 1463 workers, Moore and Viscusi calculate a real discount rate of 2 percent.[169] The authors note that this real rate "accord[s] roughly with financial market interest rates for the period, once these nominal rates are adjusted for inflation."[170] Their results, therefore, "provide no empirical support for utilizing a separate rate of discount for the health benefits of environmental policies."[171]

---

[169]See id. at S-59, S-61.

[170]Id. at S-59; see supra text accompanying notes 55; note 76 (discussing difference between real and nominal rates).

[171]Id. at S-61; see id. at S-52.

It is worth thinking about how the regulatory system ought to react if, contrary to the findings by Moore and Viscusi, one found that individuals discounted health risks at a very high rate, even when they were well informed about these risks. In such situations, it might be appropriate for the government to act in a paternalistic fashion and make social policy on the basis of a lower discount rate. The rationale would be somewhat analogous to the rationale for the usury laws, which prohibit lending at an overly high interest rate.

The utility of an individual with an unusually high discount rate would increase if she were allowed to borrow at a rate up to her discount rate in order to transfer consumption from the future to the present. The usury laws, however, prevent her from doing so because of concern that she might later experience excessive regret. Similarly, in deciding how stringently to regulate future environmental risks, the government could be skeptical of discount rates for health risks that are high compared to the rates at which money gets transferred through the financial markets.

Empirical findings of high discount rates would at the very

Moore and Viscusi reach this conclusion despite their earlier studies, which had found discount rates in the 10-12 percent range.[172] They maintain that the confidence limits around these estimates were sufficiently large that the results should be thought of as "quite similar."[173] The authors conclude:

> "In each case, the confidence intervals for the discount rate estimates overlap available market rates of return. Moreover, since the point estimate of the discount rate falls short of the market rate in one case and exceeds the market rate in two cases, we find no clear evidence of systematic differences between discount rates for health and financial rates of time preference."[174]

With respect to the control of environmental carcinogens, it is relevant that the authors found that education has a large effect on the discount rate. In a study that found an overall real discount rate of 11 percent, the rates for workers with eight years of schooling and college-educated workers were 15 percent and 5.5 percent, respectively.[175] Thus, to the extent

---

least be troubling and raise difficult questions as to how social policymakers should react. The Moore and Viscusi studies, showing an equivalence between the rates at which individuals discount health risks and the rates at which the market discounts flows of money, make it unnecessary to face this issue.

[172]See Moore & Viscusi, supra note 92, at S-61. The earlier studies are Michael J. Moore & W. Kip Viscusi, Models for Estimating Discount Rates for Long-Term Health Risks Using Labor Market Data, 3 J. Risk & Uncertainty 381 (1990); Michael J. Moore & W. Kip Viscusi, The Quantity-Adjusted Value of Life, 26 Econ. Inquiry 369 (1988); Viscusi & Moore, supra note 95.

[173]See Moore & Viscusi, supra note 92, at S-61.

[174]Id. at S-61.

[175]See Viscusi & Moore, supra note 95, at 314.

that workers in risky occupations have a lower-than-average level of educational attainment, a downward adjustment on the discount rate would need to be made. Thus, for environmental carcinogens, this factor strengthens the authors' conclusion that the discount rate exhibited by financial markets is appropriate.[176]

---

[176]The issue is not entirely free of doubt. For example, a more recent study by Viscusi and a different co-author, using a similar methodology, found real discount rates ranging from 11 to 17 percent, in the context of automobile safety. See Mark K. Dreyfus & W. Kip Viscusi, Rates of Time Preference and Consumer Valuations of Automobile Safety and Fuel Efficiency 79, 84, 99 (1995). The authors note that the riskless rate of interest, which they estimate in the 2-5 percent range, is outside the confidence limit of their estimates. See id. at 99. They note, however, that in many cases consumers face interest rates that are far higher than the riskless rate, and that their estimated discount rate was not statistically different, at a 95 percent confidence interval, from the real rates for the financing of automobile purchases (8.5 percent and 11.0 percent for new and used cars, respectively). See id. at 99-100

Individuals also exhibit inordinately high discount rates with respect to purchases having an effect on energy conservation. Thus, they have not been willing to pay much of a premium on the purchase on products such as air conditioning or heating units in return for lower energy costs in the future. See Jeffrey A. Dubin, Will Mandatory Conservation Promote Energy Efficiency in the Selection of Household Appliance Stocks, 7 Energy J. 99 (1986); Jerry A. Hausman, Individual Discount Rates and the Purchase and Utilization of Energy-Using Durables, 10 Bell J. Econ. 33 (1979); Douglas A. Houston, Implicit Discount Rates and the Purchase of Untried, Energy-Saving Durable Goods, 10 J. Consumer Res. 236 (1983).

These studies, which are discussed in Dreyfus & Viscusi, supra, at 83-84, affect only financial flows and do not raise the question of how to discount future health risks. The problem here may well be that consumers lack clear information on energy savings benefits or cannot properly process this information if they have it, see Wesley A. Magat & W. Kip Viscusi, Informational Approaches to Regulation 5 (1992), or that they violate some of the postulates of rational theory, see George Loewenstein & Richard H. Thaler, Intertemporal Choice, 3 J. Econ. Persp. 181, 182, 192 (1989).

To conclude, it is worth noting that the methodology used to estimate the rate at which individuals discount future utilities may lead to an overstatement of this rate. Recall that Moore and Viscusi assume that all life years are valued equally.[177] This assumption is consistent with the standard approach in life-cycle models, in which the utilities derived from living in particular years are a function solely of the level of consumption available those years.[178] It is plausible, however, that such utilities are affected also by one's age, and that they fall (for a given level of consumption) with increasing age, as a result of the deterioration of one's physical capacity.

For example, at age fifty, one might not be able to engage in the full range of pleasurable activities that one could have undertaken at age thirty. Thus, the choices on how to convert consumption resources into utility at age fifty would be more constrained.[179] If this were the case, part of the lower valuation attributed to later years in one's life would result from the lower utility derived from living during those years, rather than from discounting to reflect the passage of time. As

---

[177]See supra text accompanying note 167.

[178]See supra text accompanying notes 70-71, 107-09; Rosen, supra note 70, at 224.

[179]In fact, the situation may be even more complicated. Children, for example, may increase one's utility. Then, for a given level of consumption, after one has children one's utility might be higher than before.

a result, the discount rate estimated from a model in which utilities are constant across time (or a function only of the magnitude of resources available for consumption) would overestimate the actual discount rate.

2. Selecting an Appropriate Rate

The choice of a discount rate is a key variable in the cost-benefit analysis of many environmental regulations. Because the costs of regulatory programs are typically borne around the time that the regulations go into effect but the benefits, in the case of latent harms, do not accrue for decades into the future, the higher the discount rate, the less desirable the regulation will seem. Recall, for example, that in the Corrosion Proof Fittings case, the present discounted value of the benefits would have been approximately ten times greater under a 4 percent discount rate than under a 10 percent discount rate.[180]

The OMB policy on discount rates does not address specifically the issue of how to discount health risks.[181] Thus, these risks are discounted at the rates used in the evaluation of government projects in general, and government regulation in particular.

Until 1992, OMB employed a discount rate of 10 percent

---

[180]See supra text accompanying notes 36-38.

[181]See Circular No. A-94, 57 Fed. Reg. 53,519 (1992).

pursuant to a policy contained in its Circular A-94.[182] In 1992, OMB amended this circular to mandate a real discount rate of 7 percent.[183] OMB justifies this rate as "the marginal pretax rate of return on an average investment in the private sector in recent years."[184]

The OMB policy, however, uses a different discount rate for cost-effectiveness analysis--that is, to determine which of several programs yielding identical benefits has the lowest cost in present discounted terms. For this purpose, OMB employs the real return on long-term government debt--the interest rate on long-term government bonds minus the rate of inflation.[185] In recent years, this figure has fluctuated between 3 percent and 4 percent.[186]

The use of different rates for cost-benefit and cost-effectiveness analysis can produce perverse results. For example, consider two policies that have the same benefits, which are designed to address a future risk. Policy A costs $700,000

---

[182]See Robert C. Lind, Discounting for Time and Risk in Energy Policy 5-6 (1982). For criticisms, see Daniel A. Farber, Risk Regulation in Perspective: Reserve Mining Revisited, 21 Envtl. L. 1321, 1349-50 (1991); Farber & Hemmersbaugh, supra note 19, at 278; Viscusi, supra note 76, at 129.

[183]57 Fed. Reg. 53,519, 53,522-23 (1992).

[184]Id. at 53,523.

[185]See 57 Fed. Reg. 53,519, 53,520, 53,523 (1992).

[186]See 57 Fed. Reg. 53,519, (1992) (3.8%); 61 Fed. Reg. 6397, 6397 (1996) (3.0%); 63 Fed. Reg. 3932, 3933 (1998) (3.8%).

at present whereas Policy B costs $1,200,000 in 10 years (the figures are in constant dollars). At a 3 percent discount rate, the present discounted value of the cost of Policy B is higher than $700,000, and thus Policy A would be preferred on cost-effectiveness grounds. On the other hand, at the discount rate of 7 percent, which would apply to cost-benefit analysis, Policy B would be more attractive.

Cost-effectiveness analysis can be used as a short-cut to cost-benefit analysis where the benefits of two policies are the same. But logic compels that the policy with the most attractive cost-benefit ratio also be the most cost-effective. This consistency requirement can be violated when the discount rates used for cost-benefit and cost-effectiveness analysis are different. Otherwise a trivial difference, say of $1, in the benefits of the two policies (so that cost-benefit analysis rather than cost-effectiveness analysis must be used) would alter the choice between two policies that are essentially identical.

More fundamentally, however, there appears to be a growing consensus in the economics literature that the appropriate real discount rate for government projects is the real return on long-term government debt--the interest rate on long-term government bonds minus the rate of inflation. The underlying issues are quite complex, but can be simplified considerably for the

purposes of this discussion.[187]

When the government undertakes a regulatory project it is trading costs and benefits on behalf of its citizens. As Frank Arnold notes, "it seems reasonable to discount the future benefits to the present using the same rate that the affected citizens would use, for it is on their behalf that the project is undertaken."[188] This rate, often referred to in the literature as the "consumption" rate of interest,[189] is generally taken to be the after-tax rate of return, adjusted for inflation,[190] on relatively risk-free financial instruments,[191] such as government bonds. In recent years, the economics literature has generally called for the use of a real discount rate of 2 to 3 percent.[192]

---

[187]For clear analyses, see Arnold, supra note 22, at 177-97; Lind, supra note 22. For an excellent primer on discounting, see Lind, supra note 182, at 21-94.

[188]Arnold, supra note 22, at 180.

[189]See id. at 181.

[190]Because income taxes are due on nominal interest, the tax adjustment must be performed first. See Arnold, supra note 22, at 192, n.10.

[191]See id. at 192.

[192]See Arnold, supra note 22, at 192; Viscusi, supra note 76, at 129, 134.

The yield on 30-year Treasury bonds now stands at 5.57 percent, the lowest since auctions on these bonds began in 1977. See Guy Dixon & Candace Cumberbatch, Bond Price Hit New Highs, Lifted by Concerns About Japan and Signals of a U.S. Slowdown, Wall St. J., July 7, 1998, at C19, col. 1. An individual facing a 28 percent federal marginal tax rate would have an after-tax

There is a complication, however. Consider initially two environmental projects undertaken directly by the government, one financed by taxes and the other by borrowing. In the case of the project financed by taxes, the taxes will reduce the consumption of goods, so discounting the benefits at the consumption rate of interest is the appropriate procedure: individuals are simply trading off less consumption now, as a result of the taxes, for future benefits flowing from the project.[193]

The situation is potentially different if the government finances the project through borrowing. In a closed economy, with no capital flows into the country, the borrowing would displace money available for private investment. Because the returns from this investment yields taxes, its displacement would produce a loss to the government, equal to the foregone taxes.[194]

An analytically analogous situation is posed by environmental regulation that imposes costs on firms, if these costs cannot be shifted to consumers. In a closed economy, such investments would displace other private sector projects.[195]

---

return of 4.0 percent. Subtracting the change in the consumer price index for the twelve-month period ending in May 1998, which is 1.7 percent, see U.S. Bureau of Labor Statistics, Consumer Price Index Summary (visited July 8, 1998) <http://stats.bls.gov/news.release/cpi.nws.html>, would result in a discount rate of 2.3 percent.

[193]See Arnold, supra note 22, at 181.

[194]See id. at 184-85.

[195]See Arnold, supra note 22, at 190.

The appropriate discount rate under these circumstances is the marginal pre-tax rate of return on private investment--the rate used by OMB.[196] After this return is taxed by the government, the remaining return must be sufficient to cover the consumption rate of interest. If the return on the government's project was lower, social welfare would be enhanced by not undertaking the government project and thereby not displacing the private investment.[197]

In summary, traditionally, the literature on cost-benefit analysis inquired as to whether the project under consideration displaced consumption or private investment. It used the consumption rate of interest in the former case and the rate of return on capital in the latter.[198]

---

[196]See supra text accompanying notes 183-84.

[197]In the case of environmental regulation, the government is not making the investment, but is instead requiring private parties to make it. The same analysis is applicable, however. See Arnold, supra note 22, at 189-91.

[198]See Arnold, supra note 22, at 180-84; Lind, supra note 22, at S-10, S-11.

The Department of Energy continues to engage in this inquiry:

> "Because the proposed appliance efficiency standard will primarily affect private, rather than public, investment, the Department continues to believe that using the average real rate of return on private investment as the basis for the social discount rate is most appropriate. If the primary impact of the standards were on Federal or other public expenditures, DOE agrees that real interest rates on long term government securities would likely be a better basis."

60 Fed. Reg. 37,388, 37,394 (1995).

In recent years, however, the assumptions underlying this bifurcated approach have been called into question. In particular, increasing globalization has led to the integration of capital markets and the opening of the U.S. economy to foreign investment.[199] As a result, our economy can no longer realistically be viewed as closed. In an open economy, the level of taxable investments is unaffected by environmental regulation because no capital projects are displaced; the government therefore does not lose the corresponding tax revenues. Under these conditions, the consumption rate of interest is the appropriate discount rate.[200]

Consistent with this view, the consumption rate of interest is currently used as the discount rate by the General Accounting Office (GAO) and the Congressional Budget Office (CBO).[201] Even EPA, which must submit its proposed and final regulations to OMB for review under Executive Order 12,866, has used a 3 percent

---

[199]See Arnold, supra note 22, at 184-85; Lind, supra note 22, at S-8, S-9.

[200]See Arnold, supra note 22, at 184-85, 190-91; Lind, supra note 22, at S-8, S-9.

[201]See Ronald G. Cummings, Legal and Administrative Uses of Economic Paradigms: A Critique, 31 Nat. Resources J. 463, 471 (1991); Randolph M. Lyon, Federal Discount Rate Policy, The Shadow Price of Capital, and Challenges for Reforms, 18 J. Envtl. Econ. & Mgmt. S-29, S-30 (1990). For an interesting survey of the different choices of discount rates in federal agencies, see Edward R. Morrison, Note, Judicial Review of Discount Rates Used in Regulatory Cost-Benefit Analysis, 65 U. Chi. L. Rev. 1333, 1336-37, 1364-69 (1998).

discount rate in connection with a proposed regulation designed to address lead-based paint hazards.[202] Other agencies, however, have explicitly linked their discount rate to OMB's.[203]

G. Estimating the Undervaluation of Lives Under OMB's Policy

Section E explains the nature of the corrections that need to be made to intelligently translate the existing valuations of life from industrial accidents to appropriate valuations for environmental harms in general and carcinogenic harms in particular. Section F discusses how to choose an appropriate rate to discount the utility of life-years saved at the end of a latency period. The purpose of this section is to obtain a rough estimate of the underestimation of the value of human life that results from the OMB approach of taking valuations from workplace settings and mechanically reducing them by an inappropritaely high discount rate over the length of the latency period. Because of OMB's role as the arbiter of regulatory analysis under Executive Order 12,866, this undervaluation has important public policy consequences.

Once again, the focus is on comparing the valuation of two

---

[202]59 Fed. Reg. 45,872, 45,872, 45,895-97 (1994).

[203]See 43 C.F.R. §11.84(e)(2) (1997) (Department of the Interior). Ohio v. Department of the Interior, 880 F.2d 432, 464-65 (D.C. Cir. 1989) upheld the Department of the Interior's choice of a 10 percent discount rate for natural resources damages, following OMB's pre-1992 policy, see supra text accompanying note 182.

different forty-year olds: one who faces a probability of instantaneous death in an industrial accident, $V_{40,40}$, and the other who faces a probability of death at age 60 from an environmental carcinogen with a twenty-year latency period, $V_{40,60}$. Recall the two factors that make $V_{40,60}$ smaller.[204] First, assuming, for the sake of simplicity, that these individuals would otherwise die at age 80, the number of life years lost from the carcinogenic risk is only half. Second, the years lost from the carcinogenic harm occur later, and discounting is therefore appropriate; at a discount rate of three percent, the discount factor is 0.55. So, using round numbers, if these two corrections were the only relevant ones, $V_{40,60}$ would be about one-quarter of $V_{40,40}$, reflecting reductions of about one-half each on the account of the discounting and the difference in the life-years saved, respectively.

One should not overlook, however, the corrections on the other side, particularly those resulting from the involuntary nature of the environmental harm compared to the voluntary nature of the workplace harm, and the dread nature of deaths from environmental carcinogens compared to the non-dread nature of deaths from instantaneous industrial accidents. With respect to the first adjustment, the Cropper and Subramanian study, which compares deaths from voluntary and involuntary harms suggests

[204]See supra text accompanying notes 73-75.

that an adjustment by a factor of two is appropriate.[205] As to the second, the study by Tolley, Kenkel, and Fabian finds that avoiding deaths from cancer is valued twice as much as avoiding instantaneous deaths.[206]

There is a question about how to combine the results of these two studies. It is not completely clear that the correction from the Tolley, Kenkel, and Fabian study is based only on the dread nature of the harm, and is not also affected by different degrees of voluntariness of the harm. If the carcinogenic and non-carcinogenic harms compared by these authors shared the same level of voluntariness, then it would be reasonable to multiply the two factors of two, and conclude that an adjustment by a factor of four is necessary to account for the differences in voluntariness and dread.

In contrast, if the carcinogenic harm considered in their estimate is less voluntary than the non-carcinogenic harm, such a correction would be excessive. It is clear that the difference in valuations comes in part from the morbidity that precedes carcinogenic deaths--one component of the dread nature of cancer.[207] Moreover, nothing in the survey on which this study relied for the remainder of the correction focused the attention

---

[205]See supra text accompanying notes 133-43.

[206]See supra text accompanying notes 153-60.

[207]See supra text accompanying note 156.

of the respondents on differences in the level voluntariness.[208] Thus, it seems unlikely that this issue would have played a large role in the valuations.[209]

While further research on these matters is clearly needed, to a first approximation it is reasonable in light of the designs of the two studies to treat the two factors as multiplicative.

Thus, other things being equal, the value of avoiding a death from an involuntary, carcinogenic risk should be estimated as four times as large as the value of avoiding an instantaneous workplace fatality. This upward adjustment thus cancels the two downward adjustments resulting from the fewer number of life-years lost and the discounting for the latency period.

Moreover, other upward adjustments are necessary as well.[210] First, as indicated above, the median salary for all wage earners is about 23 percent higher than the median salary for operators, fabricators and laborers, the U.S. Census category most likely to contain the subjects of willingness-to-pay studies in the context

---

[208]See Jones-Lee, Hammerton & Philips, supra note 159, at 55-56.

[209]In contrast, in the Cropper and Subramanian study the respondents were asked to evaluate the ease with which each of the risks could be avoided. See supra text accompanying notes 136-38.

[210]The upward adjustment resulting from the unrepresentativeness of the risk preferences of the population exposed to workplace risks cannot be estimated as a result of the paucity of the empirical data, though logic compels the conclusion that such workers will have a lower-than-average willingness-to-pay to avoid risk. See supra Part I.E.2.b.

of industrial accidents.[211] Thus, the valuation of lives threatened by environmental carcinogens should be the subject of an upward adjustment of another 23 percent.

Second, economic growth must be accounted for. As a result, based on the 1982-96 period, the discount rate used in making the downward adjustment necessary to account for the fact that the life-years would be lost in the future should be reduced by 1 percent.[212] Thus, accounting for economic growth leads to an upward adjustment of the valuation of life of 22 percent.[213]

As indicated above, the OMB approach is to take the valuations of life from workplace settings and discount them for the length of the latency period at a rate of 7 percent.[214] While this approach does not reduce the valuation to reflect the smaller number of life-years saved,[215] using a 7 percent discount rate instead of a 3 percent rate over a twenty-year latency period leads to a downward adjustment of the valuation by a

---

[211]See supra text accompanying notes 123-25.

[212]See supra text accompanying notes 103-04.

[213]For a twenty year lag, a discount rate of 2 percent reduces the valuation to 67 percent of the undiscounted amount, as compared to a reduction to 55 percent of the undiscounted amount for a 3 percent discount rate.

[214]See supra text accompanying notes 183-84.

[215]See supra text accompanying note 98.

factor of about four, rather than by a factor of about two.[216]

Moreover, the OMB approach neglects to perform any of the necessary upward adjustments. Thus, over a twenty-year latency the approach may undervalue human life by a factor of about six.[217] For contaminants with longer latency periods, the undervaluation would be even greater.[218]

Finally, this estimate of the undervaluation that results from the OMB approach is probably a lower bound. The true figure may well be higher because the calculation is based only on those differences between instantaneous deaths from workplace accidents and deaths from environmental carcinogens that can be quantified on the basis of plausible empirical studies. The preceding discussion has identified two additional possible sources of undervaluation, but the quantification of the impact of these sources is not possible as a result of the lack of relevant

---

[216]The OMB approach, however, avoids the pitfall of using $V_{60,60}$ as the basis for estimating $V_{40,40}$. Such a procedure might lead to undervaluation because of changes over time in the income and saving levels of individuals. See supra Part I.E.1.b.

[217]The adjustments for the dread nature of the harm, the involuntary nature of the harm, the salary differential, and the impact of economic growth are 2, 2, 1.23, and 1.22, respectively. See supra text accompanying notes 204-16. The calculation assumes that all the factors are multiplicative. See supra text accompanying notes 209-10. This assumption should be the focus of empirical study.

[218]See B.T. Westerfield, Asbestos-Related Lung Disease, 85 Southern Med. J. 616 (1992). Some of the adverse consequences of exposure to asbestos have latency periods of 30 and 40 years. See id. at 618.

empirical analysis. First, and probably most importantly, the population exposed to workplace accidents has a comparatively low willingness-to-pay to avoid death, as a result of a disproportionate tolerance for risk.[219] Second, to the extent that, for a given level of resources available for consumption, the utility of being alive at a particular age falls with increasing age, the estimates in the literature of the rate at which individuals discount their future consumption would be higher than warranted.[220]

H. Recasting the Debate

It is now worth highlighting that this Article's approach to discounting in an intragenerational setting does not pose significant ethical issues that are distinct from those raised by cost-benefit analysis in general or the valuation of human life in particular.[221] In principle, one could directly ascertain, through willingness-to-pay studies, the value of lives threatened by latent harms. Because practical problems stand in the way of obtaining such valuations, a second-best measure, constructed in part by means of discounting future utilities, must be used

[219]See supra Part I.E.2.b.

[220]See supra text accompanying notes 177-79.

[221]For discussion of the differences with the intergenerational setting, see infra text accompanying notes 281-83.

instead.[222] The use of such a proxy, however, does not give rise to ethical issues other than those that might exist if the measurement were done directly.

The reason for discounting in the case of latent harms is not that a regulator or some other outsider determines that life in the future is less valuable than life in the present.[223] Instead, discounting simply reflects the fact that the individual who is valuing her own life derives less utility from living a year in the future than in the present.[224] Discounting is therefore necessary to provide an accurate value of the utility that the individual loses in the present as a result of a premature death that might occur in the future.

At the same time, however, discounting is only one of many necessary adjustments that need to be made when valuations in the context of industrial accidents are used as the starting point to construct a value of human life for the purpose of regulating environmental carcinogens. It has no greater call for legitimacy than any of the other adjustments analyzed in Part I.E. As the various empirical estimates show, it is not even dominant in terms of magnitude.[225] Thus, the failure of the regulatory

---

[222]See supra text accompanying notes 65-69.

[223]See supra text accompanying note 35 (discussing Barnes' testimony).

[224]See supra Part I.F.1.

[225]See supra Part I.G.

process to make other adjustments, principally as a result of OMB's approach to the matter, leads to a substantial undervaluation of human life.[226]

The preceding discussion views discounting in this intrapersonal situation raised by the presence of latent harms as an essentially technocratic procedure, which must be undertaken in conjunction with other adjustments of the value of life from instantaneous industrial accidents, in order to obtain a second-best estimate of the value of a human life threatened by latent environmental contaminants. This characterization of the problem may give rise to two types of concerns. Neither, however, calls for a reevaluation of the ethical status of discounting in the case of latent harms.

First, one might worry that an individual's decisions today do not sufficiently protect the person that the individual might become in several decades. This perspective views the individual as a succession of "multiple selves."[227] Its concern is that the individual's current self would make decisions that undervalued

---

[226]See supra text accompanying notes 204-18.

[227]For applications of this concept in the legal literature, see Bruce Ackerman & Anne Alstott, The Stakeholder Society 131-42 (forthcoming 1999); Christine Jolls, Contracts as Bilateral Commitments: A New Perspective on Contract Modification, 26 J. Legal Stud. 203, 210, 219-24 (1997); Christine Jolls, Cass R. Sunstein & Richard Thaler, A Behavioral Approach to Law and Economics, 50 Stan. L. Rev. 1471, 1538-41 (1998); Deborah M. Weiss, Paternalistic Pension Policy: Psychological Evidence and Economic Theory, 58 U. Chi. L. Rev. 1275, 1285-86, 1300-06 (1991).

the interests of the individual's future self by choosing a discount rate that was too high. This formulation gives rise to a typical externality problem and converts a technocratic intrapersonal problem into an ethically-laden quasi-interpersonal one.

The objection, however, would not be confined to the role that discounting plays as a step toward a second-best valuation of human life threatened by latent harms. Precisely the same objection could be lodged against an attempt to measure this value directly through willingness-to-pay studies. One would worry in this context that the wage premiums demanded by individuals would be too low because the future costs would be borne not by their current self but by a future self. The complaint would thus not be attributable to the specific role played by discounting but, more generally, to the process of valuing life itself. Thus, as a formal matter, the objection does not disprove my claim that discounting in an intragenerational setting poses no significant ethical issues that are distinct from those raised by cost-benefit analysis in general or the valuation of human life in particular.[228]

Moreover, such a criticism of revealed preference approaches to the valuation of threats to human life would not be confined to latent harms. Take, for example, an instantaneous industrial

[228]Intergenerationally, the situation is different. See infra text accompanying notes 281-83.

accident in which an individual faces probabilities of both death and serious morbidity. The individual's current self might not have sufficient empathy towards a future self confined to a wheelchair, and might therefore demand too low a wage premium.

More broadly, most decisions that we make have future consequences. Every time that we borrow money, we reduce the resources that will be available to us in the future. Similarly, every current expenditure affects the amount that will be available for future expenditures. To find an externality in each decision with future consequences as a result of the presence of multiple selves would open the door to government regulation of essentially every financial decision that we make. Such an approach would therefore constitute a serious affront to individual autonomy.

Interfering with individual preferences in this manner might be appropriate in the face of fairly egregious myopia. For example, in the somewhat analogous context of social welfare policy, Bruce Ackerman and Anne Alstott note:

> "The aim of liberal policy is not to second-guess [individuals'] choices by supposing that everybody 'ought' to save a lot for retirement if they are to maximize their happiness over their lifetimes. Its mission is more modest but more fundamental. It is to protect elderly citizens against the worse consequences of their earlier psychological myopia. The watchword is not utility maximization but the assurance of dignified existence in old age."[229]

---

[229] See Ackerman & Alstott, supra note 227, at 141.

It would be unwarranted, however, to attack this Article's approach to the problem of latent harms by deploying the machinery of "multiple selves" analysis. Recall that the approach advocated here is to use the after-tax return on riskless investments--a rate that currently stands at between 2 and 3 percent.[230] If this rate were to be trumped as insufficiently protective of the future, one would need to trump every decision to borrow money at market rates of interest. Then, governmental regulation of individual choices in the face of any decision with future consequences would become the norm, rather than a relatively rare club to be wielded only in the face of egregious lack of foresight.

A different type of objection might be raised to the claim that, in the context of latent harms, discounting is a technocratic exercise that does not give rise to difficult ethical choices. Different individuals have different discount rates, but the social decision of how to control latent environmental harms needs to be based on a single rate. Thus, in choosing the rate on which to base social policy, one needs to make some type of interpersonal comparison. Such comparisons, which are highly value laden, are inevitable, even if they are made implicitly by using a common rule of thumb such as basing the policy on the median discount rate.

---

[230]See supra note 192.

Because environmental quality is a public good, once the government acts, individuals will enjoy a uniform level of quality regardless of their individual discount rates. Thus, individuals with a low discount rate would be exposed to more latent harms than they would have preferred, and individuals with high discount rates will be exposed to harms that are lower than they would have preferred (and consequently, perhaps, would have to face too high a current financial sacrifice to fund the policy).

This objection, again, is not particular to the role played by discounting future utilities in the case of latent harms, but can be raised more generally against both cost-benefit analysis and the valuation of human lives. Under cost-benefit analysis, public policy is chosen on the basis of the aggregate valuations of the benefits. Thus, individuals with a particularly high valuation have to accept a policy that is laxer than they would have preferred, whereas individuals with a particularly low valuation face the opposite problem. Similarly, in the case of public policy decisions taken to prevent even instantaneous deaths, individuals who value their lives particularly highly (perhaps because they are unusually wealthy or have a particularly low tolerance for risk) will face a policy that is laxer than they would have preferred.

In summary, to the extent that the valuation procedures discussed in Part I give rise to ethical objections, these

objections should be leveled either against cost-benefit analysis generally or against the valuation of life in particular.[231] If these two techniques survive ethical scrutiny, no substantial independent ethical argument should be raised against the role played by discounting in an intragenerational setting. More generally, it is not defensible to argue that the value assigned by the regulatory process to a human life should be independent of when an individual's life-years are lost, regardless of how the timing affects the individual's own valuation.

II. Harms to Future Generations

As indicated at the outset of this Article, discounting at a rate of return comparable to that earned by financial investments turns the utilities of generations living a few hundred years from now into a negligible present discounted value.[232] Under such conditions, practically no current expenditure for the benefit of relatively distant generations could be justified within a cost-benefit framework. Because many of the consequences of climate change will not manifest themselves for a

[231]For critiques of cost-benefit analysis, see Steven Kelman, Cost-Benefit Analysis: An Ethical Critique, Regulation, Jan./Feb. 1991, at 33; Duncan Kennedy, Cost-Benefit Analysis of Entitlement Problems: A Critique, 33 Stan. L. Rev. 387 (1981). For critiques of the techniques for valuing human lives, see sources cited supra note 64.

[232]See supra text accompanying notes 21-22.

long time,[233] the consequences of discounting at the rate of return of financial instruments may well be to make any plausible expenditure to address climate change fail a cost-benefit test.

The emphasis of many economists on the use of constant discounting models stands in stark contrast to the approach of international environmental law, which has given its unqualified endorsement to an alternative concept to guide intergenerational allocations: the principle of sustainable development. Indeed, the concept of sustainable development figures prominently in the most important agreements concerning international environmental law,[234] including the Stockholm Declaration,[235] the Rio Declaration,[236] and the Framework Convention on Climate Change.[237]

Section A shows that models of discounting harms to future generations cannot be justified merely through appeals to logic.

---

[233]See William D. Nordhaus, Managing the Global Commons: The Economics of Climate Change 4 (1994) ("A complete analysis of the economics of climate change must recognize the extraordinarily long time lags involved in the reaction of the climate and economy to greenhouse gas emissions.").

[234]For a comprehensive list, see 1 Philippe Sands, Principles of International Environmental Law 198-213 (1995).

[235]Stockholm Declaration of the United Nations Conference on the Human Environment, June 16, 1972, 11 I.L.M. 1461.

[236]United Nations Conference on Environment and Development: Rio Declaration on Environment and Development, June 14, 1992, 31 I.L.M. 874.

[237]United Nations Conference on Environment and Development: Framework Convention on Climate Change, May 9, 1992, 31 I.L.M. 849.

Section B reviews the empirical literature concerning how individuals would discount benefits to future generations. The results reveal a strong intuition against the use of constant discounting models. Section C analyzes the serious shortcomings of discounting models when they are used in an intergenerational context. Section D discusses the role of opportunity costs; even if future utilities are not discounted, expenditures for environmental projects might nonetheless be postponed if other investments can yield higher returns. Section E analyzes the principle of sustainable development and shows why it too suffers from serious shortcomings. Finally, Section F presents the outlines of an attractive theory of intergenerational obligations with respect to the environment.

A. Discounting and Appeals to Logic

Some proponents of discounting the benefits to future generations justify their position through appeals to logic, invoking a set of absurd consequences that would inexorably follow if discounting was not performed. Their arguments in this regard are unpersuasive.

1. No Environmental Projects Will Be Undertaken Unless One Discounts at a Market Rate

Some commentators argue that unless environmental benefits are discounted at the rate of return on other investments,

environmental expenditures would always be deferred into the future and ultimately would never be undertaken. For example, Susan Putnam and John Graham state:

> "[I]f a smaller discount rate were to be applied to health than to money, it would always make sense to postpone adoption of public health programs that invest money now for deferred health improvements. In short, society would continually delay risk reduction into the future and impose the burdens on future generations."[238]

Similarly, according to Emmett Keeler and Shan Cretin:

> "[T]he discounting of costs but not benefits ... has a paralyzing effect on a decisionmaker. ... For any attractive program, there is always a superior delayed program which should be funded first. The result is that no program with a finite starting date can be selected."[239]

The idea behind this position is that instead of undertaking the environmental program, one could invest the funds in an alternative project, watch the investment grow, and then address the environmental problem at some time in the future. At this future time, moreover, one would engage in the same calculus and decide to postpone the environmental expenditure once more.

Environmentalists have traditionally favored low discount rates because the costs of environmental protection generally must be borne well before the benefits begin to accrue.[240] Thus, a low discount rate makes a given expenditure seem more

---

[238]See Putnam & Graham, supra note 6, at 60.

[239]Keeler & Cretin, supra note 5, at 303; see id. at 304 ("Delaying any program ... increases its benefit to cost ratio.").

[240]See Arnold, supra note 22, at 178.

desirable. The argument that no environmental programs would be undertaken absent discounting at a market rate turns this view on its head: lack of discounting becomes environmentally undesirable.

There are several responses to the justification of the discounting of environmental benefits by an appeal to a seemingly logical claim that any alternative would lead to the indefinite postponement of environmental expenditures. To begin, regardless of whether one discounted the environmental benefits at the market rate, it would always be desirable to undertake environmental investments that yielded a market rate of return. So, the claim has to be somewhat more modest: that only environmental investments yielding at least a market rate of return would be undertaken. Other environmental projects, in contrast, would be delayed forever because they would always look more attractive in the future, after the funds that would have been allocated to these projects earned a higher rate of return elsewhere.[241]

There is then a seemingly inescapable logic to discounting environmental benefits at the rate of return earned by other investments. If one used a lower discount rate for environmental benefits, environmental remediation projects could pass a cost-

[241]See Nordhaus, supra note 233, at 125 ("If investments in equipment or human capital yield 10 percent annually, it would be inefficient to make investments that yielded only 3 percent."); see id. at 135.

benefit inquiry even though the resources would be best spent elsewhere. The use of a discount rate equal to the rate of return on other projects ensures that only desirable projects pass a cost-benefit test.[242]

Even with this reformulation, however, the appeal to logic assumes implicitly that the costs and benefits of the environmental program will remain unchanged over time;[243] it is because of this invariance that delaying expenditures in order to invest at the market rate of return seems attractive. This assumption, however, is inconsistent with the structure of many environmental problems.

For example, in the case of the remediation of hazardous waste sites under the Superfund program, the damages caused by the contamination are likely to increase significantly over time if the problem is left unattended.[244] If addressed early, a cleanup can take place before the hazardous waste has seeped down to an aquifer, affecting the quality of the groundwater. At this stage, the cost of remediation is comparatively modest and the damage from the contamination (and therefore the benefit of

---

[242]See id. at 125.

[243]See Michael W. Jones-Lee & Graham Loomes, Discounting and Safety, 47 Oxford Econ. Papers 501, 511 (1995); Hillman & Kim, supra note 5, at 200-02; Lipscomb, supra note 94, at S237.

[244]See Lewis A. Kornhauser & Richard L. Revesz, Evaluating the Effects of Alternative Superfund Liability Rules, in Analyzing Superfund, supra note 133, at 115, 118.

undertaking a remediation) is comparatively modest as well.

A few years or decades later, however, the pollutants may have worked their way down to the aquifer.[245] Then, the damage may be far higher, since the pollutants could have destroyed important sources of drinking water. In turn, the costs of remediation would be far higher as well.[246]

Alternatively, certain environmental problems may become irreversible. Once that occurs, any finite expenditure on abatement, no matter how high, will fail to remedy the problem. The costs of abatement will effectively have increased to infinity.

Thus, in deciding whether to undertake an environmental project now, one cannot just do a static calculation of the magnitude of costs and damages on a particular date. One needs also to look at the problem dynamically and determine how the costs and damages would vary over time if the problem were left unattended.

Consider the following simple example. We could remove some soil from the site and incinerate it now at a cost of $110,[247] and the damage from the current contamination is $100, reflecting a

---

[245]See id.

[246]In some cases, in contrast, environmental remediation costs may fall over time as a result of technological innovation.

[247]Even if the cost were less than $100, a static evaluation would counsel against investing in remediation if the funds could be invested in an alternative project with a sufficient return.

small increase in the cancer risk of certain residents in neighboring areas. If one looked at these figures statically, one would decide, on cost-benefit grounds, not to undertake the cleanup. If the problem is left unattended, however, in 10 years the remediation cost would be $500, as a result of the need to pump and treat groundwater, and damage from the contamination would be $600. At that point, the cleanup would be justifiable on cost-benefit grounds. But, for any plausible discount rate, it would be better to spend the $110 upfront to remove and incinerate the contaminated soil, thereby addressing the current $100 damage problem as well as preventing it from becoming a $600 damage problem in the future.

Thus, the situation described above presents three policy options: remediate now, remediate later, or do not remediate. It is desirable to remediate now not only when the current damage is greater than the current cost of addressing this damage, but also when the future damage is greater than the future cost of addressing it, and the increase in costs in the intervening period is greater than the rate of return on other investments.[248]

These features concerning the structure of environmental benefits and costs are no less an issue for climate change than

[248]In practice, the problem is more complicated because the increase in costs and damages is likely to be continuous but the structure of the analysis remains the same.

they are for Superfund problems.[249] Certain climate change problems may be irreversible,[250] and in such cases delaying investment in the environmental project is not an option. More generally, to make intelligent policy choices one needs to know, for example, not only the costs and damages at the time that carbon dioxide loadings in the atmosphere are doubled relative to some baseline, but also how the damage changes over time and the extent to which this damage can be reduced by means of particular policy measures.[251]

In addition, in the case of climate change, there is the possibility of catastrophic consequences.[252] In the face of such consequences, risk aversion would justify undertaking projects even if their expected return was lower than that of other projects.[253]

---

[249]See William D. Nordhaus, Economic Approaches to Greenhouse Warming, in Global Warming: Economic Policy Responses 33, 58 (Rudiger Dornbusch & James M. Poterba eds. 1991) ("we are likely to be increasingly averse to climate change as the change becomes larger").

[250]See Robert C. Lind, Intergenerational Equity, Discounting, and the Role of Cost-Benefit Analysis in Evaluating Global Climate Policy, 23 Energy Pol'y 379, 382 (1995); David W. Pearce et al., The Social Costs of Climate Change: Greenhouse Damage and the Benefits of Control, in Climate Change 1995: Economic and Social Dimensions of Climate Change 185-86 (James P. Bruce, Hoesung Lee & Erik F. Haites eds. 1996).

[251]See Pearce et al., supra note 250, at 214.

[252]See Lind, supra note 250, at 384.

[253]See James K. Hammitt, Outcome and Value Uncertainties in Global-Change Policy, 30 Climatic Change 125, 130 (1995).

Moreover, the view that before addressing environmental programs we should exhaust higher-yielding investments in other areas overlooks important difficulties concerning the transfer of resources across projects.[254] Say, for example, that initially the greatest returns to a given investment would be to improve the educational system of particularly poor developing countries.[255] Over the first twenty years, resources invested in this manner earn a greater return than if they had been placed in an environmental project. Moreover, over this period, the costs of environmental remediation are increasing at a rate lower than the return on the educational investment.

After twenty years, however, the calculus changes. The costs of the environmental project, though less than the resulting benefits, begin to rise at a rate higher than the rate of return to education in the developing country. At that point, it is desirable to take the proceeds of the educational investment and transfer them to the environmental investment.

There is good reason to be skeptical about the feasibility of this transfer. Part of the returns from the educational

---

[254]See Arrow et al., Intertemporal Equity, Discounting, and Economic Efficiency, in Climate Change 1995, supra note 250, at 129, 132 ("society cannot set aside investments over the next three centuries, earmarking the proceeds for the eventual compensation of those adversely affected by global warming"); Farber & Hemmersbaugh, supra note 19, at 297 (same); Lind, supra note 250, at 381-82 (questioning society's ability to make transfers across several generations).

[255]See Nordhaus, supra note 249, at 57.

investment may have been consumed by its beneficiaries, and may therefore no longer be available to fund the environmental project. Other resources may be sunk in long-term investments, such as infrastructure, from which they could not feasibly be extricated.

The transfer of even liquid investments may raise problems. The developing countries (or whatever interest group benefits from the initial allocation) might object to having the resources transferred to address a problem that they attribute to developed countries. Absent their consent, there might be no clear mechanism for effecting the transfer. Of course, one could attempt to deal with this problem ex ante by contracting between the provider of the funds and the temporary recipient. Nonetheless, there are likely to be difficulties enforcing the rights under such a contract.

In summary, the resort to logic must fail. Perhaps the argument could be further recast to state that environmental expenditures should not be undertaken if other projects have a higher return, if the costs and damages associated with leaving the environmental problem unattended do not rise too fast, if the potential for catastrophic environmental consequences in the absence of immediate measures is sufficiently low, and if the difficulties of transferring resources across projects are not insurmountable. Then, of course, the claim made by supporters of discounting would have lost all their bite and would have become

essentially tautological.

2. Failure to Discount Would Lead to the Impoverishment of the Current Generation

A different argument maintains that not discounting the value of benefits to future generations makes it desirable for us to impoverish ourselves down to subsistence levels for the benefit of future generations. As Tyler Cowen and Derek Parfit describe the argument (to which they do not subscribe):

> "We clearly need a discount rate for theoretical reasons. Otherwise, any small increase in benefits that extends far into the future might demand any amount of sacrifice in the present, because in time the benefits would outweigh the cost."[256]

The logic is not limited to our generation. In turn, subsequent generations face the same incentive, and they become impoverished as well. Thus, "failure to discount would leave all generations at a subsistence level of existence, because benefits would be postponed perpetually for the future."[257]

There are two serious problems with the argument. First, it assumes implicitly that the objective of the decisionmaker is to

---

[256]Tyler Cowen & Derek Parfit, Against the Social Discount Rate, in Justice Between Age Groups and Generations 144, 148 (Peter Laslett & James S. Fishkin eds. 1992); see Farber & Hemmersbaugh, supra note 19, at 291; James C. Wood, Intergenerational Equity and Climate Change, 8 Geo. Int'l L. Rev. 293, 321 (1996).

[257]David W. Pearce & R. Kerry Turner, Economics of Natural Resources and the Environment 223-24 (1990); see Morrall, supra note 132, at 28 (without discounting "all rules yielding continuous benefits are worth any amount of immediate costs").

maximize a social welfare function that adds up the interests of all generations. Then, deferring consumption now makes additional resources available for the future, when more people are around to derive utility from them. The question whether it is appropriate to determine our obligations to future generations by reference to an aggregate social welfare function cannot be resolved as a matter of logic. Instead, it must be defended by means of an ethical theory.[258] The argument that all generations will be impoverished unless we discount environmental benefits assumes away the hard ethical choice,[259] and then notes that an absurd conclusion would follow absent discounting.

Moreover, the argument for discounting as a way to avoid impoverishment takes a truncated and fundamentally misleading view of the manner in which one generation affects the welfare of subsequent generations. One component, to be sure, is through its consumption of renewable and nonrenewable resources. Thus, one way in which we could attempt to impoverish ourselves is by foregoing the consumption of such resources.

But to a large extent the standard of living of future

---

[258]For further discussion, see infra Part II.C.

[259]For example, Tyler Cowen and Derek Parfit note:
"[N]o generation can be morally required to make more than certain kinds of sacrifice for the sake of future generations. And this is part of a more general view, which has nothing to do with time. On this view, no one is required to make great sacrifices merely to benefit others."
Cowen & Parfit, supra note 256, at 149.

generations will depend on current investments in areas such as technological knowledge, educational attainment, and productive capacity.[260] Would our generation make those investments if it was wholly deprived of the resulting benefit? The answer, presumably, must be negative--that the level of effort that we bring to the business of making investments with long-term consequences is a function of the benefits that we can realize from those investments.

As a result, a requirement that we impoverish ourselves to leave more resources for future generations could actually decrease, rather than increase, the resources available in the future. One might respond by saying that our generation has an obligation to provide the level of investment that it would have provided under a regime in which it could at least share in the fruits of its labors. That may well be a plausible argument, but it derives from an ethical judgment. Thus, the appeal to logic fails here as well.

In summary, the failure to discount does not inexorably lead to the impoverishment of all generations: it does so only if one makes two ethical judgments: that the appropriate social welfare function adds up the utilities of all generations, and that the current generation has an ethical obligation to invest in a stock of activities affecting long-term well-being even if it cannot

[260]See Robert Solow, An Almost Practical Step Toward Sustainability, 19 Resources Pol'y 162, 168 (1993).

keep any of the resulting benefits.

B. Intuitions About Discounting

Before proceeding further, it is worth reviewing some empirical studies seeking to determine how individuals think about long-term discounting issues. A caveat is appropriate at the outset. If individuals in the current generation indicate that they would discount the benefits of future generations, one should not automatically conclude that the decision reflects a honest ethical judgment. Instead, the judgment of these individuals might be compromised by self-interest. On the other hand, it would be relevant if members of the current generation, despite their self-interest to the contrary, were prepared to make social decisions protective of future generations. Their generosity might be indicative of an ethical intuition that the benefits accruing to future generations should not be discounted very much, or perhaps not at all.

Most of the empirical studies in this area use a similar methodology. Typical of the approach is the questionnaire prepared by Maureen Cropper, Sema Aydede and Paul Portney, which states:

> "Without new programs, 100 people will die this year from pollution and 200 people will die 50 years from now. The government has to choose between programs that cost the same, but there is only enough money for one ... . Which

program would you choose?"[261]

In their surveys, the authors varied the number of lives that would be saved in the future (but kept constant at 100 the number of lives saved in the present). They also varied, between 5 years and 100 years, the time at which the future lives would be saved.[262] From the responses, they computed the discount rates that the respondents assigned to future consequences. The mean of the respondents' discount rates was 8.6 percent, 6.8 percent, and 3.4 percent, for time horizons of 25, 50, and 100 years, respectively.[263] A similar study, conducted in Sweden, calculated discount rates of about 25 percent, 12 percent, and 8 percent, for time horizons of 20, 50, and 100 years, respectively.[264]

---

[261]See Maureen L. Cropper, Sema K. Aydede & Paul R. Portney, Rates of Preference for Saving Lives, 80 Am. Econ. Rev. Papers & Proc. 469, 469 (1992) [hereinafter Cropper, Aydede & Portney, Rates of Time Preference]. For an earlier version of the study, see Maureen L. Cropper, Sema K. Aydede & Paul R. Portney, Discounting Human Lives, 3 Am. J. Agric. Econ. 1410 (1991).

[262]See Cropper, Aydede & Portney, Rates of Time Preference, supra note 261, at 469.

[263]See id. at 471 (Table 1). For studies using shorter time frames, see Cairns, supra note 164, at 222; John A. Cairns & Marjon M. van der Pol, Saving Future Lives: A Comparison of Three Discounting Models, 6 Health Econ. 341, 343 (1997); Horowitz & Carson, supra note 11, at 408; Jan Abel Olsen, Time Preferences for Health Gains: An Empirical Investigation, 2 Health Econ. 257, 259 (1993).

[264]See Johannesson & Johansson, supra note 13, at 331. For an evaluation of the extent to which the framing of the question affects the results, see Magnus Johannesson & Per-Olov Johansson, Saving Lives in the Present Versus Saving Lives in the Future--Is There a Framing Effect, 15 J. Risk & Uncertainty 167, 169 (1997).

More strikingly, another Swedish study sought to compare the seriousness of a leakage of spent nuclear fuel at times ranging between one thousand and almost two million years into the future. Almost one third of the respondents did not discount the future consequences at all. Among those who did, the mean discount rate attached to an accident in the year 10,000 was less than one-hundredth of one percent--practically zero.[265]

The studies reveal an essentially unanimous opposition to the core component of the traditional discounting model: that future consequences should be discounted at a constant rate and that the rate of discounting should be set by reference to the rate of return on particular investments.[266] Instead, the studies show a consistent pattern under which the discount rate falls as

---

[265]See Cropper & Portney, supra note 73, at 375. The study is Ola Svenson & Gunnar Karlsson, Decision-Making, Time Horizons, and Risk in the Very Long-Term Perspective, 9 Risk Analysis 385 (1989).

[266]See supra text accompanying notes 92-97. As three prominent commentators recently explained:

> "[I]f one discounts present world GNP over 200 years at 5 percent per annum, it is worth only a few hundred thousand dollars, the price of a good apartment. On the basis of such valuations, it is clearly irrational to be concerned about global warming, nuclear waste, species extinction, and other long-term phenomena. Yet we are worried about these issues, and are actively considering devoting very substantial resources to them. There appears to be a part of our concern about the future that is not captured by discounted utilitarianism."

Andrea Beltratti, Graciela Chichilnisky & Geoffrey Heal, Sustainable Growth and the Green Golden Rule, in The Economics of Sustainable Development 147, 149 (Ian Goldin & L. Alan Winters eds. 1995).

the time horizon gets longer.[267] Moreover, the discount rate with respect to very long time horizons is well under the rate of return on investments in financial markets.[268]

C. Discounting in a Global Utilitarian Calculus

Thus, at this point the argument has established that the propriety of discounting the benefits to future generations cannot be resolved by appeals to logic. Moreover, empirical studies reveal a moral intuition opposed, over the long-term, to constant discounting at a rate of return comparable to that generated by financial markets. It is now time to focus directly

---

[267]See Olsen, supra note 263, at 262 ("The longer the time horizon, the lower are the implied [discount] rates."); Cairns, supra note 164, at 224-25 ("the further in the future the benefit the lower the rate at which most individuals discount it"); Cairns & van der Pol, supra note 263, at 342 (referring to "increasing evidence ... that individuals do not appear to apply a constant discounting model"); Cropper, Aydede & Portney, Rates of Time Preference, supra note 261, at 471 ("Discount rates are much higher for short horizons than for long horizons."); Johannesson & Johansson, supra note 264, at 174 ("estimated discount rates decrease[] with the time horizon") [Risk & Uncertainty]. One study found a similar result in an intragenerational context. See Loewenstein & Thaler, supra note 176, at 184 ("discount rates declined sharply with the length of time to be waited").

[268]See supra text accompanying notes 264-65 (discussing Svenson & Karlsson study).

In arguing in favor of a constant discounting model, William Nordhaus argues that "it would be unrealistic to make decisions based on the premise that there is, in fact, no time preference given that many social decisions are, in fact, tilted in favor of present generations." Nordhaus, supra note 233, at 123. It is therefore worth emphasizing that the studies discussed in this section reveal a strong moral intuition against such discounting.

on the propriety of discounting.

Most economic formulations of discounting in an intergenerational context posit a social welfare function that aggregates the utilities of individuals in the different generations.[269] For each time period, the utility is multiplied by a rate of pure time preference, which is a measure of the difference in importance attached to current utility as compared to utility in the future.[270] This rate could be zero (the utilities of current and future generations have the equal importance) or positive (the utilities of earlier generations are privileged).[271] The goal of the decisionmaker is to maximize the aggregate utility function.[272]

In this framework, the discount rate that maximizes aggregate utility can be written as follows:

---

[269]See Arrow et al., supra note 254, at 137-38; Cropper & Sussman, supra note 65, at 162; Fuchs & Zeckhauser, supra note 161, at 265; Jones-Lee & Loomes, supra note 243, at 501; Lind, supra note 250, at 385-86.

[270]See Arrow et al., supra note 254, at 130, 134.

[271]In theory, the rate could also be negative, which would imply the privileging of the utilities of later generations.

[272]See Arrow et al., supra note 254, at 134-35; Lind, supra note 250, at 385. If one adds utilities over an infinite time period, the social welfare function will be ill-defined; to avoid this problem, some discounting would be required. See Arrow et al., supra note 254, at 136; Jones-Lee & Loomes, supra note 243, at 507, n.10. As Kenneth Arrow and his co-authors explain, however, [b]ecause even a very small positive discount rate ... would resolve the mathematical issue, this objection has little practical moment." Arrow et al., supra note 254, at 136.

$$d = D + 1g$$

where d is the discount rate, D is the rate of pure time preference, 1 is the absolute value of the elasticity of marginal utility (a measure of the relative effect of a change in income on welfare), and g is the growth rate of per capita consumption.[273]

The pure rate of time preference, D, reflects the fact that if the social welfare function gives less weight to the utilities of later generations, then those utilities must be discounted in order to make them comparable to the utility of the current generation. The term composed of the product of 1 and g has a less direct genesis. Most economic models of discounting assume that individuals in the future will enjoy higher rates of consumption than individuals in the present: more specifically, the level of consumption will increase at a rate of g.[274] The models also assume that individuals exhibit a declining marginal utility of consumption--that is, that a unit of consumption has a greater effect on the utility of an individual with a lower level

[273]Arrow et al., supra note 254, at 130; see Nordhaus, supra note 233, at 123-24; David Pearce, Edward Barbier & Anil Markandya, Sustainable Development: Economics and Environment in the Third World 30 (1990). For the derivation of the relationship, see Arrow et al., supra note 254, at 134-35.

[274]See Arrow et al., supra note 254, at 130; Lind, supra note 250, at 384.

[275]

As a result, if later generations will enjoy a higher level

be increased by allocating some additional resources to earlier generations. The g term represents the amount of discounting that must be performed, in order to maximize social welfare, on

The following subsections deal specifically with each of the two components of the discount rate.

Pure Rate of Time Preference

and Richard Zeckhauser take a strong position in favor of discounting at the rate of return on financial instruments. They

> "Most policy planning discussions assume full altruism future citizens are given equal weight with present citizens--and discount solely for the time value of money.
>
> future generations should be discounted at the time-value-of-money rate."

Terming this approach "full altruism" is somewhat contrived. In fact, it privileges the interests of the current generation to a

---

[275]See Cline, supra note 106, at 249; Arrow et al., supra

[276]
added).

Recall that, at a time-value-of-money rate of five percent,

a billion lives in 500 years.[277]
assume that the population of the world remains constant at about 6 billion people over the next 500 years. Under a model of time

could be justified in order to prevent the death of every living individual in 500 years? Placing a value of life of $5 million,

justify spending now to avert the destruction of the human race in 500 years would be $30 million. (At the OMB rate of 7

definitions of altruism would presumably call for a different result.

compare the value attached to the utilities of individuals in different generations. A pure rate of time preference of zero is

points in time the same weight in the social welfare calculus.[278] Any positive rate simply reflects the preferences of a social welfare evaluator to depreciate the utilities of future

---

See supra text accompanying notes 21-22.

See Robert C. Lind, Intertemporal Equity, Discounting, and Economic Efficiency in Water Policy Evaluation, 37 Climatic

generations.[279]

The ethically compromised status of discounting for time preference at a constant rate can perhaps be best illustrated by the following example. Consider an exceedingly simple economy with 100 units of resources. Two individuals, with identical utility functions, live in this economy: one from year 1 to year 50 and the other from year 51 to year 100. There is no possibility for productive activity; thus, the individuals will be able to derive utility only from the existing 100 units of resources.[280]

In the absence of discounting for time preference, each individual would be allocated 50 units of resources. In the face of a positive rate of time preference, however, even a relatively modest one, the first individual would get the bulk of the resources. It would be difficult to construct an attractive ethical theory that privileged the first individual in this manner merely because she lived fifty years earlier than the second individual.

The possible justifications for discounting for time

---

[279]See Thomas C. Schelling, Intergenerational Discounting, 23 Energy Pol'y 395, 396 (1995) ("To be less interested in the welfare of East Africans than former Yugoslavians is less like 'discounting' than, perhaps, depreciating.' When we count future welfare less than our own we are depreciating generations that are distant in time, in familiarity, in culture, in kinship, and along other dimensions.").

[280]As a result, the issue of growth discounting is not presented by the example.

preference at a positive rate are not compelling. First, one might posit that if discounting for time is appropriate

as well. There is a fundamental difference, however, between the two situations.

a particular individual decides to expend a fixed amount of resources. It is merely a reflection of the individual's

significant ethical questions. In contrast, intergenerational discounting affects the quantity of resources available to each

In an intergenerational context, one must initially decide how to allocate resources to individuals in different

Then, each individual must decide how to time the consumption of resources across her lifetime--a personal decision with no [282] other than a weak concern about

---

[281]Of course, taking a "multiple selves" analysis to its would turn any intragenerational problem into an intergenerational problem.

[282]See Cowen & Parfit, supra note 256, at 155 ("Pure time preference across different lives."). As Joseph Lipscomb notes in the medical context, with respect to future generations weights current decision makers should attach to future population cohorts." Lipscomb, supra note 94, at S246. He adds

excessive myopia.[283]

Some economic models that purport to analyze intergenerational problems construct their utility function by reference to an individual who lives forever.[284] Models of this type collapse the intergenerational and intragenerational aspects of the optimization across generations.[285] Thus, they overlook an important dimension of the problem. One simply cannot avoid making ethical judgments about intergenerational transfers by mechanically importing to this endeavor the intragenerational

---

that this discount rate "need have no relationship to how a given population member (or a statistically representative member) values current versus future gains in health status." Id.

[283]See supra text accompanying notes 227-30 (discussing "multiple selves").

[284]See Lind, supra note 250, at 385 (discussing why other approaches are preferable); Richard Dubourg & David Pearce, Paradigms for Environmental Choice: Sustainability versus Optimality, in Models of Sustainable Development 21, 24 (Sylvie Faucheux, David Pearce & John Proops eds. 1996) ("For maximizing a single utility function ... over infinite time cannot help but suggest that we are dealing with a single generation which exists forever, or even a single individual."). For example, Kenneth Arrow and his co-authors acknowledge that the rate of time preference "is sometimes said to represent discounting for impatience or myopia." Arrow et al., supra note 254, at 131. These are precisely the sorts of psychological characteristics that justify intragenerational discounting.

[285]The problem is fairly pervasive. For example, Kenneth Arrow and his co-authors note that discounting for time preference reflects that "one cares less about tomorrow's consumer than today's, or about one's own welfare tomorrow than today." Arrow et al., supra note 254, at 140. This formulation conflates the intergenerational and intragenerational problems.

framework.[286]

The second possible justification is that time discounting does not show lesser regard for future generations because even though it undervalues the interests of a particular generation relative to an earlier generation, it overvalues its interests relative to a later one. According to this claim, each generation is treated in a comparable way: somewhat worse than its predecessors and somewhat better than its successors.

The claim is not an affirmative argument for discounting. Instead, its ambition is far narrower: it merely responds to one possible argument against discounting. It does not carry the day, however, even in this limited respect. Absent economic growth, as would be the case for example in economies with high levels of consumption, constant discounting for time preference would lead to the progressive impoverishment of subsequent generations. Given the choice between consuming resources in the present and leaving them for future generations one would choose the former because the utilities derived from these resources by later generations would be heavily discounted.

It is true that if discounting actually threatened to impoverish future generations additional resources would be allocated to these generations as a result of the declining

[286]See Lipscomb, supra note 94, at 238 (constant discounting "is basically a political judgment about intergenerational equity").

marginal utility of consumption, which would make the poorer generations value a unit of consumption more. This phenomenon, which is a feature of growth discounting at a negative rate of growth, could mitigate some of the harshness that would otherwise result. The existence of such a safety valve, however, is hardly a ringing endorsement of discounting for the pure rate of time preference.

Yet another argument for discounting for time preference focuses on the greater affinity that the current generation feels for itself and for the generations that immediately follow it. As Kenneth Arrow and several co-authors note, the rate of time preference "may represent discounting for empathetic distance (because we may feel greater affinity for generations closer to us)."[287] By its terms, the statement purports to make a descriptive claim rather than a normative judgment: it does not explain why a social welfare function that reflects such judgments is ethically defensible.[288]

---

[287]Arrow et al., supra note 254, at 131; see Parfit, supra note 21, at 485.

[288]An even narrower view of the role of future generations in the utilitarian calculus is that of Maureen Cropper and Frances Sussman. They explain their approach:

> [E]ach generation receives utility from its own consumption and that of its immediate descendants. Because this is true of all generations, the current generation necessarily takes into account the utilities of all future generations in making its consumption and bequest plans."

Cropper & Sussman, supra note 64, at 170.

This approach has been criticized as unduly privileging the position of the current generation. See Zeckhauser, supra note

Moreover, this argument for discounting is suspect even as a descriptive claim, as the empirical evidence discussed in Part

[289] It is plausible that we would like to future generations we would like to privilege the generations of our children and grandchildren, and perhaps even great-

[290] But discounting at generations continues forever. For example, it seems unlikely that we would value the loss of one billion lives 1000 years no the case if we used a discount rate of 5 percent.[291]

probability that some catastrophe in the future will result in the destruction of human civilization. The point then is that if we are not sure that a future generation will exist, we should

---

102, at 440-41 ("There is the significant issue ... whether ... links that will be truly felt.").

See supra text accompanying notes 261-68.

See Arrow et al., supra note 254, at 137.

See supra text accompanying notes 21-22; Schelling, supra note 279, at 396.

[292]See Arrow et al., supra note 254, at 136; Jones-Lee & Fabian, Future Directions for Health Value Research, in Tolley, Kenkel & Fabian, supra note 70, at 300, 311.

allocate more resources to earlier generations, which are more likely to be around to enjoy the resources. This argument could well justify discounting at a constant rate but it is very unlikely that the rate would be more than infinitesimal.[293]

Also embedded in the claim is an ethical issue. To some extent, the survival of humanity is imperiled by actions of our generations, and of a few generations immediately preceding ours. The consequences of nuclear war are one such example. Over the long run, climate change itself may result in a catastrophic scenario.[294] If we are contributing to the probability of humanity's extinction, should we then invoke this possible outcome as an argument to allocate more resources to ourselves? A quite plausible principle is that the current generation should not benefit in this manner from its externalizing behavior.

Finally, time discounting is sometimes justified on the grounds that over time some kind of countermeasures or cures for environmental problems may be devised.[295] If, indeed, there were a scientific basis to support such an assumption, a welfarist

---

[293]See Arrow et al., supra note 254, at 136 ("Some have argued that the discount rate should be adjusted for the probability of extinction. Plausible estimates of this effect would add very little to the discount rate.").

[294]See supra text accompanying notes 252-53.

[295]See Parfit, supra note 21, at 482; Jones-Lee & Loomes, supra note 243, at 502, n.4; John F. Morrall III, Cotton Dust: An Economist's View, in The Scientific Basis of Health and Safety Regulation 107-08 (Robert W. Crandall & Lester B. Lave eds. 1981).

framework would call for reducing the harm by the probability that ultimately the harm will not in fact accrue. To the extent

aversion would mitigate that reduction.[296]

would be an exceedingly unusual coincidence if the probability that an environmental problem would self-correct just happened to

problem and for every length of time.[297]

formulation, this argument for discounting must be rejected as devoid of any factual basis.

In summary, the arguments for discounting as a result of the pure time preference are not compelling. The confusion

---

[296]See supra text accompanying notes 252-53.

[297]See

[298]

particularized, factually grounded case for a probabilistic reduction of harms.

[299]John Rawls makes the following case against a pure time

> There is no reason for the parties [in the original position] to give any weight to mere position in time. They
>
> civilization. If they make a distinction between earlier and more remote periods because, say, future states of
>
> affairs will seem less important in the future. Although any decision has to be made now, their is no reason for
>
> future's discount of today. The situation is symmetrical and one choice is as arbitrary as the other. Since the
>
> each period, being subject to the veil of ignorance, this symmetry is clear to them and they will not consent to a

surrounding the issue stems, at least in part, from equating intragenerational discounting, which ought not to be considered particularly controversial,[300] with intergenerational discounting,[301] which raises a different set of issues.[302] To

---

principle that weighs nearer periods more or less heavily." John Rawls, A Theory of Justice 294-95 (1971); see id. at 284-98 (setting forth a theory of intergenerational justice). For commentary, see John Broome, Counting the Costs of Global Warming 31, 96-98 (1992); B.M. Barry, Justice Between Generations, in Law, Morality, and Society: Essays in Honour of H.L.A. Hart 268, 276-81 (P.M.S. Hacker & J. Raz eds. 1977).

[300]See supra Part I.H.

[301]Some prominent economists are at the very least ambivalent about discounting for pure time preference. For example, Robert Solow notes:

> "You may wonder why I allow discounting at all. I wonder, too: no generation should be favored over any other. The usual scholarly excuse--which relies on the idea that there is a very small fixed probability that civilization will end during any little interval of time--sounds far-fetched. You can think of intergenerational discounting as a concession to human weakness or as a technical assumption of convenience (which it is)."

Solow, supra note 260, at 165; Robert M. Solow, Intergenerational Equity and Exhaustible Resources, 41 Rev. Econ. Stud. 29, 40 (1973) (expressing doubts as to whether time discounting is appropriate); see Cline, supra note 106, at 249 ("Impatience or "myopia" may be a legitimate basis for a single individual's preferring consumption earlier rather than later in his lifetime, but from society's standpoint it is hardly a justifiable basis for making intergenerational comparisons; Lind, supra note 22, at S-20 (intergenerational discounting "would seem a highly questionable if not immoral public policy"). Kenneth Arrow and his co-authors do not analyze explicitly what the rate of time preference should be, but assume at times that it would be zero. See Arrow et al., supra note 254, at 131.

[302]In practice, the distinction is not as crisp because generations are not successive, but overlapping. The conceptual distinction, however, remains important. For models of overlapping generations, see Burton, supra note 13; Cropper & Sussman, supra note 65, at 169-72. When generations overlap, the

conclude, it is worth noting that even though discounting for time preference is a relatively standard technique in economics, there is a long and respectable tradition, traced to an article published in 1926 by Frank Ramsey, that rejects such discounting in intergenerational contexts.[303]

2. Growth in Levels of Consumption Over Time

It is time to turn to the question of discounting as a result of the growth in levels of consumption over time. Recall that the argument in favor of such discounting rests on the predicted additional wealth of future generations and the decreasing marginal utility of consumption.[304] Given these conditions, growth discounting leads to the maximization of the social welfare function.[305]

Before evaluating the argument for such discounting, it is worth pausing to consider the magnitude of what is at stake. As explained above, the discount rate for growth that maximizes social welfare is the product of g, the growth rate of per capita

---

current generation tends to convey benefits on the next generation even when it is motivated only by its self-interest. See Barry, supra note 299, at 268 (as a result of the overlap "[p]rudent provision for the welfare of all those currently alive therefore entails some considerable regard for the future").

[303]See Geoffrey H. Heal, Discounting and Climate Change: An Editorial Comment, 37 Climate Change 335, 335 (1997).

[304]See supra text accompanying notes 273-75.

[305]See Arrow et al., supra note 254, at 134-35.

consumption, and $\frac{1}{}$, the absolute value of the elasticity of marginal utility. Arrow and his co-authors indicate that most empirical estimates of this elasticity place it in the range between one and two; thus they use the mid-point, 1.5, in some of their calculations.[306] With respect to long-term per capita growth, the central estimate of the Intergovernmental Panel on Climate Change placed it at 1.6 percent.[307] Thus, the rate of discount for growth would be 2.4 percent. This amount is far from inconsequential. It implies, for example, that we would be indifferent between saving one life now and 10.7 lives in 100 years, or between saving one life now and 141,247 lives in 500 years.

This type of discounting gives rise to two important concerns. First, to the extent that subsequent generations are wealthier, they will value the benefits of environmental protection more highly. The standard economic models calculate the environmental damage on the basis of the valuation of the current generation: economic growth implies that later generations will have higher valuations.[308] Standard estimates of the benefits of climate change measures include a reduction in

---

[306]See id. at 131-32, 141 n.10.

[307]See id. at 132.

[308]See supra Part I.E.1.a.

[309] As shown above, the elasticity of this

one.[310]

rate of economic growth.[311]

environmental amenities and natural resources are closely linked to levels of income, and will rise with rising income.[313]

the valuation of all the components of the damage of climate change increased at the rate of economic growth, this factor

greater wealth (when 1

extent of such discounting (when 1

More fundamentally, the growth discounting account assumes implicitly that the benefits of environmental activities are

benefits accrue to individuals who are wealthier than those who bear the costs, the beneficiaries have a lower marginal utility

welfare. This implicit assumption is highly questionable. Most

---

See Cline, supra note 106, at 116-19; Pearce et al., supra note 250, at 195, 198.

[310]See supra text accompanying note 100.

[311]See Heinzerling, supra note 7, at 2051.

[312]See Cline, supra note 106, at 101-106 (discussing species

[313]
7, at 2051.

studies of the impact of climate change show that the damages will be suffered disproportionately by individuals in poor developing countries: Bangladesh, for example, is likely to be particularly affected by sea level rises.[314] In contrast, the contribution to the global warming problem lies to a large extent with the developed countries, and financial responsibility for mitigation measures will be borne primarily by these countries.[315]

Currently, the United States and Bangladesh have per capita gross national products (GNP) of $26,980 and $240, respectively.[316] The figures differ by a factor of about 112. It is quite unlikely that in 100 years or so Bangladesh and the United States will have the same per capita GNP. Thus, to the extent that the United States is paying for the environmental measures and Bangladesh is benefiting from them, the kind of growth discounting contemplated in the standard economic models

---

[314]See Cline, supra note 106, at 110-12.

[315]See Schelling, supra note 279, at 399.

The 1990 Amendments to the Montreal Protocol on Substances that Deplete the Ozone Layer marked the first time that a developing country's adherence to the provisions of an international environmental treaty was linked to the receipt of financial resources. See 1 Sands, supra note 234, at 269. As Philippe Sands points out, these amendments "introduced a radical and innovative change which has had profound consequences on the negotiation of subsequent global environmental treaties." Id. This change is evident in the provisions of the 1992 Climate Change Convention which requires developed countries to provide financial assistance and technological assistance to developing countries. See id. at 740-41.

[316]World Bank, GNP Per Capita (visited July 24, 1998) <http://www.worldbank.org/depweb/gnp/gnpaas01.htm>.

is clearly inapposite. In order to maximize the social welfare function, a lower factor would have to be used to reflect the fact that even when the benefits of climate change measures begin to accrue, Bangladesh will be poorer than the United States.

It is quite possible that even in a hundred years Bangladesh's per capita GNP, in constant dollars, will be lower than the per capita GNP in the United States is now. Then, in order to maximize the social welfare function, one would have to apply a negative discount rate. Such a rate would justify spending more now than the benefits in the future because the benefits in the future would accrue to individuals with lower levels of consumption, and hence higher marginal utilities of consumption.

One might object to this line of argument on the grounds that citizens of the United States have no obligation to improve the lot of Bangladesh. Such a position is certainly debatable, but it resides outside the domain of utilitarianism, where the concept of discounting future utilities has its intellectual home. In the example described above, where in constant dollars the per capita GNP in Bangladesh in 100 years is lower than the current per capita GNP in the United States, a negative discount rate does maximize the social welfare function and is the policy that should be chosen on utilitarian grounds.

This discussion points to an obvious anomaly. If we are prepared to be serious about utilitarianism in the

intergenerational context, why do we not take it seriously in the intragenerational context? Doing so would imply a large increase in the aid from developed to developing countries, where the marginal utility of consumption is far higher as a result of the much lower per capita GNP.

One can, to be sure, construct a plausible ethical theory under which greater current foreign aid is not compelled but mitigation measures for climate change are. The depressed economic status of developing countries might not be the direct consequence of any actions by the developed countries, although the issue is not uncontroversial. In contrast, any damages that might affect developing countries as a result of climate changes are caused to a large degree by energy consumption patterns in the developed countries.[317] So, the developed countries might have an obligation to mitigate a problem that they caused and yet not have a similar obligation to reduce a level of inequality that they did not cause.

It is difficult, however, to reconcile such an ethical theory with welfarist approaches. Whether the lower level of per capita GNP in developing countries is caused by climate change or not, it still results in a higher marginal utility of

[317]The differences in the patterns of per capita energy consumption between developed and developing countries are stark. See International Energy Agency, Climate Change Policy Initiatives 28, table 3 (1992). Over time, this share of the responsibility might decrease, as developing countries industrialize.

consumption. If the purpose is to transfer resources to where they will produce the greatest increase in utility, the cause of

rejection of utilitarianism to justify the low current levels of foreign aid would call into question its selective invocation to

generations of environmental measures.[318]

maximizing only the aggregate social welfare function of the relevant polity. With respect to the analysis of foreign aid,

would then be justified only to the extent that donors in a wealthy country derive utility from helping recipients in a

recipients.

In the context of climate change, given the global nature of

obligations merely by reference to that nation's aggregate social welfare function. Indeed, the standard economic formulation of

and no commentator that I am aware of argues for a more

Perhaps, however, there is a concern that direct foreign aid would not be spent wisely by the recipient, or could create

serious, long-term environmental investments could be that the most desirable way of providing foreign assistance.

constrained view. Perhaps one could construct a defensible theory under which the relevant polity changed with the nature of the problem, but it could not be derived solely from utilitarian principles and would have to be grounded on some nonconsequentialist ethical norm.

Growth discounting also inappropriately merges the decision concerning the desirability of a project with distributional considerations. Under cost-benefit analysis, projects are undertaken based on the aggregate willingness to pay of the beneficiaries. Because the government undertakes large numbers of projects and regulatory initiatives, the losers with respect to one governmental intervention may well become winners with respect to another. It therefore does not make sense to suffer social welfare losses with respect to an individual project simply to obtain a more desirable distribution of resources.

After aggregating all projects, however, the set of policies that maximizes net social welfare across the population as a whole might impose significant net costs on a subset of the population. To the extent that such inequities persist, the government can effect redistribution intragenerationally through the income tax system. Such an approach generally gives rise to fewer distortions and is therefore more desirable than compromising the social welfare consequences of individual

projects.[319]

In contrast, under growth discounting the amount invested in an environmental project will be less than would be justified by reference to the aggregate willingness to pay of the beneficiaries. Thus, the efficiency of each individual project would be compromised in order to effect redistribution.

It is true, of course, that intergenerational redistribution is more difficult to achieve than its intragenerational counterpart. For example, if we allocate more to the current generation in order to improve the aggregate social welfare but feel that such a policy imposes net costs on future generations, there is no easy means to compensate future generations. In theory, we could tax ourselves to create a trust fund that future generations could tap into at predetermined times, but there is a high likelihood that the money would become an attractive target in the future for our generation, or for intervening generations. Thus, the durability of the arrangement over the long-term could not be assured.

A different problem would arise if social welfare were to be maximized by allocating resources to future generations in a

---

[319]See Louis Kaplow & Steven Shavell, Property Rules Versus Liability Rules: An Economic Analysis, 109 Harv. L. Rev. 713, 744-45 (1996); Louis Kaplow, The Optimal Supply of Public Goods and the Distortionary Cost of Taxation, Nat'l Tax J., Dec. 1, 1996, at __, __. For discussion of the distributional consequences of environmental policy, see Richard L. Revesz, Foundations of Environmental Law and Policy 102-03 (1997).

manner that imposed unacceptably high net costs on the current generation--the phenomenon that underlies the growth discounting approach. There is no obviously desirable mechanism by which we could tax future generations in order to compensate ourselves.[320] While we could consume suboptimally high levels of renewable and nonrenewable resources, such consumption imperils social welfare in a way that is avoided by redistribution through the tax system. A better alternative is to finance measures that benefit the current generation through long-term debt, the burden of which would eventually fall on future generations.

These difficulties suggest that the benefits of intragenerational redistribution through the tax system will not be fully available intergenerationally. Nonetheless, these difficulties do not necessarily call for conflating the resource allocation and distribution inquiries, as growth discounting does. Instead, one needs to ascertain, as one typically does in the intragenerational context, whether bifurcating the inquiry and performing the redistribution through a different mechanism would reduce undesirable distortions.

D. Role of Opportunity Costs

My argument should not be read to imply that discounting has no role to play in the intergenerational context. For example,

[320]See Farber & Hemmersbaugh, supra note 19, at 300.

consider a harm that could be averted either now or in the future. In this scenario, assume that if the problem were addressed in the future, funds could be invested now in other projects and then transferred at a later time to avert the harm. The most that it would be worth paying to avert the future harm now is the present discounted value, at the rate of return generated by these alternative projects, of the amount that would be needed if the problem were addressed in the future. Regardless of the nature of our obligation to future generations, it makes no sense to spend more when we can achieve the same result for less.

A similar result could attach even to an irreversible environmental problem. Consider an environmental harm that can be remedied only through a current expenditure: if the problem is not addressed now, it cannot be successfully addressed in the future. Even if the objective were to transfer resources to a future generation, it might nonetheless be preferable to leave the problem unattended if alternative investments would yield a higher rate of return. Then, the future generation would have to face the environmental harm but would enjoy, for example, the fruits of greater investments in technological innovation.[321]

The substitutability of environmental and non-environmental

[321]The substitutability of these future benefits is discussed below in the context of the principle of sustainable development. See infra Part II.E.

benefits can be seen most clearly from the vantage point of a utilitarian perspective. The utilitarian objective is to deploy society's resources in whatever way increases aggregate utility by the largest amount, not to prevent specific environmental harms. Suppose that aggregate utility would increase by transferring current resources to a future generation. If a given investment of resources would yield a larger return in a non-environmental project, the utilitarian calculus would favor this investment over an environmental investment yielding a lower return.

One might conclude at first glance that my disagreement with advocates of discounting the utilities of future generations is only semantic. It might appear, indeed, that taking account of opportunity costs in deciding whether to undertake environmental projects for the benefit of future generations leads to the same results as discounting the utilities of those generations.

Indeed, consider the following two procedures. Under the first, one undertakes any project for which the current cost (in foregone utility for the current generation) is greater than the present discounted value of the utilities of the future generation that the project is intended to benefit. Under the second procedure, one does not discount the utilities of future generations, but undertakes the project only if the rate of return of the investment is greater than the rate of return of alternative investments (otherwise even if resources are worth

transferring into the future, the alternative investments will be preferable).

As is almost self-evident, these two procedures will yield the same results in certain cases. These procedures, however, are both conceptually different and can yield different results in other cases.

Most importantly, discounting the utilities of future generations is a means for determining our obligations to those generations. It is the objective function of a specific ethical theory. In contrast, paying attention to opportunity costs does not imply the choice of any particular theory. It is simply a way of ensuring that society furthers its chosen theory, whatever that theory may be, in the most cost-effective way possible.

For example, suppose that a societal goal is in fact to prevent certain types of irreversible environmental harms, as may be the case under formulations of the principle of sustainable development.[322] We would still defer expenditures for environmental projects if alternative uses of the funds could have a higher rate of return over a given period. But at the point at which such a harm was about to become irreversible, we would undertake the environmental expenditure to prevent this outcome regardless of the rate of return on other projects. Moreover, in deciding how long to delay the expenditure, one

[322]See infra text accompanying notes 343-44.

would have to consider whether funds invested in other projects could easily be transferred at a later time to the environmental project.[323] In contrast, if the social objective were to maximize a discounted social welfare function, the expenditure would never be undertaken if the present discounted value of the benefits was lower than the costs.

Similarly, under a corrective justice approach countries responsible for environmental degradation would have an obligation to mitigate the adverse effects of such degradation. It would nonetheless be appropriate to delay expenditures if alternative interim investments were to yield a higher rate of return. But, at some point, the mitigation would have to be tackled. In contrast, the approach of discounting the utilities of future generations could provide a different prescription altogether.

E. Intergenerational Obligations and Sustainable Development

There is virtual agreement that the central function of the principle of sustainable development is to guide intergenerational allocations.[324] Because this principle is

---

[323]See supra text accompanying notes 254-56.

[324]See, e.g., Gary D. Meyers & Simone C. Muller, The Ethical Implications, Political Ramifications and Practical Limitations of Adopting Sustainable Development as National and International Policy, 4 Buff. Envtl. L.J. 1, 6, 9-10 (1996) ("The core idea of sustainability, then, is the concept that current decisions should not impair the prospects for maintaining or improving

strongly endorsed in international environmental law agreements,[325] it is important to ascertain the extent to which it sets forth an attractive theory of intergenerational obligations.[326]

Before turning to this task, however, one must at least attempt to convert what is still quite an amorphous concept, which suffers from the lack of a uniform definition,[327] into a

---

future living standards."); Edith Brown Weiss, Intergenerational Equity: A Legal Framework for Global Environmental Change, in Environmental Change and International Law: New Challenges and Dimensions 385, 385 (Edith Brown Weiss ed. 1991) ("Sustainable development rests on a commitment to equity with future generations.").

For a strong critique of the concept of sustainable development, see Wilfred Beckerman, Through Green-Colored Glasses: Environmentalism Reconsidered 143-60 (1996).

[325]See supra text accompanying notes 234-37; Dubourg & Pearce, supra note 284, at 27 ("[S]ustainability has become a common policy objective of many government institutions, international agencies, and non-governmental organisations.").

[326]Some commentators link the attractiveness of sustainable development with criticisms of discounting approaches: "There appears to be a part of our concern about the future that is not captured by discounted utilitarianism. Perhaps as much as anything it is this that is driving an interest in formalising the concept of sustainability." Beltratti, Chichilnisky & Heal, supra note 266, at 149.

[327]See David Hodas, The Climate Change Convention and Evolving Legal Models of Sustainable Development, 13 Pace Envtl. L. Rev. 75, 77; Christopher D. Stone, Deciphering Sustainable Development, 69 **Chi.-Kent L. Rev.** 977, 978 (1994); Averil Rothrock, Oregon's Goal Five: Is Ecologically Sustainable Development Reflected?, 31 Willamette L. Rev. 449, 451 (1995); Mary Pat Wiliams Silveira, International Legal Instruments and Sustainable Development: Principles, Requirements, and Restructuring, 31 Willamette L. Rev. 239, 243 (1995). For general discussion of the principle, see 1 Sands, supra note 234, at 198-213.

tool that can actually guide decisions. The starting point to most discussions in this area is the language in Our Common Future, the 1987 report of the World Commission on Environment and Development (often referred to as the Brundtland Report, after its chair, the then Prime Minister of Norway).[328] This report defines sustainable development as development that "meets the needs of the present without compromising the ability of future generations to meet their own needs."[329] This statement, however, leaves open wide room for disagreement.

Perhaps the two most influential perspectives on what obligations to future generations are encompassed by the principle of sustainable development are those of Edith Brown Weiss and Robert Solow, which are rooted in the traditions of international law and of economics, respectively.[330]

Weiss equates sustainable development with intergenerational

One commentator has suggested that over 70 definitions of the term exist. See Susan L. Smith, Ecologically Sustainable Development: Integrating Economics, Ecology, and Law, 31 Willamette L. Rev. 261, 276 (1995); see also John Peezey, World Bank Environment Paper Number 2: Sustainable Development concepts: An Economic Analysis, App. A (1992) (presenting an extensive list of definitions).

[328]World Comm'n on Environmental and Development, Our Common Future (1987).

[329]Id. at 43.

[330]See Weiss, supra note 324, at 401-05; Solow, supra note 260.

equity, which she defines by reference to three principles.[331] First, the principle of conservation of options requires each generation to preserve the natural and cultural resource bases, so that the options available to future generations are not unduly restricted. Second, the principle of conservation of quality requires each generation to prevent a worsening of the planet's environmental quality. Third, the principle of conservation of access requires each generation to provide its members with equitable rights of access to the legacy of past generations, and to conserve this access for the benefit of future generations.[332]

In contrast, according to Solow, sustainability requires that each future generation have the means to be as well off as its predecessors. He gives content to this principle by proposing a modification to the traditional measure of a nation's economic activity. From Net National Product (NNP)--Gross National Product (GNP) minus the depreciation of fixed capital assets--he would subtract the value of expended nonrenewable resources and environmental assets like clean air and water.[333] Solow argues that each generation must use its nonrenewable and

---

[331]The following two paragraphs are adapted from Revesz, supra note 319, at 307-08.

[332]See Weiss, supra note 324, at 401-05; Edith Brown Weiss, In Fairness to Future Generations: International Law, Common Patrimony, and Intergenerational Equity 40-45 (1988).

[333]See Solow, supra note 260, at 162-63.

environmental resources in a way that does not detract from the ability of future generations to have a similar standard of living.[334] He admits that certain unique and irreplaceable resources, like certain national parks, should be preserved for their own sake,[335] but maintains that the consumption of non-unique natural and environmental resources ought to be permissible as long as they are replaced by other resources such as equipment or technological knowledge.

The two formulations share important characteristics. First, they define the primary obligation to future generations in terms of a constraint that specifies how much must be left to a subsequent generation.[336] Second, Weiss and Solow would both allow some level of destruction of most natural resources, as long as future generations are compensated in another way, such as by technological development.[337] Third, they both regard

---

[334]See id. at 167-68.

[335]See id. at 168.

[336]Compare Weiss, supra note 324, at 404 ("The principle of conservation of quality requires that we leave the quality of the natural and cultural environments in no worse condition than we received it.") with Solow, supra note 260, at 167 ("If sustainability means more than a vague emotional commitment, it must require that something be conserved for the very long run.").

[337]Compare Weiss, supra note 324, at 404 ("[W]e may exhaust more reserves of a natural resource and cause modest levels of pollution, but pass on a higher level of income, capital, and knowledge sufficient to enable future generations to develop substitutes for the depleted resource and methods for abating or removing pollutants.") with Solow, supra note 260, at 168 ("Most

certain natural resources as irreplaceable and would require that such resources be protected for subsequent generations.[338]

In essence, then, under both formulations, every generation must provide the subsequent generation with the means to do at least as well as it did. So, for example, sustainable development would be consistent with the current generation seeking to maximize its own utility, as long as this maximization is subject to a constraint resulting from the need to leave sufficient resources to future generations.

There are, of course, daunting challenges ahead in providing further specificity to the principle. For example, additional work needs to be done to determine how to value the increase in knowledge or the negative long-term environmental effects of economic activity.[339]

Also, throughout history, there has been a progressive increase in standards of living. Should the constraint defining

---

routine natural resources are desirable for what they do, not for what they are. It is their capacity to provide usable goods and services that we value. Once that principle is accepted, we are in the everyday world of substitutions and trade-offs.").

[338]Compare Weiss, supra note 324, at 403 (we "must proceed extremely cautiously" with respect to the possible destruction of a "unique natural resource) with Solow, supra note 260, at 168 ("It makes perfectly good sense to insist that certain unique and irreplaceable assets should be preserved for their own sake.").

[339]See Solow, supra note 260, at 163 ("So far ... the proper adjustments needed to measure the stocks and flows of our natural resources and environmental assets are not being made in the published national accounts.").

one generation's obligation to its successors thus provide for a progressive increase in well-being, so that this pattern may continue? On what basis would that increase be determined? What would be the ethical underpinnings for such a requirement?

Moreover, the link between sustainable development and population policy is not well articulated.[340] The population in any generation is a function of decisions of prior generations.[341] For example, one might argue that if the current generation's actions were to lead to an increase in population, it would have an obligation to provide additional resources so as not imperil the level of wellbeing of an average person in the next

---

[340]Michael Jacobs, The Green Economy: Environment, Sustainable Development and the Politics of the Future 84 (1991) ("The final objection which might be made to our definition of sustainability is that it ignores population growth"); Michael Redclift, Sustainable Development: Exploring the Contradictions 29 (1987) ("The concept of 'sustainability' makes little sense ... unless we consider the impact of rapid population growth on the physical resource base."); Nafis Sadik, Population, Environment, and Sustainable Development, in In the Aftermath of the Earth Summit 21, 23 (Andreas Gettkant ed. 1993) ("The universal acceptance of the strong links between sustainable development and the preservation of the environment does not extend to the links between these two and the population policy."). But see President's Council on Sustainable Development, Population and Consumption Task Force Report 13-32 (1997) (discussing how population growth is linked to sustainability).

The link to population does not play a role in the discussions by Weiss, supra note 324, at 401-05, and Solow, supra note 260.

[341]For an exploration of the ethical consequences of this link, see Parfit, supra note 21, at 351-441; Broome, supra note 86, at 161-62.

generation.[342]

Many commentators also believe that the concept of sustainable development contains a precautionary principle, which prescribes that scientific uncertainties be resolved in favor of environmental controls.[343] As discussed above, there is some possibility that catastrophic events would materialize in the future if the climate change problem is left unattended.[344] The precautionary principle would presumably call for avoiding such consequences. In fact, given that technological advances may greatly contribute to the wealth of future generations, it may be that the precautionary principle will do most of the work in justifying climate change expenditures.

---

[342]See Jacobs, supra note 340, at __ ("[I]t could be argued that what sustainability demands is not simply a constant level of environmental capacity but a constant per capita or per person level."); Richard Baldwin, Does Sustainability Require Growth?, in The Economics of Sustainable Development, supra note 266, at 51, 52 ("The simple fact is that current population growth rates, if they were maintained, would lead to an unsustainable world population.").

[343]See Gregory D. Fullem, The Precautionary Principle: Environmental Protection in the Face of Scientific Uncertainty, 31 Willamette L. Rev. 495, 501 (1995); Alexandre Kiss, The Rights and Interest of Future Generations and the Precautionary Principle, in The Precautionary Principle and International Law: The Challenge of Implementation 19, 27 (David Freestone & Ellen Hey eds. 1996); Bernard A. Weintraub, Science, International Environmental Regulation, and the Precautionary Principle: Setting Standards and Defining Terms, 1 N.Y.U. Envtl. L.J. 173, 177-78 (1992). For a discussion of the status of the precautionary principle in international environmental law, see 1 Sands, supra note 234, at 208-13.

[344]See supra text accompanying notes 252-53.

Left unanswered in the academic discussions concerning the precautionary principle, however, are important questions about its scope. For example, what probability of a catastrophic event is sufficiently high to trigger the operation of the principle? Similarly, what is a sufficiently harmful consequence?[345] Spending the resources needed to avoid a low-probability, catastrophic outcome might interfere with the ability to make resources available to subsequent generations. How should this tradeoff be resolved?

This background on the scope of the principle of sustainable development is sufficient to permit an evaluation of the extent to which the principle can form the basis for a desirable theory of intergenerational obligations with respect to environmental matters. At a very general level, the principle appropriately underscores that the current generation, which has control of vast decisionmaking authority concerning the resources that will be available in the future, should not simply ignore the interests of future generations.

Beyond this level of generality, however, the principle of suffers from severe shortcomings. Most importantly, in practice it is likely to impose too limited an obligation on the current generation. Say, for example, that the current generation, for a comparative small sacrifice, can prevent a very large harm to a

[345]These issues are explored briefly in Revesz, supra note 319, at 330-31.

subsequent generation. Perhaps an expenditure of only $1 at the present would lead to averting harm of several hundred billion dollars in 100 years. Even if the future benefit were discounted at a high level, the present discounted value of the benefit would greatly exceed the corresponding cost.

The principle of sustainable development, however, would not require this expenditure if the subsequent generation would, despite the harm, be better off than the current one. Thus, if the next hundred years can be expected to bring sufficiently rapid technological progress, the environmental expenditure would not need to be undertaken. In fact, because the rate of technological progress is currently so high, the principle of sustainable development could in fact remove from the current generation any obligation to undertake environmental measures for the benefit of future generations.

While this issue is of less direct practical importance, the principle of sustainable development could, in theory, demand excessive sacrifice from the current generation. Say, for example, that absent some intervention, the generation living 100 years from now would be $1 poorer than the current generation, and that for an expenditure of several hundred billion we could confer upon that generation an extra $1. The principle of sustainable development would require the expenditure, despite

the obvious waste in resources.[346]

These shortcomings of the principle of sustainable development serve to underscore the relative attractiveness of utilitarian approaches. Consistent with such approaches, in an intragenerational context, the social decisionmaker would seek first to undertake all projects that have desirable cost-benefit ratios. Then, if the resulting distribution of resources was unattractive, the social decisionmaker would require redistribution. In a utilitarian framework, redistribution is justified as a result of the fact that poorer individuals have a higher marginal utility of consumption; total utility is therefore increased by redistributing from rich to poor.[347]

The costs of effecting redistribution (whether in the form of transaction costs or perverse incentives) play an important role in determining how much redistribution is socially desirable. Indeed, sufficiently high costs could dominate the benefits that would come from transferring resources from wealthier individuals, with a lower marginal utility of consumption, to their poorer counterparts.

In an intergenerational context, the inquiry could be essentially the same: pick projects with good cost-benefit ratios and redistribute as guided by reference to the relative marginal

---

[346]In this context, the principle of sustainable development has the same features as the maximin principle.

[347]See supra text accompanying notes 314-16.

utilities of consumption and by the costs of effecting redistribution. In contrast, the principle of sustainable development requires expenditures with unattractive cost-benefit ratios, fails to require expenditures with attractive cost-benefit ratios, and is oblivious to the costs of effecting redistribution.

F. Toward a Theory of Intergenerational Obligations

The articulation of a complete theory of intergenerational obligations with respect to environmental matters is beyond the scope of this Article. Nonetheless, the preceding discussion can be crystallized into a set of principles setting forth the backbone for such a theory.

First, the mechanical importation of discounting for time preference at the rate used intragenerationally is wholly unjustified: how one individual decides to time her expenditure of a fixed set of resources over her lifetime is a fundamentally different question from how society allocates a given set of resources among individuals in different generations.[348] Intergenerationally, discounting for time preference is an unjustifiably undervalues the interests of future generations.

Second, discounting for economic growth is also fraught with problems. Most importantly, the formula used in the standard

[348]See supra text accompanying notes 281-86.

economic models ignores the fact that the primary contributors to international environmental measures are far wealthier than the primary beneficiaries of such measures. In fact, even in the future when the benefits of measures undertaken now actually accrue, these beneficiaries are likely to be poorer than the contributors to such measures are now. Under these circumstances, any positive discounting for economic growth would be inappropriate. To the contrary, given the decreasing marginal utility of consumption, a utilitarian framework would call for environmentally protective measures even if the current costs are somewhat greater than the future benefits.[349]

Third, a theory of intergenerational obligation must play close attention to opportunity costs. Even though it is inappropriate to discount the utility functions of future generations, it does not make sense to undertake environmental expenditures for the benefit of future generations if the investment can yield higher benefits elsewhere, and if no ethical obligations are compromised by delaying expenditures.

Fourth, consistent with the principle of sustainable development,[350] an attractive theory of intergenerational obligations should seek to prevent catastrophic harms and the destruction of unique natural resources. Admittedly, however,

---

[349]Other objections to growth discounting are discussed at supra text accompanying notes 308-11.

[350]See supra Part II.E.

the dividing line between the use of everyday renewable and nonrenewable natural resources, and the destruction of unique resources may be hard to draw in particular circumstances.

Fifth, proper attention needs to be given to distributional issues. As in the intragenerational context, one should not compromise the efficiency of a particular environmental policy in the name of distributional concerns, but one should be prepared to redistribute if the aggregate effects of such policies lead to unattractive distributional outcomes. In the intergenerational context, the mechanisms for redistribution are more cumbersome,[351] but the issue nonetheless merits attention.

Sixth, an attractive theory of intergenerational obligations is likely to contain a corrective justice component. Within a traditional utilitarian framework, one cannot explain the moral intuition that industrialized nations have a responsibility to mitigate the adverse effects of climate change, but not to effect massive current redistributions of wealth to poorer countries.[352] To the extent that the current pattern of expenditures and concern on the part of industrialized countries derives from a moral intuition concerning differential levels of responsibility for the two situations,[353] this intuition should be an element of

---

[351]See supra text accompanying notes 319-20.

[352]See supra text accompanying notes 316-17.

[353]See supra text accompanying note 317.

a theory of intergenerational obligations.

Conclusion

This Article shows that the lack of a proper understanding of discounting has led to bad regulatory decisions in the case of latent harms and to an undesirable skewing of the debate in the case of harms to future generations.

If two individuals of the same age are exposed to latent harm from an environmental carcinogen and a risk of instantaneous death, respectively, the person exposed to the carcinogen stands to lose fewer life-years and to lose them later in life. Discounting is an appropriate technique for taking account of the latter factor. The use of discounting, however, will lead to misleadingly low valuations of life unless it is coupled with significant upward adjustments to account for the dread and involuntary nature of environmental carcinogens as well as for higher income levels of the victims. Unfortunately, the regulatory regime has failed to recognize the need for such adjustments.

With respect to harms to future generations, the Article shows that the use of discounting is ethically unjustified. It privileges the interests of the current generation without a defensible foundation.

The misguided approach to discounting in the two contexts

may be attributable in part to a fairly generalized failure to take proper account of the differences between the cases of latent harms and harms to future generations. For the former, discounting raises no significant ethical objections that are independent of those that could be raised against cost-benefit analysis in general and the valuation of human lives in particular. For the latter, in contrast, discounting gives rise to daunting ethical issues.

This Article aims to effect two important public policy changes. With respect to latent harms, it seeks to provide an impetus for correcting the substantial undervaluation of environmental benefits that comes from the regulatory system's approach of mechanically taking valuations of life from the workplace setting and discounting them at an artificially high rate, without performing any of the necessary upward adjustments. With respect to harms to future generations, it seeks to move the debate away from discounting and towards more attractive alternatives.