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THE COST OF TIME: HAPHAZARD DISCOUNTING AND THE UNDERVALUATION OF REGULATORY BENEFITS

*Arden Rowell**

When performing cost-benefit analyses, regulators typically use willingness-to-pay studies to determine how much to spend to avert risks. Because money has a time-value, when a risk is valued is inextricable from how much it is valued. Unfortunately, the studies on which regulators rely are insensitive to this fact: they elicit people's willingness to pay for risk reductions without identifying the time at which the risk reduction will occur. Relying on these time-indeterminate studies has led to a systematic skew in regulatory cost-benefit analysis, toward the undervaluation of risks to human lives. Insofar as cost-benefit analyses inform regulation, this suggests that the current system systematically under regulates against risks to health and safety.

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INTRODUCTION

To perform cost-benefit analyses, regulators often trade off immediate costs with benefits that will not accrue until some future time. How this trade-off is performed has important implications, particularly where—as with climate change, nuclear power, and the preservation of endangered species—most of the benefits of a regulatory action will be enjoyed by the future.

How do regulators value risks to the future? At first glance, much the way they value immediate risks: they rely on studies that measure people's willingness to pay for a risk reduction and assume that those preferences are constant across contexts. If study participants are, on average, willing to pay $80 to ameliorate a risk of 1-in-100,000 of dying from cancer, regulators assume that preventing a single cancer death will justify an expenditure of $8 million.[1]

But an expenditure of $8 million . . . when? If the cancer death will not occur until twenty years from now, regulators assume that it will be appropriate to spend $8 million to prevent the death in twenty years. To determine how much to spend *today* to reduce the future (or "latent") risk, regulators "discount" the value of the risk reduction to modern-day dollars. They do this on the assumption that money has a time-value: a dollar today is worth less than a dollar twenty years from now, because money can be invested and made to grow. The

1 When these calculations are used to monetize mortality risks, they are often referred to as finding the "value of a statistical life" (VSL). The term is somewhat misleading, as the "value of a statistical life" reflects neither the amount any single person would pay to save a life nor the amount any group of people would pay to save a single life. It is merely the aggregated amount of people's valuations of (typically very small) statistical risks. *See* Eric A. Posner & Cass R. Sunstein, *Dollars and Death*, 72 U. CHI. L. REV. 537, 560 (2005) (noting the unfortunate pervasiveness of the term "valuation of statistical lives," and proposing "valuation of statistical mortality risks" as a less misleading alternative).

effect of discounting is marked: at a 7% discount rate—a rate currently recommended by the Office of Management and Budget[2]—regulators would be willing to spend only $2 million today to prevent the future cancer death.

This approach is highly controversial.[3] For the purposes of this Article, however, I take current practice on its own terms[4] and make a basic internal point. The point is this: study participants may discount too.

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2 The Office of Management and Budget (OMB) is responsible for coordinating and reviewing regulatory analyses. *See* Exec. Order No. 12,866, 3 C.F.R. 638, 640 (1993), *reprinted in* 5 U.S.C. § 601 (2006). OMB currently recommends that regulators use a 7% discount rate as a default and that they prepare analyses with both 3% and 7% discount rates. *See* OFFICE OF MGMT. & BUDGET, EXEC. OFFICE OF THE PRESIDENT, CIRCULAR A-4 ON REGULATORY ANALYSIS 33–34 (2003) [hereinafter OMB CIRCULAR A-4]. These rates have yet to be reviewed by the Obama administration. Post-2008 market conditions may well lead to a lower default rate, as the discount rate is primarily a measure of opportunity for economic investment.

3 Because discounting implicates difficult legal, political, philosophical, and economic concerns, the controversy arrives on many fronts. For objections to the project of monetization, see Frank Ackerman & Lisa Heinzerling, *Pricing the Priceless: Cost-Benefit Analysis of Environmental Protection*, 150 U. PA. L. REV. 1553, 1562–63 (2002). For objections to aggregating economic preferences to guide political decisionmaking, see ELIZABETH ANDERSON, VALUE IN ETHICS AND ECONOMICS 190–216 (1993); AMARTYA SEN, RATIONALITY AND FREEDOM 286–88 (2002). For a discussion of the negative distributional implications of relying solely on willingness to pay, see Cass R. Sunstein, *Valuing Life: A Plea for Disaggregation*, 54 DUKE L.J. 385, 422–39 (2004). For a discussion of the appropriate discount rate, see DISCOUNTING AND INTERGENERATIONAL EQUITY (Paul R. Portney & John P. Weyant eds., 1999); RICHARD A. POSNER, CATASTROPHE 150–55 (2004); William J. Baumol, *On the Social Rate of Discount*, 58 AM. ECON. REV. 788, 793–96 (1968); Daniel A. Farber & Paul A. Hemmersbaugh, *The Shadow of the Future: Discount Rates, Later Generations, and the Environment*, 46 VAND. L. REV. 267, 279–89 (1993). For a useful overview of alternatives to preference-based accounts of welfare, see MATTHEW D. ADLER & ERIC A. POSNER, NEW FOUNDATIONS OF COST-BENEFIT ANALYSIS 28–35 (2006) (discussing mental-state, objective-good, and preference-based accounts). For a discussion of various framing and data effects that affect current VSL measurements, see generally W. Kip Viscusi & Joseph E. Aldy, *The Value of a Statistical Life: A Critical Review of Market Estimates Throughout the World*, 27 J. RISK & UNCERTAINTY 5 (2003) (considering a variety of factors, including unionization, income, and age).

4 That is, I assume that it is appropriate to manage at least some risks through the regulatory system; that cost-benefit analysis and monetization are helpful processes; that people's willingness-to-pay for goods—such as risk reduction—should inform policy; and that future regulatory benefits should—once monetized—be discounted at the market rate, just like any other money. In previous work, I have offered a partial defense of these assumptions. *See* Cass R. Sunstein & Arden Rowell, *On Discounting Regulatory Benefits: Risk, Money, and Intergenerational Equity*, 74 U. CHI. L. REV. 171, 181–86 (2007). For a more detailed discussion of these issues, see *infra* Part I.

This point will turn out to be very inconvenient for regulators. To see why, consider the example above. The initial study found that, on average, people were willing to spend $80 to ameliorate a cancer mortality risk of 1-in-100,000. Regulators used this figure to calculate both the amount they would spend now to prevent a single cancer death today ($8 million) and the amount they would spend now to prevent a single cancer death in twenty years ($2 million). To avert the risk of one hundred cancer deaths in twenty years, then, regulators would be willing to spend $200 million today.

But if participants in the study gave their initial valuations on the assumption that the cancer death would come (if it did come) not today, but at some time in the future—then these numbers are completely wrong. In that case, the $80 figure was the participants' current valuation of the future risk—which means that it was *already discounted* by study participants.[5] If study participants made the same assumptions as the regulators—if they assumed that it would be twenty years until they might die from the cancer risk they faced, and if they applied a 7% rate,[6] then the underlying valuation of the harm is not $80, it is $310—the amount you get if you invest $80 at a 7% return over twenty years. This means that, to prevent one immediate death from cancer, regulators should be spending not $8 million, but $31 million. And if $31 million is the correct underlying figure, then regulators should be spending $8 million today per cancer death avoided in twenty years—quadruple the amount they would spend under the current system.

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5 Behavioral evidence suggests that people do discount future events and at positive rates. *See, e.g.*, Anna Alberini et al., *Willingness to Pay for Mortality Risk Reductions: Does Latency Matter?*, 32 J. RISK & UNCERTAINTY 231, 243 (2006) (finding that delaying the time at which the risk reduction occurs by ten to thirty years decreases the willingness to pay for reduced mortality risk by more than half for respondents forty to sixty years old). But even if study participants did not discount—or more formally, discounted at a 0% rate—it would be inappropriate for regulators to discount their valuations, as present values should not be discounted.

6 For simplicity's sake, this example spells out what would happen if people discounted like regulators do—if they applied a single, flat discount rate over time. There is robust behavioral evidence that people's actual discounting behavior is not this consistent: people in fact exhibit what is called "hyperbolic discounting," meaning that they place a very high premium on goods they get immediately, and apply a steeply declining discount rate thereafter. *See* Shane Frederick et al., *Time Discounting and Time Preference: A Critical Review*, 40 J. ECON. LITERATURE 351, 360–62 (2002) (summarizing evidence of hyperbolic discounting). To the extent that people do discount hyperbolically, the effect I am identifying is significantly *magnified*, because even a very small amount of perceived latency would lead to very large devaluation.

This is a relatively conservative estimate of how much double discounting could affect analyses, because it assumes a relatively short latency period. As the latency period increases, the effect of any double discounting increases as well. If both study participants and regulators assumed a forty-year latency period and applied a 7% discount rate, regulators would spend only 1/15 of what they ought to spend, as measured against what people would actually be willing to spend for the future benefit. And at a one-hundred-year latency, such as could exist for longer term issues like global warming, regulators would be valuing future benefits at less than 1/800 of their actual value.[7]

What does this mean for regulators? It means that, to the extent that any willingness-to-pay study participants have perceived *any* latency in *any* of the risks they have valued over the past thirty-odd years—and as I discuss in more detail below, this describes many of the studies that regulators rely upon—regulatory cost-benefit analysis systematically undervalues risk reductions. And where regulators discount future risks, they are *re*discounting already-discounted valuations. To the extent that cost-benefit analysis affects regulatory policy, this means that regulatory policy is systematically (albeit inadvertently) *underprotective* against risks to public health and safety.

So that is the basic concern of this Article: regulatory analyses systematically undervalue the benefits of regulation. Practical readers will note that there is a seemingly straightforward solution to this issue: if this problem arises from time-indeterminate studies, then it can be solved by using better studies, ones which identify the time at which risks are being valued. And indeed, this is my initial recommendation: that regulators use time-explicit monetization studies. Unfortunately, the choice of how to make monetization studies time-explicit turns out to be highly normatively charged, and requires a sophisticated and necessarily controversial account of intertemporal

7 If study participants assumed that there was a forty-year latency and applied a 7% discount rate, they would be willing to spend only $534,000 to secure an $8 million benefit in forty years; if regulators assumed a forty-year latency period as well, they would be willing to spend only $35,676.95 today to prevent the future risk—about 1/15 what they should be spending. If study participants assumed that there was a one-hundred-year latency between when they were making a payment and when the benefit would accrue—a period that might be reasonable for long term issues such as global warming, nuclear waste disposal, or the existence of species—then at a 7% discount rate, they would be willing to pay $9,219.60 today to gain the future benefit. If regulators discounted this figure over one hundred years at 7% again, they would end up spending only $10.63 for the benefit. That would be 1/867 or 1/10% of what they should be spending, as measured against what people would actually be willing to pay today for the future benefit.

choice. I do not attempt to develop that account here. I merely outline two defensible approaches to valuing future risk, and argue that either would be a significant improvement over current practice. Further recommendations will be addressed in future work.

This Article is primarily concerned with drawing the outline of the problem. Accordingly, it starts in Part I with an orientation into the application of economic cost-benefit analysis to regulatory risks. Readers who are already familiar with debates about discounting and monetization may wish to skip to Part II, where I begin my analysis of how agencies value risks across time. That Part focuses particularly on the studies and methods used by the Environmental Protection Agency. It concludes that current practice undermines much of the value of monetizing risk reductions, because it inadvertently introduces a systemic downward bias into the valuation of the benefits of regulation. Part III outlines a (partial) solution for remedying this bias and flags additional concerns in selecting a methodology for measuring risks across time. Part IV addresses potential objections and Part V identifies some additional implications of time-indeterminacy in other contexts.

I. TIME, MONEY, AND RISK: AN ORIENTATION

The analysis that I undertake in Part II is based upon a number of assumptions about time, money, and risk.

This Part seeks to explicate some of these assumptions. It proceeds in three sections. The first looks at the relationship between risk and money, and explains why this Article assumes that monetizing risk is helpful to regulatory policy. The second addresses the relationship between time and money. It describes the time-value of money and explains why future monetary amounts must be discounted before they can be meaningfully compared to present-day monetary amounts. The third identifies how the relationship between risk and time operates with money as an intermediary. It explains why this Article assumes that future monetized risks must be discounted just like money.

A. Risk and Money

Economists generally assume that regulatory benefits—such as increased safety against risks to life and health—can be dealt with just like money.[8] But monetization remains controversial, particularly

8 *See* John J. Donohue III, *Why We Should Discount the Views of Those Who Discount Discounting*, 108 YALE L.J. 1901, 1904–06 (1999); Robert W. Hahn, *The Economic Analy-*

among those who are concerned that money cannot accurately represent the worth of nonmonetary goods.[9] The more we are concerned that money does not capture the entire "worth" of a good, the less helpful we will find economic cost-benefit analyses, as these analyses will portray less and less of the total worth of the goods being compared.

But even if we think that money is a deeply incomplete measure of some goods, monetized valuations are still useful as informational floors, particularly where money will be spent to secure the good in question. A person considering whether or not to adopt a second child might want to know that she is likely to spend at least $10,930 per year on child-rearing costs.[10] If she chose to adopt the child under those circumstances, an observer might reasonably conclude that, at the time of her decision, she was willing to pay *at least* $10,930 a year to add the child to her family. Of course it is possible—even likely—that she is willing to "pay" far more, in both money and other goods (for example, emotional investment). And other people (grandparents, friends, the state, the child himself) might be willing to pay additional amounts of various goods for the adoption to take place. But none of that suggests that it is incorrect to speak of the mother as willing to pay (at least) $10,930 a year to adopt the child or that it is any less helpful for the mother to know the expected monetary cost before she commits to the adoption.

The same methodology applies to the valuation of risks. If people are willing to spend $50 to reduce their risk of dying tomorrow in an automobile crash by 1 in 100,000, then policymakers can take that as evidence that reducing that risk is worth *at least* $50. Reducing the risk may, of course, be worth far more than that in emotional cost, for example. And it might be worth significantly more than that even in dollars if policymakers include the preferences of the study participants' families,[11] or if the study was structured to capture minimum

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sis of Regulation: A Response to the Critics, 71 U. CHI. L. REV. 1021, 1026–27 (2004). For various economic perspectives on the issue, see generally DISCOUNTING AND INTERGENERATIONAL EQUITY, *supra* note 3 (offering essays of renowned economists on the use of discounting).

9 *See, e.g.*, Ackerman & Heinzerling, *supra* note 3, at 1564–65 (arguing that human life "is not a commodity and does not have a price").

10 The U.S. Department of Agriculture estimates that a two-parent family with a "middle" income (between $45,800 and $77,100 combined) spends between $10,930 and $12,030 on each child. *See* CTR. FOR NUTRITION POLICY & PROMOTION, U.S. DEP'T OF AGRIC., EXPENDITURES ON CHILDREN BY FAMILIES 7 (2007), *available at* http://www.cnpp.usda.gov/Publications/CRC/crc2007.pdf.

11 Some stated preference studies do elicit people's willingness to pay both for themselves and their families. *See, e.g.*, TED MILLER & JAGADISH GURIA, THE VALUE OF

willingness-to-pay rather than maximum willingness-to-pay.[12] But even where willingness-to-pay studies only provide a minimum valuation, they are still useful to inform policy decisions.

B. Time and Money

Money has a time-value—a dollar today is worth more than a dollar next year—so monetary amounts that accrue at different times must be adjusted before they can be compared to one another. When future monetary values are adjusted to their present value, the process is called "discounting."

Much of the time-value of money comes from the possibility of investment: in any functioning economy, money can be put to use and made to grow.[13] People also exhibit "pure time preference" for money, meaning that—even without investment opportunities—people prefer to receive a dollar now than a dollar in twenty years.[14]

The rate at which money is predicted to gain value determines the economic discount rate.[15] Predicting the future value of money is a chancy enterprise, as it requires the prediction of return on invest-

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STATISTICAL LIFE IN NEW ZEALAND 4–5, 25–26 (1991) (determining the value of a statistical life based upon household willingness to pay and finding that 35% of respondents were also willing to pay some amount to benefit the general public). Whether or not to include so called "disinterested preferences" into cost-benefit analysis remains a debated topic. For an argument that agencies should disregard non-self-regarding preferences, see ADLER & POSNER, *supra* note 3, at 133–36.

12 Or if the study were structured to elicit willingness-to-accept instead of willingness-to-pay. Willingness-to-accept studies routinely elicit far higher numbers than willingness-to-pay numbers. For a review of the empirical literature comparing the two methods, see John K. Horowitz & Kenneth E. McConnell, *A Review of WTA/WTP Studies*, 44 J. ENVTL. ECON. & MGMT. 426, 435–40 (2002). For an argument that regulatory cost-benefit analyses should be adjusted in response to the disparity between the two types of studies, see Jack L. Knetsch, *Environmental Policy Implications of Disparities Between Willingness to Pay and Compensation Demanded Measures of Values*, 18 J. ENVTL. ECON. & MGMT. 227, 230 (1990).

13 For a very helpful overview, see generally Geoffrey Heal, *Discounting: A Review of the Basic Economics*, 74 U. CHI. L. REV. 59 (2007).

14 For a discussion of "pure time preference," see Richard L. Revesz, *Environmental Regulation, Cost-Benefit Analysis, and the Discounting of Human Lives*, 99 COLUM. L. REV. 941, 997–1002 (1999) (arguing that pure time preference has different implications for intra- and inter-generational discounting). For an argument that pure time preference is irrational, see Tyler Cowen & Derek Parfit, *Against the Social Discount Rate*, *in* JUSTICE BETWEEN AGE GROUPS AND GENERATIONS 144, 155 (Peter Laslett & James S. Fishkin eds., 1992).

15 I speak only of the discount rate for money—also described variously as the market discount rate, the descriptive discount rate, and the economic discount rate. There is significant debate about whether this rate should be applied to non-monetary goods—as to whether there should be a "social discount rate." For an overview of

ment, among other factors.[16] Perhaps unsurprisingly, the choice of the appropriate discount rate remains quite controversial.[17]

The choice of a discount rate is made no easier by the scale of the stakes involved. Frequently, the choice of discount rate will be solely responsible for determining whether a regulation looks to be cost-justified.[18] That is because discounting is the flipside of compound interest.

As you may recall from high school math, compounding interest adds up quickly. Consider the classic example of the "penny doubling game," where the player starts with a series of boxes in front of him: the first with one penny in it, the second with two, the third with four, the fourth with eight, and so on. The effect of compounding is such that the sixty-fourth box would have to contain more than the entire world's wealth.[19]

Discounting works the same way, but in reverse. If we knew the discount rate (i.e., the rate of increase) and the total amount of money in the sixty-fourth box, we could discount to determine the amount of money in the first box, the second, or the forty-third.

Economists continue to argue about the appropriate discount rate.[20] But there is a general consensus that money has a time-value,

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this controversy and an argument that the market rate should apply once regulatory goods have been monetized, see Sunstein & Rowell, *supra* note 4, at 181–86.

16 *See* OMB CIRCULAR A-4, *supra* note 2, at 33 (recommending the "shadow price" approach to discounting, and suggesting that "any agency that wishes to tackle this challenging analytical task should check with OMB before proceeding"); *see also* Heal, *supra* note 13, at 77 (suggesting the valuing of investment changes by the shadow price of capital as a reflection of the contribution extra capital makes to consumption).

17 For a discussion of the disagreement among economists as to what the market discount rate should be and a proposal as to how the disagreement might be resolved, see Martin L. Weitzman, *Gamma Discounting*, 91 AM. ECON. REV. 260, 266–69 (2001). For a discussion of the inter-field controversies surrounding the choice of a discount rate, see David Weisbach & Cass R. Sunstein, *Climate Change and Discounting the Future: A Guide for the Perplexed*, 27 YALE L. & POL'Y REV. 433, 441–49 (2009).

18 For an argument that the choice of discount rate alone will determine the majority of climate change policy during our lifetimes, see Weisbach & Sunstein, *supra* note 17, at 440–41. For a useful economic primer on discounting, see Heal, *supra* note 13, at 67–68.

19 *See* Martin L. Weitzman, *"Just Keep Discounting, but . . .", in* Discounting and Intergenerational Equity, *supra* note 3, at 23, 28. In 2008, the global GDP was approximately $61 trillion, or 6.1×10^{13}. *See* THE WORLD BANK, GROSS DOMESTIC PRODUCT 2008 (2009), *available at* http://siteresources.worldbank.org/DATASTATISTICS/Resources/GDP.pdf.

20 *See* Weitzman, *supra* note 17, at 261.

and that future money must therefore be discounted at some rate before it can be compared to current-day money.

While there is a general consensus that it is appropriate to discount money, numerous commentators have questioned whether discounting is appropriate when it is lives or health that are at risk instead.[21] This uneasy intuition has led several analysts to conclude that, when regulators face risks to health or human safety, they should refuse to discount altogether.[22]

The question of whether goods should be valued differently at different times is indeed a vexing one. But the debate, which has centered around the process of discounting, misses a simple point. The monetary "value" of regulatory benefits is calculated based on people's willingness to pay to secure those benefits.[23] When regulators discount the value of those benefits, they are discounting money that people want to use to protect life or health—not life or health as such.[24]

So long as regulatory policy relies on willingness to pay, regulators must discount future benefits—including future risk reductions—to their present value, just as they would with any other money.[25]

Monetized valuations of nonmonetary benefits can provide policymakers with a baseline for setting policy, particularly when policy determinations will be paid for with money. Part of maintaining the accuracy of monetization studies is respecting the metric in which they measure valuations. Money has certain characteristics—among them, time-value—and *monetized* valuations of risk have the same characteristics.

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21 *See* Ackerman & Heinzerling, *supra* note 3, at 1571 (noting that when long time spans are involved, discounting at any positive rate makes even global catastrophes seem trivial); Cowen & Parfit, *supra* note 14, at 145; Paul R. Portney & John P. Weyant, *Introduction* to DISCOUNTING AND INTERGENERATIONAL EQUITY, *supra* note 3, at 1, 5 (describing "the unease even the best minds of the profession feel about discounting, due to the technical complexity of the issues and to their ethical ramifications"); Revesz, *supra* note 14, at 1008–09.

22 *See* Lisa Heinzerling, *Discounting Life*, 108 YALE L.J. 1911, 1913 (1999) (arguing that lives should not be subject to discounting because they do not "compound the way money does"); Revesz, *supra* note 14, at 987–1007 (suggesting that discounting harms to future generations over a long period of time likely produces a negligible present discounted value).

23 *See* Sunstein & Rowell, *supra* note 4, at 181–82.

24 *See id.* at 183.

25 *See id.* at 185.

C. *Risk and Time*

To see how the time-value of money interacts with the monetization of risk, suppose that people in general are willing to pay $8 million in today's dollars to save a life today. If regulators do not discount, a life saved one hundred years from now would justify the same expenditure: $8 million. If regulators discount at a 10% discount rate,[26] saving the same life would justify a modern expenditure of only $581.[27] Even at a lower discount rate of 5%, saving one hundred lives in one hundred years would justify an expenditure of only $6.25 million today[28]—versus $800 million without discounting. That means that, under traditional cost-benefit techniques, we would spend less to save one hundred lives in one hundred years than we would spend to save a single life today.

Critics of discounting point to numbers like these as evidence that discounting produces troubling results,[29] while defenders of discounting point to equally perverse outcomes from refusing to discount.[30] But the striking effect of discounting is not a good reason to either use or refuse it as a tool. Just as compound interest makes

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26 The OMB recommended a 10% discount rate during the 1980s. *See* Donohue, *supra* note 8, at 1906 n.26. More recently, it has switched to suggesting that agencies prepare analyses using rates of both 3% and 7%. For the 7% rate, see Benefit-Cost Analysis of Federal Programs; Guidelines and Discounts, 57 Fed. Reg. 53,519, 53,522–23 (Nov. 10, 1992). For a more recent suggestion that agencies use both 3% and 7%, see OMB CIRCULAR A-4, *supra* note 2, at 33–34. All of these numbers remain controversial. *See* Richard W. Parker, *Grading the Government*, 70 U. CHI. L. REV. 1345, 1373–75 (2003).

27 *See* Michael B. Gerrard, *Demons and Angels in Hazardous Waste Regulation: Are Justice, Efficiency, and Democracy Reconcilable?*, 92 NW. U. L. REV. 706, 742–43 (1998).

28 *See* Sunstein & Rowell, *supra* note 4, at 172.

29 *See, e.g.*, Ackerman & Heinzerling, *supra* note 3, at 1571 (finding that with "a discount rate of 5%, for example, the death of a billion people 500 years from now becomes less serious than the death of one person today," and arguing that "[s]een in this way, discounting looks like a fancy justification for foisting our problems off onto the people who come after us"); Cowen & Parfit, *supra* note 14, at 145 ("Imagine finding out that you, having just reached your twenty-first birthday, must soon die of cancer because one evening Cleopatra wanted an extra helping of dessert.").

30 *See, e.g.*, DAVID W. PEARCE & R. KERRY TURNER, ECONOMICS OF NATURAL RESOURCES AND THE ENVIRONMENT 223–24 (1990) (arguing that a negative discount rate leaves all generations in subsistence with consumption postponed until tomorrow); Dexter Samida & David A. Weisbach, *Paretian Intergenerational Discounting*, 74 U. CHI. L. REV. 145, 169–70 (2007) (noting that "[b]ecause of the power of discounting it is easy to come up with rhetorical quips that make discounting seem unattractive," and responding to Cowen and Parfit's Cleopatra example, *see supra* note 29, with the claim that "every time you eat a banana, you condemn a million people in the future to death").

retirement funds grow large, so discounting makes future benefits look small in today's dollars. We do not refuse to invest in retirement funds on the grounds that projected growth—at least of investments made at a young age—results in an outlandishly large figure. Refusing to discount on these grounds makes as little sense.

Refusing to discount these monetary amounts can even be misleading. If economic cost-benefit analysis has a claim to usefulness, it is because it converts disparate goods into a single metric: money. Money can be invested. This is one of its fundamental qualities. The practice of discounting monetized benefits stems from this quality: removing that characteristic from the mix means that we are no longer dealing with money. Instead, we are comparing classic soda to diet soda—"money" to something like "money lite," which has some (but not all) of the qualities of money.

And so long as regulators purport to perform economic cost-benefit analyses—analyses expressed in monetary terms—it would be misleading for them to compare money (which has the qualities of fungibility and time-value) with "money lite" (which has neither, or has them only occasionally). It is similarly misleading to act as if willingness-to-pay studies—which measure people's willingness to pay money for particular goods—can tell us how much "money lite" people would pay for similar goods.

This is not to say that money is always the best metric for measuring everything.[31] We may have reasonable concerns that exchanging money for some goods creates a dignitary harm; that the amount of money people are willing to pay for a good is limited by their existing wealth, which is a function of inequitable allocations of resources; or that some goods—such as those not commonly traded on the market, or which are wrapped up with identity or other disaggregable qualities—can only be "monetized" so inaccurately that it is not worth the trouble.

But if money is not the right metric for valuing all regulatory goods, the solution is not to pretend that we are still using money even as we subversively introduce "money lite" into the mix. The solution is to find a new metric or to use monetized values as a minimum for regulatory action, rather than a maximum. So long as we *do* use money as the metric for regulatory analyses, we must discount future monetary amounts before we compare those amounts to present-day dollars. This is not for any peculiar or controversial reason—it is sim-

31 *Cf.* MARTHA C. NUSSBAUM, WOMEN AND HUMAN DEVELOPMENT 34–110 (2000) (arguing that there are diverse objective goods that represent different dimensions of human welfare).

ply because discounting follows from time-value, which is a basic attribute of money.

So regulators should discount future monetary amounts before they compare them to present monetary amounts. It is true that discounting has a massive effect on how much we spend today to secure future goods, like reductions in mortality risks. But while the extraordinary effect of positive discount rates should not dissuade regulators from discounting where appropriate, it should make them extremely hesitant to discount haphazardly.

II. MONETIZATION AND TIME-INDETERMINACY: PROBLEMS WITH PRACTICE

This Part proceeds in three sections. It begins with an overview of the reasons why regulators monetize risks, and the legal and political decisionmaking structures that promote and support the monetization of risk. It then analyzes studies that the Environmental Protection Agency (EPA)—often regarded as one of the more economically savvy agencies—uses to set the baseline "value of a statistical life" for environmental regulations. A review of the studies leads to the conclusion that it would be highly implausible to think that the willingness-to-pay numbers elicited in these studies reflect willingness-to-pay to avert immediate risks. It concludes by discussing the policy implications of study time-indeterminacy.

A. Regulatory Cost-Benefit Analysis in Practice

Most people proceed through their days quite happily without worrying about tiny risks. But for administrative agencies, the concerns are different. For risks of 1-in-100,000, we individually have only a .001% chance of being affected. But where there is a 1-in-100,000 risk spread across a population of three hundred million people, 3,000 people will probably be affected.[32]

There are countless such risks, and resources must be spent on larger risks as well. A dollar spent one place cannot be spent elsewhere, so agencies must allocate scarce resources. This requires some method of prioritizing amongst risks.[33]

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32 As a point of comparison, the September 11th attacks killed about this many people. *See* BUREAU OF LABOR STAT., U.S. DEP'T. OF LABOR, NATIONAL CENSUS OF FATAL OCCUPATIONAL INJURIES IN 2001, at 7 tbl.A (2002), *available at* http://www.bls.gov/iif/oshwc/cfoi/cfnr0008.pdf (reporting that 2886 workers died in the events of the day).

33 The pervasiveness of risk is a constant in risk analysis. For various perspectives, see RISK VERSUS RISK (John D. Graham & Jonathan Baert Wiener eds., 1995).

The prevailing approach in the United States is to rely on trade-off analyses, primarily cost-benefit analysis.[34] Indeed, under Executive Order 12,866, agencies are required to evaluate alternative strategies for all economically significant regulations.[35] As part of that evaluation, agencies must analyze the expected costs and benefits of the proposed regulation.

The Office of Management and Budget (OMB) is the gatekeeper for federal regulatory decisionmaking. In particular, it is responsible for coordinating and reviewing regulatory analyses.[36] OMB provides agencies with written guidance on preferred practices for implementing regulatory analyses in its Circular A-4.[37] The exact nature of this document is somewhat disputed,[38] but as a functional matter, agencies must receive a pass from OMB before they can promulgate major regulations.

OMB then issues a report to Congress on the costs and benefits of federal regulation.[39] The report must include an estimate of the total annual benefits and costs of each "major rule."[40] The report offers a summary of the costs and benefits of all federal regulations promulgated in the previous ten years, as well as individual estimates for each

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34 This focus is not inevitable. For a comparison of United States and European practices, see David Vogel, *The Politics of Risk Regulation in Europe and the United States*, *in* 3 THE YEARBOOK OF EUROPEAN ENVIRONMENTAL LAW 1, 7–14 (H. Somsen ed., 2003).

35 *See* Exec. Order No. 12,866, 3 C.F.R. 638, 640 (1993), *reprinted in* 5 U.S.C. § 601 (2006). Only clear statutory prohibition bars agencies from performing cost-benefit analysis. *Cf.* Entergy Corp. v. Riverkeeper, Inc., 129 S. Ct. 1498, 1508 (2009) (holding that EPA appropriately applied cost-benefit analysis to a provision of the Safe Drinking Water Act, on the grounds that use of cost-benefit analysis had not been expressly prohibited). President Obama has indicated that he is reviewing Executive Order 12,866. *See* Memorandum for Heads of Executive Departments and Agencies, 74 Fed. Reg. 5977 (Jan. 30, 2009).

36 *See* 3 C.F.R. 640. For a discussion of OMB's role in regulatory decisionmaking, see Steven Croley, *White House Review of Agency Rulemaking: An Empirical Investigation*, 70 U. CHI. L. REV. 821, 824–30 (2003).

37 OMB CIRCULAR A-4, *supra* note 2, at 9–11, 33–34.

38 *See* Lisa A. Robinson, *How US Government Agencies Value Mortality Risk Reductions*, 1 REV. ENVTL. ECON. & POL'Y. 283, 286 (2007) (noting that "OMB treats some of the guidance as mandatory," but concluding that "[u]ltimately, each individual regulatory analysis is the result of negotiations between the OMB and the agency").

39 The yearly report is required under the Regulatory Right-to-Know Act, 31 U.S.C. § 1105 (2006).

40 "Major rules" include all regulations with an annual effect on the economy of $100 million or more. *See* OFFICE OF MGMT. & BUDGET, EXEC. OFFICE OF THE PRESIDENT, REPORT TO CONGRESS ON THE COSTS AND BENEFITS OF FEDERAL REGULATION AND UNFUNDED MANDATES ON STATE, LOCAL, AND TRIBAL ENTITIES 2 (2008), *available at* http://www.whitehouse.gov/omb/assets/information_and_regulatory_affairs/2008_cb_final.pdf.

major rule promulgated during the year.[41] The amounts of money involved are enormous: between October 1997 and September 2007, OMB estimates that the quantifiable benefits of federal regulation were between $122 billion and $656 billion, and that the quantifiable costs were between $46 and $54 billion.[42]

Where do these dollar amounts come from? OMB's preferred methodologies for monetizing risk are presented in its Circular A-4, which provides recommendations as to how agencies should value the expected benefits from proposed regulations.[43] In valuing reduced mortality risks, OMB recommends that agencies present valuations for lives saved.[44] The Circular cites to academic literature on the valuation of mortality risk reduction, and concludes that "[a] substantial majority of the resulting estimates of VSL vary from roughly $1 million to $10 million per statistical life."[45] When submitting proposals to OMB, agencies typically use values within this range.[46]

OMB has emphasized—both in Circular A-4 and in other guidance—the importance of study quality and fit.[47] Yet no OMB guidance deals with the timing of valuations. OMB Circular A-4 does

41 *See id.*

42 *See id.* at iii.

43 *See* OMB CIRCULAR A-4, *supra* note 2, at 39–42.

44 *Id.* at 12. The Circular also recommends that agencies provide valuations for life-years saved (VSLY). *Id.* Note that, due to the controversy surrounding the VSLY-related "senior death discount," EPA is prohibited from using life-years in its analyses. *See* Robinson, *supra* note 38, at 287; *see also* Consolidated Appropriations Act of 2004, Pub. L. No. 108-199, 118 Stat. 3, 419. OMB is aware of the controversy surrounding these valuations and encourages agencies to explicitly identify any drawbacks of their chosen approach(es). *See* OMB CIRCULAR A-4, *supra* note 2, at 13–14. The FDA continues to use life-year estimates in calculating the monetized value of nonfatal health conditions. *See, e.g.*, Food Labeling: Trans Fatty Acids in Nutrition Labeling, Nutrition Content Claims, and Health Claims, 68 Fed. Reg. 41,433, 41,488 (July 11, 2003).

45 OMB CIRCULAR A-4, *supra* note 2, at 30. For these numbers, the Circular cites two meta-analyses of existing studies: Viscusi & Aldy, *supra* note 3, at 37, and Janusz R. Mrozek & Laura O. Taylor, *What Determines the Value of Life? A Meta-Analysis*, 21 J. POL'Y ANALYSIS & MGMT. 253, 258 (2002). Circular A-4 does not attach a dollar year to the figures, but it was issued in 2003.

46 *See* Robinson, *supra* note 38, at 286. Occasionally agencies provide estimates for the entire suggested range. *See, e.g.*, Mine Safety & Health Admin., U.S. Dep't of Labor, Regulatory Economic Analysis for Refuge Alternatives 9 (2008), *available at* http://www.msha.gov/regs/rea/refuge-alternatives.pdf (calculating the net cost of the rulemaking at a $1 million VSL and a $10 million VSL "purely for informational purposes").

47 *See* OMB CIRCULAR A-4, *supra* note 2, at 17; Memorandum from Joshua B. Bolton, Director, Office of Mgmt. & Budget, Exec. Office of the President, to Heads of Dep't and Agencies 2 (Dec. 16, 2004), *available at* http://www.whitehouse.gov/omb/assets/omb/memoranda/fy2005/m05-03.pdf.

provide detailed guidance to regulators seeking to evaluate (or perform) stated preference studies, but nowhere among the nine "principles" they propose is a warning about time-indeterminacy.[48] Similarly, in a recent study requested by EPA to evaluate the strengths and weaknesses of new approaches to valuing mortality risks, there was no mention of time-indeterminacy as an evaluative factor.[49]

It is not that regulators do not realize that many risks will not accrue until some time in the future. On the contrary, regulators routinely apply discount rates to future monetized risks to make them comparable to current costs.[50] But there is no accommodation for the possibility that study participants might also perceive a lag between payment and risk reduction.

B. One Agency's Practice: EPA

Do study participants perceive any lag between payment and risk reduction? To answer this question, this section focuses on the cost-benefit practices used by a single agency: EPA. It gives a bit of background into EPA's monetization procedures and then looks more specifically at the two types of studies EPA uses to monetize risk. It concludes that the studies regulators rely upon are largely time-indeterminate: they elicit people's willingness to pay for risk reductions without identifying the time at which the risk reduction will occur. At the same time, most of these studies measure at least some risks with an objective period of latency—that is, some kind of measurable lag between when participants would pay and when they would receive the benefit of mortality risk reduction. This means that at least some of the valuations we get from willingness-to-pay studies have latency periods and discount rates incorporated into valuation. Current regulatory practice does not account for this, in fact, it compounds the problem, because regulators routinely treat the numbers they get from these studies as if they are valuations of immediate risks—as if none of the studies ask people to value risks with any latency period at all. As this section will discuss, this reading of the studies is implausible.

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48 *See* OMB CIRCULAR A-4, *supra* note 2, at 23.

49 *See* U.S. ENVTL. PROT. AGENCY, REPORT OF THE EPA WORK GROUP ON VSL META-ANALYSES 13–19 (2006) [hereinafter EPA, VSL META-ANALYSES], *available at* http://yosemite1.epa.gov/ee/epa/eermfile.nsf/vwAN/EE-0494-01.pdf.

50 In fact, OMB's Circular A-4 directs agencies to discount future benefits, *see* OMB CIRCULAR A-4, *supra* note 2, at 31–34, and it provides detailed recommendations on how to discount accurately. *See* OMB CIRCULAR A-94, *supra* note 2, at 7–10.

EPA is a good subject for this analysis for two reasons: (1) it deals with a number of latent risks, and (2) it identifies the twenty-six specific studies on which it bases its cost-benefit analyses.[51] Unlike many other federal agencies, EPA has issued detailed guidelines to regulators seeking to perform cost-benefit analyses. These guidelines make cost-benefit practices at EPA relatively transparent, and therefore easier to evaluate. The fact that this analysis focuses on EPA is not meant to single it out for criticism. On the contrary, EPA's practices are easier to criticize because they are more transparent, but they are presumably better for the same reason.

How generalizable is this critique to the practices of other federal agencies? Highly, OMB's $1 million–$10 million VSL range was calculated based on the same studies that EPA uses, and while OMB directs all federal agencies under its purview to follow that range, it does not identify any methodology for dealing with time-indeterminacy. And the fact that even the EPA does not address the time-indeterminacy in its internal guidance suggests that this is a pervasive problem in regulatory analyses.[52]

1. Cost-Benefit Analysis at EPA

EPA is an independent executive agency, established in 1970 to protect human health and the environment.[53] EPA administers all or part of over twenty-five environmental statutes, including the Clean Air Act,[54] the Federal Water Pollution Control Act,[55] the Safe Drink-

51 Furthermore, OMB's range for regulatory cost-benefit analyses ($1 to $10 million) is drawn from meta-analyses that rely on these twenty-six studies. *See* U.S. ENVTL. PROT. AGENCY, GUIDELINES FOR PREPARING ECONOMIC ANALYSIS 89 (2000) [hereinafter EPA, 2000 GUIDELINES] (listing a table of all twenty-six studies in Ex. 7-3).

52 Furthermore, OMB's "recommended range" for regulatory cost-benefit analyses ($1–$10 million (unknown $ year)) is drawn from meta-analyses that rely on these twenty-six studies.

53 Unlike other agencies, EPA does not have only one enabling act establishing it as an agency. Before 1970, environmental regulation was handled piecemeal by a multiplicity of departments spread out across a number of federal agencies. THE president transferred these functions to a single "Environmental Protection Agency." *See* Reorganization Plan No. 3 of 1970, 35 Fed. Reg. 15,623, 15,623–26 (Oct. 6, 1970). Congress has effectively ratified the 1970 Plan by expressly delegating responsibility for administering subsequent major environmental legislation to the "Administrator" of EPA. *See, e.g.*, 33 U.S.C. § 1251(d) (2006) (granting the Administrator the authority to administer the Federal Water Pollution Control Act); 42 U.S.C. §§ 7601(a)–7602 (2006) (authorizing the Administrator to prescribe regulations for the Clean Air Act).

54 42 U.S.C. §§ 7401–7431 (establishing standards to protect outdoor air quality and limit outdoor air pollution).

ing Water Act,[56] the Toxic Substances Control Act,[57] the Solid Waste Disposal Act,[58] the Comprehensive Environmental Response, Compensation, and Liability Act[59] ("Superfund"), and the Federal Insecticide, Fungicide, and Rodenticide Act.[60]

Different statutes direct EPA to apply different forms of analyses. Some require that regulations be promulgated on the basis of cost-benefit analysis.[61] Other statutes—particularly those established in the 1970s, at the beginning of the environmental movement—focus on "feasibility" analysis.[62] "[T]o the extent permitted by law," however, Executive Order 12,866 requires EPA to perform cost-benefit analyses on all major proposed regulations.[63] In practice, this has meant that EPA performs cost-benefit analyses to satisfy the Executive Order and feasibility studies to satisfy statutory feasibility requirements.[64]

Since 2000, cost-benefit analyses at EPA have been performed according to its Guidelines for Preparing Economic Analyses.[65] The Guidelines encourage regulators to use a default central VSL of $5.8

55 33 U.S.C. §§ 1257–1387 (2006 & Supp. 2008) (regulating the discharge of pollutants into navigable waters).

56 42 U.S.C. § 300j-26 (2006).

57 15 U.S.C. §§ 2601–2629 (2006 & Supp. 2008) (regulating the use of hazardous chemical substances).

58 42 U.S.C. §§ 6901–6992(k) (2006 & Supp. 2008) (regulating the generation, transport, management, and disposal of solid and hazardous wastes).

59 *Id.* §§ 9601–9675 (establishing a system of remediation and liability for the release of hazardous substances).

60 7 U.S.C. §§ 136–136y (2006 & Supp. 2008) (regulating the sale and distribution of substances used to kill insects, fungi, and rodents).

61 *See, e.g.*, Corrosion Proof Fittings v. EPA, 947 F.2d 1201, 1216, 1222 (5th Cir. 1991) (interpreting the Toxic Substances Control Act as requiring a cost-benefit approach to limiting toxic substances).

62 The Clean Air Act, for example, requires air pollution emission standards to be set for the "maximum degree of reduction . . . achievable." *See* 42 U.S.C. § 7412(d)(2) (2006). The Federal Water Pollution Control Act requires new sources of water pollution to meet discharge limits reflecting the "best available demonstrated control technology." *See* 33 U.S.C. § 1316(a)(1) (2006).

63 Exec. Order No. 12,866, 3 C.F.R. 638, 640 (1993), *reprinted in* 5 U.S.C. § 601 (2006).

64 For an argument that feasibility-focused statutes should not be interpreted (as they have been) as *allowing* for cost-benefit analysis, see David M. Driesen, *Distributing the Costs of Environmental, Health, and Safety Protection: The Feasibility Principle, Cost-Benefit Analysis, and Regulatory Reform*, 32 B.C. ENVTL. AFF. L. REV. 1, 3 (2005).

65 *See* EPA, 2000 GUIDELINES, *supra* note 51. An update to the Guidelines is pending review. *See* U.S. ENVTL. PROT. AGENCY, GUIDELINES FOR PREPARING ECONOMIC ANALYSIS (External Review Draft Sept. 2008) [hereinafter EPA, 2008 GUIDELINES]. For a discussion of EPA's monetization practices, see Robinson, *supra* note 38, at 288–93.

million (1997 dollars), updated to the base year of the analysis.[66] As I discuss in more detail below,[67] this baseline VSL is the calculated mean of twenty-six studies, which were performed between 1974 and 1991.[68] Most—although not all—cost-benefit analyses performed by EPA use this baseline VSL to calculate the monetized benefit of reducing mortality risks.[69] Recently, EPA has also been investigating the possibility of using more formal meta-analyses to set baseline VSLs:[70] these meta-analyses rely on most of the same studies as EPA's own analysis from 2000, and the figures they support are quite close to EPA's existing recommendations.[71]

EPA is well aware of the fact that many of the risks it manages have latency periods. The Guidelines note that "[m]any environmental policies are targeted at reducing the risk of effects such as cancer, where there may be an extended period of latency between the time of exposure and eventual death from the disease."[72] The Guidelines devote an entire chapter to discounting,[73] and encourage regulators

66 *See* EPA, 2000 GUIDELINES, *supra* note 51, at 90. EPA regulators tend to use the Consumer Price Index to adjust for inflation, but the agency is aware that some economists prefer the Gross Domestic Product (GDP) Deflator inflation index, and the Guidelines merely direct analysts to use one or the other consistently. *Id.* at 90 n.31.

67 *See infra* Part II.B.2.

68 *See* EPA, 2000 GUIDELINES *supra* note 51, at 89 ex. 7-3 (listing the studies on which EPA relies). The September 2008 draft of the Guidelines currently recommends a central baseline mean based on these same studies. *See* EPA, 2008 GUIDELINES, *supra* note 65, at 7–6 n.106. In 2006 dollars, this results in a baseline $7.0 million VSL. *Id.* at 7–6.

69 *See* Robinson, *supra* 38; *see also* EPA, 2008 GUIDELINES, *supra* note 65, at 7–6 (noting that some programs may vary from this default).

70 *See* EPA, VSL META-ANALYSES, *supra* note 49, at 2; *see also* EPA, 2008 GUIDELINES, *supra* note 65, at 7–6 (discussing air programs using VSL based on meta-analyses).

71 EPA recommends a $7.0 million VSL (2006 dollars), while analyses relying on meta-analyses have typically used a $6.6 million VSL (2006 dollars). *See* EPA, 2008 GUIDELINES, *supra* note 65, at 7–6; *see also* U.S. ENVTL. PROT. AGENCY, SUMMARY OF THE UPDATED REGULATORY IMPACT ANALYSIS (RIA) FOR THE RECONSIDERATION OF THE 2008 OZONE NATIONAL AMBIENT AIR QUALITY STANDARD (NAAQS), at S1–4 (2008), *available at* http://www.epa.gov/ttn/ecas/regdata/RIAs/s1-supplemental_analysis_full.pdf (comparing current estimates to estimates derived from meta-analyses). In 2006, EPA commissioned a study on the possible use of meta-analyses in valuing mortality risks. EPA, VSL META-ANALYSES, *supra* note 49, at 2. It then sought guidance from the Science Advisory Board on this and other proposed changes to valuation practices.

72 EPA, 2000 GUIDELINES, *supra* note 51, at 92; *see also* U.S. ENVTL. PROT. AGENCY, VALUING THE BENEFITS OF FATAL CANCER RISK REDUCTIONS (2006).

73 EPA, 2000 GUIDELINES, *supra* note 51, at 33–57.

to adjust for "latency periods" between exposure to a risk and fatality by discounting the value of future risk reductions.[74]

Although EPA encourages regulators to account for the timing of risks, the Guidelines do not direct regulators to consider the timing of risks from the perspective of study participants. Only a single line in the Guidelines addresses the timing of the valuations, and then only to breezily claim that "existing VSL estimates are based upon risks of relatively immediate fatalities."[75] In its reviews, EPA's Science Advisory Board has supported this reading of the literature.[76] Accordingly, EPA cost-benefit analyses routinely discount VSLs as if they represent valuations of immediate risks.[77]

2. A Review of the Studies

Do the willingness-to-pay values used by agencies elicit present values of the underlying risk reduction—as regulators assume—or do they elicit valuations of future risk? Review of the twenty-six studies used by EPA suggests that most are time-indeterminate in that they

74 *See id.* at 92.

75 *Id.* The 2008 draft of the Guidelines operates based on the same assumption: it distinguishes between latency (the time difference between initial exposure to a contaminant and an increase in health risk) and cessation lag (the time difference between reduction in exposure and a reduction in observed health effects), and concludes that both should be "discounted at the same rate as other benefits and costs in the analysis." EPA, 2008 GUIDELINES, *supra* note 65, at 6–23.

76 The Science Advisory Board (SAB) was established by Congress in 1978 to advise EPA on technical matters. *See* Environmental Research, Development, and Demonstration Authorization Act of 1978 (ERDDAA), Pub. L. No. 95-155, § 8, 91 Stat. 1257, 1260 (1977) (codified as amended at 42 U.S.C. § 4365 (2006)). For SAB comments on EPA's discounting practices, see U.S. ENVTL. PROT. AGENCY, AN SAB REPORT ON THE EPA GUIDELINES FOR PREPARING ECONOMIC ANALYSIS, § 3.1, at 3 (1999) (supporting EPA's discounting practices). Six years later, in its report to EPA on EPA's white paper *Valuing the Benefits of Fatal Cancer Risk Reductions*, the SAB did note an example of a study where "[t]he study itself suggests that the subjects believed that there was a latency period." U.S. ENVTL. PROT. AGENCY, AN SAB REPORT ON EPA'S WHITE PAPER *VALUING THE BENEFITS OF FATAL CANCER RISK REDUCTION* 12 (2009) (citing Wesley A. Magat et al., *A Reference Lottery Metric for Valuing Health*, 42 MGMT. SCI. 1118, 1127 (1996)). The report acknowledges the possibility that some respondents might have assumed there was a latency period, but goes on to recommend that EPA continue to discount its valuations. *Id.* at 12–14.

77 *See* EPA, 2000 GUIDELINES, *supra* note 51 at 92 (recommending that regulators discount the valuations); Robinson, *supra* note 38, at 292–93; *see also* U.S. ENVTL. PROT. AGENCY, ECONOMIC ANALYSIS FOR THE FINAL STAGE 2 DISINFECTANTS AND DISINFECTION BYPRODUCTS RULE, at ES–25 to ES–27 (2005), *available at* http://www.epa.gov/safewater/disinfection/stage2/pdfs/anaylsis_stage2_ecconomic_main.pdf (analyzing the costs and benefits of a proposed regulation limiting the amount of disinfectant in drinking water; applying a 3% and 7% discount rate to cancer mortality risks).

measure risks of unclear vintage—and that many measure risks with objective periods of latency.

EPA recommends its baseline VSL of $5.8 million (1997 dollars) on the basis of twenty-six studies.[78] These studies fall into two general categories: wage/risk studies and stated preference studies. Both types of studies seek to determine how much people are willing to pay for reductions in risk, but they look to different types of evidence for those valuations.

a. Wage/Risk Studies

Of the twenty-six studies EPA relies upon, twenty-one are wage/risk studies, which examine the risk premiums paid to workers for increases in job-related mortality risk.[79] These studies operate on the assumption that people demand compensation to be exposed to increased risk, so that greater risk equals increased pay.[80] Naturally other factors affect pay as well—the education of the worker, for example, or her gender or union status—and most studies seek to hold these additional factors constant so that they can focus on the amount workers are paid to assume additional risk.[81] Nevertheless, a basic assumption of this approach is that people are aware of the type and magnitude of the risks they face in their workplaces.

To measure people's valuations of workplace mortality risk, wage/risk studies compare wages[82] to some measure of occupational mortality. They typically rely on massive datasets that incorporate a

78 *See* EPA, 2000 GUIDELINES, *supra* note 51, at 90; *see also* EPA, 2008 GUIDELINES, *supra* note 65, at 7–6 (providing an updated VSL of $7.0 million (2006 dollars)).

79 For the list of studies, see EPA, 2000 GUIDELINES, *supra* note 51, at 90. For a description of the development of wage/risk studies, see W. Kip Viscusi, *The Value of Life: Estimates with Risks by Occupation and Industry*, 42 ECON. INQUIRY 29, 30–31 (2004); *see also* W. KIP VISCUSI, FATAL TRADEOFFS 17–98 (1992) (discussing issues involving wage/risk studies).

80 *See, e.g.*, Alan Marin & George Psacharopoulos, *The Reward for Risk in the Labor Market: Evidence from the United Kingdom and a Reconciliation with Other Studies*, 90 J. POL. ECON. 827, 827 (1982) (citing ADAM SMITH, WEALTH OF NATIONS 116–17 (R.H. Campbell & A.S. Skinner eds., Clarendon Press 1976) (1776)) (investigating whether workers in modern Britain are pair risk premiums as Adam Smith predicted should occur in competitive labor markets); *see also* SMITH, *supra*, at 116–17 ("The . . . following are the . . . circumstances which . . . make up for a small pecuniary gain in some employments, and counter-balance a great one in others: first, the agreeableness or disagreeableness of the employments themselves . . . . The wages of labour vary with the ease or hardship . . . of the employment.").

81 *See, e.g.*, Marin & Psacharopoulos, *supra* note 80, at 833.

82 Most commonly annual salary, but some also look at weekly or monthly wages.

wide variety of mortality risks. It is here that time-indeterminacy problems creep in to the analysis.

Consider the structure of one wage/risk study incorporated into EPA's baseline VSL.[83] This study compared a salary survey[84] to all 1.5 million of the workman's compensation claims filed in Quebec between January 1981 and May 1985.[85] It found that, on average, an increased mortality risk of 1-in-100,000 was correlated with an increase in yearly salary of $32 (1986 U.S. dollars).[86] EPA adjusted this to a VSL of $4.4 million (1997 U.S. dollars), significantly below its baseline mean of $5.8 million (1997 U.S. dollars).[87]

Where is the problem here? It is in the data from the workman's compensation claims. Like most workman's compensation schemes, the Quebecois system provides compensation both for workplace injuries and for illnesses arising from the workplace.[88] That means that

83 The study in question is a Canadian study. *See* Jean-Michel Cousineau et al., *Occupational Hazard and Wage Compensating Differentials*, 74 REV. ECON. & STAT. 166 (1992). EPA incorporates six foreign studies into its baseline VSL. EPA, 2000 GUIDELINES, *supra* note 51, at 89. These include four wage/risk studies: the Canadian study by Cousineau; a U.K. study by Marin & Psacharopoulos, *supra* note 80; Australian and Japanese studies published in Thomas J. Kniesner & John D. Leeth, *Compensating Wage Differentials for Fatal Injury Risk in Australia, Japan, and the United States*, 4 J. RISK & UNCERTAINTY 75 (1991); and two stated preference studies: a New Zealand study by MILLER & GURIA, *supra* note 11, and a U.K. study by Michael Jones-Lee, *The Value of Changes in the Probability of Death or Injury*, 82 J. POL. ECON. 835 (1974). For a comparison of foreign and U.S. VSL estimates, see Viscusi & Aldy, *supra* note 3 (particularly section 5). Most objections to using foreign studies in U.S. VSL calculations have centered on whether foreign risk preferences are similar to U.S. ones. The Viscusi & Aldy study finds that they are. *See id.* at 6 ("[N]otwithstanding the quite different labor market conditions throughout the world, the general order of magnitude of . . . foreign VSL estimates tends to be similar to that in the United States."). But even if foreign preferences are somewhat similar to U.S. preferences, we might still be concerned at the implications of using foreign preferences to set U.S. policy.

84 The salary survey was completed by Labour Canada in 1979, and provided wage data, job, and employee characteristics. The salary survey alone had 32,713 distinct hourly wage rate observations. Cousineau et al., *supra* note 83, at 166.

85 *Id.* at 166–67.

86 *See id.* at 169 & n.5.

87 EPA, 2000 GUIDELINES, *supra* note 51, at 89.

88 An Act Respecting Industrial Accidents and Occupational Diseases, R.S.Q., ch. A-3.001 (1985) (Can.) guarantees Quebecois the right to medical aid, compensation, rehabilitation, and return to work. It also defines "employment injury": it "means an injury or a disease arising out of or in the course of an industrial accident, or an occupational disease, including a recurrence, relapse, or aggravation." This act replaced the Worker's Compensation Act, R.S.Q., ch. 52 (1969) (Can.), which also provided compensation for both "accidents" and occupational diseases." For occupational diseases, "[t]he beneficiary's claim must be presented within six months of the date when it is medically established and brought to his attention that he is suffering

this study could not distinguish between the same probability of risk for latent and immediate risks of injury/disease: between a workplace where there was a 1-in-100,000 risk of dying immediately and a workplace where there was a 1-in-100,000 risk of dying in twenty years. To the extent that workers were aware of the risks they faced—and this methodology assumes that either individual workers or the labor market in general accounts for actual risks—this means that the average $32 wage premium the study identified was for some combination of immediate and latent risks. And that means that using this study as if it valued only immediate risk—as EPA has every time it has applied its baseline VSL in a cost-benefit analysis—leads to undervaluation of risk.

This study is not alone in this problem. Several other studies used to calculate EPA's baseline VSL rely on workman's compensation data with similar issues.[89]

Other studies use different sources for mortality data, but many of these are problematic as well. One common choice was to use mortality data collated by the Bureau of Labor Statistics in its Survey of Occupational Injuries and Illnesses (SOII).[90] These data were published annually starting in 1970, and until 1992, and they reported the number of fatal and nonfatal industrial injuries *and illnesses* suffered by workers in different industries. As with the workers' compensation

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from an occupational disease, or of the date of his death therefrom, as the case may be." *Id.* at XI.111.

89 *See* Richard J. Butler, *Wage and Injury Rate Responses to Shifting Levels of Workers' Compensation*, *in* SAFETY AND THE WORKFORCE 61, 85 (John D. Worrall ed., 1983) (relying on workman's compensation claims from South Carolina and finding a VSL of $1.3 million in 1997 dollars); Alan E. Dillingham, *The Influence of Risk Variable Definition on Value-of-Life Estimates*, 23 ECON. INQUIRY 277, 289–93 (1985) (relying on 1970 data from New York Worker's Compensation records and the Census and finding a VSL of $1.1 million in 1997 dollars); Kniesner & Leeth, *supra* note 83, at 82–83 (relying on workman's compensation claims from Australia and finding a VSL of $4.0 million in 1997 dollars).

90 Studies relied upon by EPA that used pre-1992 Bureau of Labor Statistics data to construct their VSL include John Garen, *Compensating Wage Differentials and the Endogeneity of Job Riskiness*, 70 REV. ECON. & STAT. 9, 11–15 (1988) (calculating $16.3 million VSL in 1997 dollars, relying on BLS data from 1981 to 1982); J. Paul Leigh. & Roger N. Folsom, *Estimates of the Value of Accident Avoidance at the Job Depend on the Concavity of the Equalizing Differences Curve*, 24 Q. REV. ECON. & BUS. 56 (1984) (calculating $11.7 million VSL in 1997 dollars); Michael J. Moore & W. Kip Viscusi, *The Quantity-Adjusted Value of Life*, 26 ECON. INQUIRY 369 (1988) (relying on BLS data from 1973 to 1976); and Craig A. Olson, *An Analysis of Wage Differentials Received by Workers on Dangerous Jobs*, 16 J. HUM. RESOURCES 167 (1981) (calculating $6.3 million VSL in 1997 dollars; relying on BLS data from 1973). For VSL figures stated, see EPA, 2000 GUIDELINES, *supra* note 51, at 89.

studies, these studies cannot distinguish between risk premiums paid to workers for (latent) risks of fatal illness and those paid for (more immediate) risks of fatal injury.

In 1992, a year after the last study incorporated into EPA's baseline VSL was performed, the Bureau of Labor Statistics began providing a Census of Fatal Occupational Injuries (CFOI), which is carefully collated to include only those fatalities that are "traumatic" (i.e. immediate) and occupational in nature.[91] Many recent studies rely on these data.[92]

There is reason to consider potential time-indeterminacy even amongst these studies, however. It might be reasonable to calculate some latency period even for injury-related deaths. This is particularly true in industries where multiple-fatality accidents drive up total numbers. In coal mining, for instance, fatal work injury statistics more than doubled between 2005 and 2006, because of multiple-fatality accidents.[93] Where mortality rates vary significantly across time, workers might reasonably assume that there will be some latency between when they are paid and when they assume the relevant risk.

We might also care about perceived latency—about whether workers valuing risks tend to perceive those risks as latent or immediate. Even a small amount of perceived latency may lead to enormous decreases in valuation,[94] so even very small perceived latencies should give regulators grounds for concern.

Do people perceive the risks that face them at work as latent? Research in risk perception suggests that some perceived latency period is the norm for many, if not most, of the kinds of risks that people face each day.[95] In one study, for example, participants were asked to rate the "immediacy" of thirty different kinds of risk on a

91 *See* Viscusi, *supra* note 79, at 31.

92 *See id.* (using CFOI data).

93 *Compare* BUREAU OF LABOR STATISTICS, U.S. DEP'T OF LABOR, FATAL OCCUPATIONAL INJURIES, EMPLOYMENT, AND RATES OF FATAL OCCUPATIONAL INJURIES BY SELECTED WORKER CHARACTERISTICS, OCCUPATIONS AND INDUSTRIES 3 (2006), http://www.bls.gov/iif/oshwc/cfoi/cfoi_rates_2006.pdf (reporting forty-seven coal mining deaths in 2006), *with* BUREAU OF LABOR STATISTICS, U.S. DEP'T OF LABOR, FATAL OCCUPATIONAL INJURIES, EMPLOYMENT, AND RATES OF FATAL OCCUPATIONAL INJURIES BY SELECTED WORKER CHARACTERISTICS, OCCUPATIONS AND INDUSTRIES 3 (2005), http://www.bls.gov/iif/oshwc/cfoi/cfoi_rates_2005.pdf (reporting twenty-two coal mining deaths in 2005).

94 Particularly where people discount hyperbolically. *See supra* note 6.

95 For an analysis of various characteristics (including "immediacy") of thirty types of common risk, see Baruch Fischhoff et al., *How Safe Is Safe Enough? A Psychometric Study of Attitudes Toward Technological Risks and Benefits*, THE PERCEPTION OF RISK 80, 92–97 (Paul Slovic ed., 2000).

scale of one to seven, where one was "immediate."[96] The three most "immediate" sources of risk—handguns, hunting, and general aviation—still averaged out measurably above a "one" (i.e. "immediate") on this scale.[97] That suggests that even for sources of risk with objectively short latency periods, the average person perceives some measurable amount of latency. Because we know latency affects people's valuations—and that people pay more to reduce immediate risks than future ones—this is a potential source of inadvertent double-discounting and an additional reason to be concerned about the valuations that regulators currently use to attach monetary values to mortality risks.

b. Stated Preference Studies

Five of the studies on which EPA relies are stated preference studies.[98] Stated preference studies elicit preferences by asking for them, rather than by observing people's actual behavior.[99]

The studies relied upon by EPA have various structures. In general, however, they have two phases: an initial phase, where they seek to inform and educate the participants about the risks they will be asked to value; and a second phase, where they ask about the participants' preferences.

The "educational" phase of the studies can be quite extensive. The Miller and Guria study, for example, was administered by an interviewer to a randomized sample of 629 persons, living in different households across New Zealand.[100] The interviewer began by informing the participant that "[w]e're trying to find out what you think

96 Fischhoff et al. look at the perceived "immediacy" of the following types of risk: alcoholic beverages, bicycles, commercial aviation, contraceptives, electric power, fire fighting, food coloring, food preservatives, general aviation, handguns, high-school/college football, home appliances, hunting, large construction, motorcycles, motor vehicles, mountain climbing, nuclear power, pesticides, power mowers, police work, prescription antibiotics, railroads, skiing, smoking, spray cans, surgery, swimming, vaccinations, and x-rays. *See id.*

97 More specifically, at a 1.66. *See id.*

98 *See* MILLER & GURIA, *supra* note 11; Doug Gegax et al., *Valuing Safety: Two Approaches, in* 4 EXPERIMENTAL METHODS FOR ASSESSING ENVIRONMENTAL BENEFITS 65 (1985) [hereinafter Gegax et al., *Valuing Safety*]; Douglas Gegax et al., *Perceived Risk and the Marginal Value of Safety*, 73 REV. ECON. & STAT. 589, 509–91 (1991) [hereinafter Gegax et al., *Perceived Risk*]; Jones-Lee, *supra* note 83, at 837; Wesley A Magat et al., *Issues in Valuing Health Risks: Applications of Contingent Valuation and Conjoint Measurement to Nerve Diseases and Lymphoma, in* DRAFT REPORT TO THE EPA 7–10 (1991).

99 None of these stated preference studies require participants to actually pay for any risk reductions.

100 *See* MILLER & GURIA, *supra* note 1, at 5.

about the risks we all face when travelling on the roads, and how much you value safety when travelling."[101] The interviewer then proceeded through a series of sections: defining risk,[102] attempting to contextualize the probabilities,[103] and testing for comprehension.[104] Only then did the interviewer reach the point of inquiring as to people's willingness to pay to reduce risks.[105]

Other studies had less extensive educational portions. The Gegax et al.[106] and the Gerking et al. studies[107] were based on the

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101 *See id.* app. 2, at 1. Participants were also reassured that "because we want to know how you feel about these things, don't worry about giving the 'right' answer—what's important is what you believe!" *Id.*

102 The study administrators told participants, "When we say that something is 'risky,' we mean that there might be an accident. The larger the risk, the greater the chance that something will go wrong. When we measure risk, we talk about the number of people involved in accidents." *Id.* app. 2, at 2.

103 This study provided numerical contextualizing information, *see id.* ("In 1987 in New Zealand there were 797 people killed in road accidents. This is the same as saying that out of every 10,000 New Zealanders around 3 were killed in a road accident during 1987. . . . The figures 3 in 10,000 tell us how large the risk of death on the road is."), and visual information, *see id.* (describing a piece of graph paper, shown to participants, with 10,000 squares, 3 of which were red).

104 One of the comprehension tests from this study ran as follows:

> Imagine that you decide to go for a walk. To get to your destination there are two different ways to go. Both ways involve walking across busy streets. Crossing Kauri Street your risk of death is 2 in 10,000. Crossing Lupin Street your risk of death is 20 in 10,000. [The interviewer showed an explanatory card at this point, with a diagram of the question.] Which is the safer street to cross? 1) Kauri Street where the risk is 2 in 10,000, or 2) Lupin Street where the risk is 20 in 10,000?

See id. Responses from participants who answered two were omitted from the analysis. *See id.* at 5.

105 This particular study was measuring people's willingness to pay for greater safety on roadways. It attempted to elicit this through several different questions. One of these was this:

> "Imagine that you have to travel in a car for a distance of 20 kilometres each weekday for some reason. You can use two different routes—one a high risk road and the other a low risk road. But before you can travel on the low risk road you must pay a fee—a toll. The time taken to travel on each road is the same. [A diagram was provided here.] The toll road will reduce your risk of dying in an accident (for each year you travel) from 6 in 10,000 to 3 in 10,000. How much would you pay per one way trip to use the toll road?" After the answer was given, the interviewer was directed to say: "That's about ___ per year to reduce your risk of death from 6 in 10,000 to 3 in 10,000. Is that O.K.?" Participants were then permitted to change their answer, if they chose to do so.

See id. app. 2, at 4.

106 *See* Gegax et al., *Valuing Safety*, *supra* note 98, at 65–66.

same mail survey, which was sent to a cross-section of the U.S. population in 1984. This survey informed participants of the thirteen "major causes of how people die on the job," and provided a "ladder" portraying the riskiness of various occupations.[108] People were told:

> The ladder below shows levels of job-related accidental risk of death. Each step shows the number of deaths per year for every 4,000 people in an occupation. The higher on the ladder, the more accidental "on the job" deaths there are each year for that occupation. A few example occupations are given and they are placed on the ladder according to their actual levels of risk. Note that schoolteachers have about one death per 4,000 workers and lumberjacks have about 10 deaths per 4,000 workers each year.[109]

The next questions asked participants to assign their own job a step on the ladder, and how much they would pay (or accept) to move down (or up) the ladder.[110] From the answers to these questions, these studies calculated a VSL of $2.1 million (1984 dollars).[111]

At first glance, this study seems less problematic than many of the wage-risk studies, because it at least purports to ask about "job-related accidental risk of death," which sounds relatively immediate at an intuitive level. As with the risks faced by people in the wage/risk studies, however, there may be reason to be concerned that people do not perceive most risk as entirely immediate (i.e., without any latency period whatsoever). Several of the thirteen "major causes of how people die on the job" identified in the Gerking et al. study have close corollaries in the Fischhoff et al. study on risk perception: compare, for example, "on the road motor vehicle accident" to risks from "motor vehicles" (perceived immediacy = 2.33); "fire" to "fire fighting" (2.33); "airplane crash" to "general aviation (1.66).[112]

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107 Shelby Gerking et al., *The Marginal Value of Job Safety: A Contingent Valuation Study*, 1 J. RISK & UNCERTAINTY 185, 186 (1988).

108 *See* Gegax et al., *Valuing Safety*, *supra* note 98, app. at 100–01.

109 *Id.* app. at 101. The ten-step ladder provided the following "rankings": (1) Schoolteachers; (2) House painters; (4) Electricians; (6) Crane and derrick operators; (7) Miners; (8) Structural ironworkers; (10) Lumberjacks. *See id.*

110 *See id.* app. at 102–03.

111 *See id.* at 90. EPA adjusted this to $4.0 million (1997 dollars). *See* EPA, 2000 GUIDELINES, *supra* note 51, at 89.

112 *See* Gegax et al., *Valuing Safety*, *supra* note 98, at app. A. In decreasing order, the thirteen causes were: on the road motor vehicle accident; a fall; heart attack; getting hit by industrial vehicle or equipment; getting hit by an object other than vehicle or equipment; getting caught in, under, or between objects other than vehicle or equipment; electrocution; gun shot; airplane crash; fire; plant machinery operation; explosion; gas inhalation. *See id.*; *cf.* Fischhoff et al., *supra* note 95, at 92–93 (measuring other activities and technologies).

The other three stated preference studies used by EPA all attempted to elicit people's valuations of lower mortality risks from traffic accidents.[113] Again, these studies seem less problematic than the wage/risk studies, because the range of risks they measure (and therefore the variance in the latency of the risks they measure) is relatively narrow. It is true that people appear to perceive risks from motor vehicles as having some measurable latency period, but the source of risk is narrow enough that we have a latency period on which to focus.[114] Two of these studies also included some kind of explicit instruction as to the timing of the risk[115]—a relatively easy fix to include in future stated preference studies, and one that presumably limits the variance in perceived latency.

Did the people in the stated preference studies used that EPA used perceive the risks they faced at work as wholly immediate, then, as regulators assume? Possibly. At the least, it would be reasonable to think that participants in the five stated preference studies may have perceived the risks they valued as *more* immediate than the ones faced by the participants in the wage/risk studies. Of course, any amount of perceived latency may be cause for alarm, since any perceived latency will lead to some amount of double-discounting. But as a comparative matter, the stated preference studies EPA uses are less time-indeterminate than the wage/risk studies.

C. *Policy Implications of Time-Indeterminacy*

Why does any of this matter? What happens when regulators use time-indeterminate studies as if they elicit willingness-to-pay for immediate risks? If even some of the participants in a willingness-to-pay study think that they are valuing latent risk instead of immediate risk, they will apply their *own* discount rate to the valuation. In combination with current discounting practice, this leads to the undervaluation of both immediate and future benefits.

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113 *See* MILLER & GURIA, *supra* note 11; Jones-Lee, *supra* note 83, at 845–46; Kip Viscusi et al., *Pricing Environmental Health Risks: Survey Assessments of Risk-Risk and Risk-Dollar Trade-Offs for "Chronic Bronchitis,"* 21 J. ENVTL. ECON. & MGMT. 44–50 (1991).

114 *See* Fischhoff, *supra* note 95, at 92 (perceived immediacy of "motor vehicles" risk was 2.33 on a 1–7 scale).

115 The Miller & Guria study in particular tended to assign times to valuations. *See, e.g.*, MILLER & GURIA, *supra* note 11. Unfortunately, the timing of risks being valued was not consistent across the study questions, so the mean VSL that EPA uses from that study—$1.5 million in 1997 dollars—is time-indeterminate, even though the actual study provided several different estimates that had a time attached to them. *See id.* The Viscusi et al. study, *supra* note 13, asked participants about their risk of dying in an automobile accident in the next year.

Immediate benefits are undervalued because regulators treat the VSL as if it is a valuation of immediate benefit. But the willingness-to-pay numbers being elicited are (at least in part) willingness-to-pay for the future risk reduction—that is, they are the *discounted* value of the risk reduction, adjusted for the presumed latency period. And of course it is inappropriate to use discounted figures to value immediate risks.

Future benefits are undervalued because regulators discount figures drawn from these studies—and the figures have already been (at least partially) discounted by the participants in the study.

Note that there is no countervailing error here that leads to benefits being overvalued:[116] no one is incorporating past costs or benefits into cost-benefit analysis, so there is no corollary opportunity for past benefits to be double-compounded (which would be the opposite of double-discounting). Because regulatory cost-benefit analyses are prospective, time-indeterminacy merely *depresses* the apparent value of regulatory risks. This means that risks to life and health are being systematically under valued. To the extent cost-benefit analyses informs regulatory policy, even at the margin, this suggests that federal regulations are *underprotecting* the public against regulatory risks.

III. TOWARDS A (PARTIAL) SOLUTION

Regulators need to know *when* a risk is being valued to determine *how much* it is being valued. This requires two things. First, regulators must know when a risk is being valued—so regulatory practices should be built on time-determinate studies. To that end, this Part recommends a few strategies for increasing the time-determinacy of valuation studies.

But time-determinate studies are not sufficient on their own. As the second section in this Part explains, once they have time-determinate valuations, regulators must match their discounting practices to the timing of those valuations. Discounting should be used to adjust the monetary value of goods so that expenditures at different times can be meaningfully compared to one another. That means that only future valuations should be discounted, and that they should only be discounted once, not twice.

116 Of course there might be other errors in the calculations, so I cannot speak to the *net* result of cost-benefit analyses. Here, I mean only that regulators are not somehow offsetting double-discounting with double compounding.

A. Improving Time-Determinacy

How can regulators make studies time-determinate, or at least more time-determinate? I can see several paths towards improvement.

First, if regulators want to use wage/risk studies to value risk reductions, they should adjust these studies for implicit latency. One option here is to identify the objective expected latency of whatever is being measured and assume that that is the time period participants are using. Another option would be to use existing studies on the perception of risks to adjust for the subjective latency of various risk sources. Neither of these is going to make wage/risk studies perfectly time-determinate, because the structure of these studies relies on implicit risk assessments. But either of these approaches would offer substantive improvement, and future wage/risk studies can be structured to account for potential latency in risk measurements.

Second, study designers should incorporate time-stamps into stated preference studies. Studies should elicit people's willingness to pay either for "immediate" risks or for risks with a particular latency.[117]

Finally, regulators should beware meta-analyses. By their nature, meta-analyses require cross-study comparisons: meta-analyses seek to aggregate data from a number of studies, to create a more meaningful baseline from which to work than a bare average. Because they necessarily compare across studies; however, they suffer from a particular vulnerability to potential time-indeterminacy. Unless the studies all have the same latency period, it is senseless to attempt to aggregate them: it is like aggregating dollars, yen, and euros, and expecting to get a meaningful number at the end. From this perspective, the growing popularity of meta-analyses is a troubling development.[118]

B. Choosing When to Value Preferences

If the solution to time-indeterminate analysis is to use time-determinate willingness-to-pay studies, however, we are left with a significant dilemma. Agencies should use time-determinate studies to

117 Note that some stated preference studies already do this. *See, e.g.*, MILLER & GURIA, *supra* note 11.

118 EPA has yet to explicitly incorporate meta-analyses into its Guidelines, although a few analyses have already been run with VSLs based on meta-analyses. EPA, 2008 GUIDELINES, *supra* note 65, at 7–6. Needless to say, recent agency evaluations of these meta-analyses have not identified either double discounting or time indeterminacy as a potential problem. *See* EPA, VSL META-ANALYSES, *supra* note 49, at 25 (failing to mention double discounting or time indeterminacy as issues to be considered).

determine how much people are willing to pay for regulatory goods, because money has a time value, and without knowing *when* the payment is to be made, we do not actually know *how much* people are willing to pay. But in that case, *when* should we measure willingness to pay? This is a surprisingly difficult question. To see why, let us imagine two possible practices for valuing future risk reductions.

First, regulators might simply elicit people's current willingness to pay for the future benefit. They might, in other words, seek to ask: "How much would you pay now to avert a 1-in-100,000 risk of dying from cancer in twenty years?" This would be asking the participant to identify the present value they attach to the benefit of the risk reduction in twenty years. If the participant responded to this question with "$3," there would be no need for regulators to discount this figure. In fact, it would be an error to do so, because the answer is already framed as a present value: discounting it would just give us mathematical nonsense. If the participant says $3, then that is the present value of the future benefit.

A second option would be this: we could elicit people's willingness to pay for a current benefit and then assume that the underlying value of the risk remains constant through time. This approach is essentially what regulators have been trying to do for decades. As an initial step, then, regulators might ask: "How much would you pay now to avert a 1-in-100,000 risk of dying immediately?" The answer would be the present value of the immediate risk. To use this figure to value future risks, regulators would have to make an additional assumption: that there is (or at least should be) *no* intertemporal variation in valuations. That is, they must assume that it is appropriate to attach the same underlying value to risk reductions regardless of when they occur.

Either of these approaches would give regulators current valuations of future risk. Both approaches result in discounted figures—the first option discounted by study participants, the second by regulators. Obviously these are either-or options because either practice gives us the present value of the valuations, so we would never want to combine them together, lest we return to current practice—inadvertent double-discounting, and the undervaluation of regulatory benefits.

Does it matter which we choose? If both of these paths led to the same destination, the choice between them would be less fraught. But there is reason to think that there would be large differences between them. That is because the first option (valuation of future risks) asks study participants to provide their own discount rates, while the second option (valuation of immediate risks) requires regulators to apply

a discount rate. These rates are likely to be vastly different: the best evidence so far is that people do not apply a constant discount rate even to money,[119] and there is some evidence that they discount differently depending upon whether they conceive themselves to be trading off money with money, or money with risk.[120] When a risk is valued is therefore likely to affect the choice of the discount rate—and therefore the valuations used in the final analyses.

There is no clear best choice from a methodological perspective about when to value risks. Rather, which approach is preferable on methodological grounds will depend upon a number of controversial questions, including whether people are good agents for their future selves, and whether they are good agents for future people. Resolving these questions requires a sophisticated behavioral account of intertemporal decisionmaking, as well as deep normative accounts of the appropriate role of the regulatory system within a democracy, and of our ethical obligations to future persons. It is beyond the scope of this Article to deal with these issues in the depth they deserve, so I merely sketch some of the concerns here.

Consider the assumption that regulators must make to apply immediate willingness-to-pay studies to future risks: that it is appropriate to attach the same underlying value to risk reductions regardless of when they occur. Why would we think that? Certainly it is not true as a behavioral matter that people *do* attach the same value to risk reductions no matter when they occur.[121] On the contrary, people

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119 *See* Shane Frederick et al., *Time Discounting and Time Preference: A Critical Review*, 40 J. ECON. LITERATURE 351, 360–62 (2002) (reviewing evidence of hyperbolic discounting).

120 *See* Anna Alberini & Aline Chiabai, *Discount Rates in Risk v. Money and Money v. Money Tradeoffs* 4 (Fondazione Eni Enrico Mattei, Working Paper No. 8.2006, 2006), *available at* http://ssrn.com/abstract=876934 (finding that "the discount rate in money v. risk tradeoffs is about 2%, while that in money v. money tradeoffs is 8.7%"). This suggests that when a good is monetized may determine whether the figures elicited are discounted at the rate for money vs. risk or risk vs. risk.

121 *See id.* at 2; Alberini, *supra* note 5, at 231 (finding that delaying the time at which the risk reduction occurs by ten to thirty years decreases the willingness to pay for reduced mortality risk by greater than 60% in samples of people forty to sixty years old). For a discussion on the social discount rate literature, see Mark K. Dreyfus & W. Kip Viscusi, *Rates of Time Preference and Consumer Valuations of Automobile Safety and Fuel Efficiency*, 38 J. L. & ECON. 79, 103 (1995) (estimating an 11–17% rate of time preference); Moore & Viscusi, *supra* note 90, at 386 (finding that workers discount future life years at 9.6–12.2% imputed discount rate); and W. Kip Viscusi & Michael J. Moore, *Rates of Time Preference and Valuations of the Duration of Life*, 38 J. PUB. ECON. 297, 314 (1989) (calculating an implied discount rate of 10.7%).

exhibit hyperbolic discounting[122] and dynamic inconsistency.[123] Nor is there reason to think that the valuations of people in the study are coextensive with the interests of future persons.[124]

It might be that people *should* attach the same value regardless of when it occurs. This might be true either as a rational or an ethical matter. Rationally speaking, it may be that hyperbolic discounting is an irrational approach to valuation, at least intra-lifetime. Ethically speaking, it may be that it is unethical, immoral, or inappropriate to value harms to future generations less than we value harms to ourselves. But is it the appropriate role of the regulatory system to enforce ethical norms? And under what circumstances ought it to do so: as a strong default, a weak default, or only upon exceptional circumstances, when there is compelling reason to believe that people's bare preferences are fundamentally unethical?

If people do not express preference for intertemporal neutrality, what should policymakers do? Three options spring to mind. First, policymakers might simply enforce existing expressed preferences, regardless of whether those preferences appear to be informed and/or ethical. Second, policymakers might implement what they (the policymakers) believe to be the ethical or appropriate policy, regardless of expressed preferences. Or third, policymakers might choose either policy as a default and create opt-out or change provisions to allow for preference change over time. [125]

These approaches have different benefits and drawbacks, and it is beyond the scope of this article to discuss them in depth. For now, the point is merely that different valuation practices should be paired with complementary discounting practices.

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122 That is, people's valuations of goods do not decline in value linearly over time. *See* Frederick et al., *supra* note 119, at 360–62; Christine Jolls et al., *A Behavioral Approach to Law and Economics*, 50 STAN. L. REV. 1471, 1539–40 (1998).

123 That is, people's preferences are not constant over time, such that what they prefer at one point in time is inconsistent with what is preferred at another point in time. *See* George Loewenstein & Drazen Prelec, *Anomalies in Intertemporal Choice: Evidence and an Interpretation*, 107 Q.J. ECON. 573, 594–96 (1992) (discussing the effect of time delays on discounting); Richard Thaler, *Some Empirical Evidence on Dynamic Inconsistency*, 8 ECON. LETTERS 201, 205 (1981) (finding individual discount rates for gains vary inversely with the size of the reward and the length of time until it is received).

124 *See* ANDERSON, *supra* note 3, at 15; Sunstein & Rowell, *supra* note 4, at 178.

125 For a model based on opt-outs, see Cass R. Sunstein & Richard H. Thaler, *Libertarian Paternalism Is Not an Oxymoron*, 70 U. CHI. L. REV. 1159, 1190–1202 (2003).

IV. OBJECTIONS

This Article has argued that the timing of preferences matters and discounting practices should be consistent with valuation practices. How might this argument be resisted?

One response might be that the project of monetization is itself problematic, because monetary valuations are necessarily incomplete representations of the true worth goods like life and health. This may be true, but it should not lead us to think that monetized valuations are worthless. Even incomplete valuations can give us some useful policy guidance.[126]

Another response might be to object to the process of discounting. That is, perhaps we should refuse to discount both immediate valuations and future valuations, so that we spend the same amount of money today to avert a mortality risk, regardless of when that mortality risk will occur. This kind of objection to discounting is really an objection to the project of monetization, because discounting follows from the time-value of money.[127]

A third objection might focus on the interests of future generations. One influential legal article on discounting, for example, distinguishes between "latent harms" (harms to one's future self) and "intergenerational harms" (harms to people who do not yet exist).[128] It argues that our ethical obligations to future generations are different than our ethical obligations to our future selves. The article concludes that it is appropriate for us to discount the value of latent harms, but not to discount the value of harms that accrue to future generations.[129]

We might have different obligations to people who exist now and people who exist in the future. What is not clear is why this should lead us to the conclusion that we should refuse to discount harms to future generations. This response is problematic for two reasons.

First, it is very difficult—perhaps impossible—to create an administrable distinction between latent harms and intergenerational harms. Time has a habit of moving forward, and people keep dying, being born, and having eighteenth birthdays: there is no fixed "present" generation. This is a real problem for any regulatory system that seeks to apply different analytical standards to present and future people.

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126 For a fuller discussion of this point, see *supra* notes 106–08.

127 *See* Sunstein & Rowell, *supra* note 4, at 181–86.

128 *See* Revesz, *supra* note 14, at 984–85, 1008–09.

129 *See id.* at 1015–17.

Of course, practical administrative difficulties might not be dispositive if it were important enough as an ethical matter to distinguish generations.[130] But this leads to the second difficulty with tying discounting policies to generationality: it is not so clear that the key ethical difficulties with intertemporality will divide along generational lines. Many intertemporal difficulties seem instead to stem from classic agency problems of conflicting interests. The more the interests of two people diverge, the less confident we feel about person one acting as an agent for person two.

Future generations do not have a monopoly on divergent interests. We are often poor agents for other (existing) people and even for our future selves.[131] Consider this popular monologue from comic Jerry Seinfeld:

> I never get enough sleep. I stay up late at night, 'cause I'm Night Guy. Night Guy wants to stay up late. "What about getting up after five hours sleep?" Oh, that's Morning Guy's problem. That's not my problem, I'm Night Guy. I stay up as late as I want. So you get up in the morning, . . . you're exhausted, groggy: ooh I hate that Night Guy! See, Night Guy always screws Morning Guy. There's nothing Morning Guy can do.[132]

To the extent that their interests diverge—here, in the matter of choosing a bedtime—Night Guy is a poor agent for Morning Guy. This is not to say that Night Guy is a poor agent for Morning Guy about all issues: on many issues, their interests likely converge, as both share the corporeal body of Jerry Seinfeld, and no doubt the majority

130 After all, the regulatory system could apply an arbitrary "generational" cut off, of say a quarter century, and make a policy determination that all citizens who have been born by the time of the promulgation of the final regulation belong to the "current" generation, and that "future" generations consist of everyone who has not yet been born or attained citizenship (but who one day will). Or perhaps the policy could include noncitizens who are in the country as well; only people who have reached their eighteenth birthday; only people between the ages of eighteen and thirty five; or only people who are all of these things and certifiably sane. Of course, to decide which of these cut-offs to select—to decide who should qualify as a future generation—we must make controversial normative decisions about who should count as a person today. But perhaps it would be worth doing so for sufficient ethical payoff.

131 For different models of intertemporal choice, see for example, DEREK PARFIT, REASONS AND PERSONS 211 (1984) (presenting the possibility of conceiving of people as successive selves, brain and body, extending through time); John C. Harsanyi, *Morality and the Theory of Rational Behaviour, in* UTILITARIANISM AND BEYOND 39, 54–56 (Amartya Sen & Bernard Williams eds., 1982) (presenting a lifetime model based on utilitarianism).

132 *Seinfeld: The Glasses* (NBC television broadcast Sept. 30, 1993).

of their preferences. But Night Guy cannot be trusted to represent Morning Guy's interests in the matter of choosing when to go to bed.

Perhaps we can presume that, on average, people have more interests in common with their future selves than with other future persons, so that generationality can be used as a proxy for quality of agency. The danger of this approach is that it is likely to be both overinclusive (as where existing people have significant interests in common with as-yet-unborn children and grandchildren) and underinclusive (as where Night Guy stays up too late or where the interests of an eighteen-year-old in looking tanned deviate significantly from the interests of that same person at retirement age). But if the relevant inquiry is really into how good an agent person one is for person two, then that is the line we should draw for policy purposes.

If present persons do have a moral obligation to avoid imposing serious harms on future persons, refusing to discount is a crude way of satisfying that obligation. And in some circumstances, it will even have the perverse effect of imposing additional uncompensated risks on future people.[133]

This point is addressed in more detail in a prior work.[134] The basic gist, however, is that future persons benefit from economic growth. Paying massive amounts for regulatory programs today will not benefit the future insofar as money spent on those programs cannot be spent elsewhere—on promoting medical, environmental, and other safety technologies, say, or on increasing education. These things benefit both present and future persons, and to the extent discounting reduces investment in projects that promote longterm prosperity, it is likely to harm—not help—future people.

The present may well have significant moral obligations to the future. These moral obligations will be fulfilled neither by discounting nor refusing to discount.[135] Determining the extent of these obligations is a massive policy inquiry in its own right, one which this Article sets aside for another time.[136] Whatever these obligations, however, regulators must match discounting practices to valuation practices. Failing to do so creates time-indeterminacy, and a fundamental mismatch between policy goals and practice.

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133 *See id.*

134 *See id.* at 198–203.

135 *See id.* at 198–99.

136 For diverse perspectives, see generally Symposium, *What Does Our Legal System Owe Future Generations? New Analyses of Intergenerational Justice for a New Century*, 77 GEO. W. L. REV. 1133 (2009) (providing fourteen articles on the topic of intergenerational justice).

V. IMPLICATIONS OF TIME-INDETERMINACY IN OTHER CONTEXTS

What are the implications for time-indeterminacy in other contexts? A few points spring to mind. First, money has a particular relationship with time, and as I have argued, we must respect that relationship if we are to continue to use money as a metric. Wherever economic cost-benefit analyses inform policy, then, we should be wary as to the timing of the underlying valuations and awake to the possibility that one side of the cost-benefit "equation" may be systematically devalued. Judges applying the Hand Formula, for example, compare the burden of a precaution to the probability and magnitude of loss if the precaution is untaken. In performing this analysis, judges ought to consider the relative timing of the precaution and the potential loss. To the extent that they monetize the expenditure and loss, they should apply a monetary discount rate to make the amount of the possible loss comparable to the cost of the possible precaution. Judges do not appear to do this, although discounting (and compounding) are used in other judicial contexts.[137] Because precautions precede losses, this suggests that time-indeterminate Hand Formula calculations tend to bias outcomes toward too much liability for defendants.

Of course, not all legal analyses are economic, and some goods may have different relationships with time than does money. So long as there is potential intertemporal variation in the valuation of a good, however—be that good risk reduction, the preservation of a beautiful natural landscape, or the extension of a life—time-indeterminacy is potentially a problem. This would include any context where preferences inform policy. In such situations, we should be careful to pin down the timing of preferences.

CONCLUSION

Because regulators treat time-indeterminate studies as if they actually measure immediate willingness-to-pay, regulatory cost-benefit analyses are systematically undervaluing regulatory benefits. To the extent cost-benefit analysis informs regulatory policy, this means that federal regulations are systematically biased against protecting the public from risks to health and safety.

Because money has a time-value, time-indeterminate willingness-to-pay studies do not actually tell us how much people are willing to

137 Most notable, perhaps, is the relatively entrenched practice of adjusting monetary damage awards for the latency period between the time that the damage occurred and the time of the judgment.

pay. To eliminate time-indeterminacy in their analyses, regulators should rely only on willingness-to-pay studies that identify the time at which regulatory goods are being valued. Regulators should adopt discounting policies that complement their valuation policies.

Unfortunately, identifying the appropriate time at which to measure valuations requires a theory of temporal valuation. This Article has identified two theories that are preferable to current practice. It is worth debating which approach is best.