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Grading the Government

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For over a decade, scathing critiques of government have been fueled by a group of studies called "regulatory scorecards," which purport to show that the costs of many government regulations vastly outweigh their benefits. One widely cited study by John Morrall, an OMB economist, claims that government regulations cost up to $72 billion per life saved. Another study, co-authored by Bush's regulatory "czar," John Graham, claims that over 60,000 people lose their lives each year due to irrational government regulation. A third group of scorecards—compiled by Robert Hahn of the AEI-Brookings Joint Center for Regulatory Studies—claims that over half of all major regulations issued since 1981 fail cost-benefit tests. These studies have contributed mightily to a widespread skepticism about the ability of government to regulate rationally. This skepticism has produced, in turn: legislative requirements for more elaborate agency analyses, closer OMB oversight, congressional review of agency decisions, a stream of proposals for further "regulatory reforms" aimed at reining in government agencies, and a hostile climate for all proposed new measures to protect public health, safety, and the environment through regulation.

But what is the skepticism based on? This Article demonstrates that all three scorecards rely on undisclosed data and non-replicable calculations; use biased regulatory samples; misrepresent ex ante guesses about costs and benefits as actual measurements; and grossly underestimate the value of lives saved, or the number of lives saved, or both. They also exclude all unquantified costs and benefits, disregard all questions about the fairness of the distribution of cost and risk, and conceal the large uncertainties that are present in virtually every regulatory analysis. Close inspection reveals that Graham's sensational claim—that 60,000 lives are lost each year through irrational regulation—is not supported by his study's own data. In short, these studies are so fundamentally flawed that they prove nothing at all about the rationality of regulation.

This Article also shows that the most serious defects in these studies are endemic to strictly numerical scorecards and render them a defunct mode of analysis. The Article concludes with several affirmative recommendations for improving the assessment of individual rules and government regulation overall.

INTRODUCTION

The Office of Management and Budget (OMB) estimates that federal government regulation costs businesses or consumers over $500 billion per year.[1] Millions of Americans—as well as many schol-

† Professor of Law, University of Connecticut School of Law. I am grateful for the comments of Ellen Brown, John Donohue, Charles Gordon, Lisa Heinzerling, Thomas McGarity, Sidney Shapiro, Peter Siegelman, Cass Sunstein, and Larry Weinstock. Peter Haberlandt, Jonathan Lave, Amanda Littell, and Jerre Harris provided valuable research assistance. I am also grateful to the Administrative Law Section of the American Bar Association for insightful comments and questions during my presentation of an early version of this Article. Special thanks to

ars, pundits, think tank analysts, the President, his staff, and a majority or near majority of the House and Senate—believe the costs of these regulations often outweigh their benefits.[2]

The result has been a sustained campaign to try to force agencies to be more "rational": demands for ever more elaborate regulatory impact analyses, closer OMB review of agency regulatory decisions (with more frequent returns), new requirements for congressional review of individual agency decisions, a stream of proposals for further "reforms" to rein in agencies, and an indeterminate number of foregone regulations aimed at protecting public health, safety, and the environment.[3]

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the library staffs of Georgetown University Law Center and University of Connecticut Law School for superb assistance in tracking down esoteric agency documents.

[1] See OMB, Draft Report to Congress on the Costs and Benefits of Federal Regulations, Notice, 67 Fed Reg 15013, 15038 (2002). Estimates by leading regulatory critics are even higher. See Clyde Wayne Crews, Jr., *Ten Thousand Commandments: An Annual Policymaker's Snapshot of the Federal Regulatory State* (2001), online at http://www.cei.org/PDFs/10KC_2001.pdf (visited May 5, 2003) (estimating year 2000 costs at $788 billion); Thomas D. Hopkins, *Regulatory Costs in Profile*, Center for the Study of American Business Policy Study No 132 (Aug 1996), online at http://wc.wustl.edu/csab/CSAB%20pubs-pdf%20files/Policy%20Studies/ps132%20hopkins.pdf (visited May 5, 2003) (estimating costs at $688 billion per year).

[2] According to a December 2002 Harris poll, 26 percent of voters polled expressed a "great deal of confidence in the executive branch of the federal government"—a number which is up from historical (pre-9/11) figures of 18–20 percent—while nearly half of those surveyed in a Council for Excellence in Government poll agreed that "we deserve to get better government." Harris Poll, Dec 12–16, 2002, and Council for Excellence in Government Poll, May 21–28, June 1, 1999, online at http://www.pollingreport.com/institut.htm (visited May 5, 2003). The Contract with America devoted an entire chapter to the need to "Roll Back Government Regulations and Create Jobs." Ed Gillespie and Bob Schellhas, eds, *Contract with America: The Bold Plan by Rep. Newt Gingrich, Rep. Dick Armey, and the House Republicans to Change the Nation* 125 (Random House 1994). Although the Contract did not pass in its entirety, major regulatory "reforms" did get enacted, and countless other reform bills have been, and continue to be, proposed. See note 3. For examples of cost-benefit critiques by policymakers and scholars, see notes 4, 8–10, 13, 15–18, 20–22, 26–27, and 29.

[3] See Unfunded Mandates Reform Act of 1995, Pub L No 104-4, 109 Stat 48 (1995), codified at 2 USC §§ 1501–71 (2000); Contract with America Advancement Act of 1996, Pub L No 104-121, 110 Stat 847, enacting the 1996 Small Business Regulatory Enforcement Fairness Act, codified at 5 USC § 601 (2000) and 5 USC §§ 801–08 (2000); Government Performance and Results Act of 1993, Pub L No 103-62, 107 Stat 285, codified at 31 USC §§ 1101, 1115 (2000). See also Patrick J. Michaels, *Regulatory Overhaul Report Card*, Wash Times A17 (June 10, 2002); Ellen Nakashima, *For Bush's Regulatory Czar, The Equation Is Persuasion; Graham Wields Cost-Benefit Analysis For, Against Rules*, Wash Post A35 (May 10, 2002). For examples of reform proposals driven primarily by cost-benefit critiques, see Robert W. Hahn and Robert E. Litan, *Recommendations for Improving Federal Regulation, Testimony before the Subcommittee on Regulatory Reform and Oversight, the House Committee on Small Business* (June 2002), online at http://www.aei-brookings.org/admin/pdffiles/testimony_02_05.pdf (visited May 5, 2003); Erin M. Hymel and Laurence H. Whiteman, *Regulation: Reining in the Federal Bureaucracy*, in *Issues 2002: The Candidate's Briefing Book* (Heritage Foundation 2002); C. Boyden Gray, *Obstacles to Regulatory Reform*, 1997 U Chi Legal F 1, 1–5; W. Kip Viscusi, *Regulating the Regulators*, 63 U Chi L Rev 1423, 1436–55 (1996); Richard H. Pildes and Cass R. Sunstein, *Reinventing the Regula-*

Although regulatory skepticism is by no means new, the recent wave of regulatory skepticism is distinct from earlier attitudes. If the traditional concern was that agencies would be captured by regulated interests and, consequently, would regulate too little, the modern critique is led by charges that agencies—driven by ideology, bureaucratic ambition, or "public interest" pressures—are regulating too strictly and too much. And the cure offered by these critics is not more or better representation in the rulemaking processes as in the past, but more analysis and searching outside review.[4]

The remarkable ascendancy of the anti-regulatory movement derives from two main empirical sources. One is a stream of well-publicized "horror stories" of government zealotry and caprice: companies forced to clean up Superfund sites to the point where children can eat the soil 245 days a year; air quality regulations issued in total disregard of costs; property owners denied development rights when the footprints of cows were declared wetlands, and so forth.[5]

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tory State, 62 U Chi L Rev 1 (1995); Stephen Breyer, *Breaking the Vicious Circle: Toward Effective Risk Regulation* (Harvard 1993). Congressional proposals for reform are far too numerous to catalogue. For a few examples, see Agency Accountability Act, S 849, 107th Cong, 1st Sess, in 147 Cong Rec S 4603 (May 9, 2001); HR 750, 107th Cong, 1st Sess, in 147 Cong Rec H 441 (Feb 27, 2001) (requiring full regulatory impact analysis for regulations impacting small businesses); Regulatory Improvement Act, S 981, 105th Cong, 1st Sess, in 143 Cong Rec S 6742 (June 27, 1997); The Dole-Johnston Comprehensive Regulatory Reform Act of 1995, S 343, 104th Cong, 1st Sess, in 141 Cong Rec S 2056 (Feb 2, 1995).

[4] Professor Shapiro offers an insightful discussion of the rhetorical shift in regulatory criticism from theories of agency capture (which he christens a "reformation") to stories of regulatory over-reach (which he calls a "counter-reformation"). See generally Sidney A. Shapiro, *Administrative Law after the Counter-Reformation: Restoring Faith in Pragmatic Government*, 48 U Kan L Rev 689 (2000). Professor Sunstein discerns three separate strands of regulatory criticism: the agency capture and the contrasting adversarial schools mentioned by Shapiro, and the bureaucratic self-aggrandizement theory of administrative behavior put forward by Niskanen and others. See Cass R. Sunstein, *Cost-Benefit Analysis and the Separation of Powers*, 23 Ariz L Rev 1267, 1269 (1981). The classic expression of the traditional critique may be found in Grant McConnell, *Private Power and American Democracy* (Knopf 1966). Dual critiques—expressing concerns with agency capture by regulated interests *or* public interest groups—may be found in Daniel C. Esty, *Toward Optimal Environmental Governance*, 74 NYU L Rev 1495, 1515–18 (1999) (providing an excellent overview of the public choice literature and documenting some egregious cases of regulatory capture—both by industry and environmental groups); and William N. Eskridge, Jr., *Politics Without Romance: Implications of Public Choice Theory for Statutory Interpretation*, 74 Va L Rev 275, 285–90 (1988).

[5] The two most famous and influential anecdote-based critiques of regulation are Philip K. Howard's national best-seller, *The Death of Common Sense: How Law Is Suffocating America* (Random House 1995), and Stephen Breyer's book, *Breaking the Vicious Circle* (cited in note 3). The journalist Richard Lacayo reported that *The Death of Common Sense* is "amply stocked with . . . loosely detailed horror stories about regulatory mischief. Some of them are memorable; some partial or misleading; some flatly wrong." Richard Lacayo, *Anecdotes Not Antidotes: Philip Howard Is Everyone's Favorite Anti-regulatory Guru, But His Best-Selling Book Is Flawed*, Time 40 (Apr 10, 1995). He goes on to rebut several prominent horror stories. See id. David Mehegan points out that "[n]one [of Howard's anecdotes] is footnoted, so we can't check Howard's facts or assess his interpretations." David Mehegan, *A Seductive, Simple-Minded Attack on Rules*, Boston Globe 57 (Feb 14, 1995). For critiques of Breyer on empirical and conceptual grounds, see

This Article will not have much to say about these stories, except that they need to be treated with caution. Anyone who begins to investigate these stories quickly finds out that some are true; others are exaggerated; many are simply fabricated.[6] Most are published (or repeated) as stories with little or no investigation of the facts. Even if the story turns out to be true, one has no way of knowing whether the incident is typical of agency practice or an aberration.[7]

The obvious shortcomings of anecdotes as vehicles of proof have given rise to a group of broader studies that have largely supplanted anecdotes as the leading source of regulatory skepticism. These studies have yet to be recognized as a formal genre. I will call them "regulatory scorecards."

Regulatory scorecards are a sub-species of cost-benefit analysis. While the typical cost-benefit analysis devotes hundreds of pages to a

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Adam M. Finkel, *A Second Opinion on an Environmental Misdiagnosis: The Risky Prescriptions of* Breaking the Vicious Circle, 3 NYU Envir L J 295 (1995); Sheila Jasanoff, *The Dilemmas of Risk Regulation: Review of* Breaking the Vicious Circle, 10 Issues in Sci & Tech 79 (1994).

[6] For example, the first anecdote cited above has not been rebutted. The second is a misstatement of law: the Clean Air Act does not rule out cost consideration in air pollution standard setting, as the Supreme Court made clear in its unanimous decision in *Whitman v American Trucking Associations, Inc*, 531 US 457, 486 (2001) (concluding from the many Clean Air Act subsections that expressly require EPA to consider cost in setting technology-based emissions standards that Clean Air Act § 109(b) does not indicate an implied congressional intent to permit EPA to consider costs in setting health-based ambient air quality standards). The third anecdote is pure fabrication. The "footprints of cows" to which House Majority Leader Tom DeLay referred (in successfully opposing Clean Water Act re-authorization) were not footprints at all, but "wetland sloughs" several feet deep and up to two hundred feet wide, which fill with water every year to provide vital sustenance to local and migrating birds. In fact, the land in question is not pasture, but a forest which forms a part of the "only [remaining] large forest habitat adjacent to the Gulf of Mexico." See Letter of David L. Hankla, Field Supervisor, US Fish and Wildlife Service, to Colonel Robert B. Gatlin, US Army Corps of Engineers (Apr 19, 1995) (on file with author).

For evidence of the broader veracity problem in the regulatory debate, see, for example, Citizens for Sensible Safeguards, *Myths & Consequences: Paying for the Use of Myths and Distortions by Anti-regulatory Zealots* (May 17, 1995) (unpublished manuscript on file with author) (collecting twenty-seven widely circulating anecdotes about government regulation that are false, exaggerated, or at least factually contested); Tom Kenworthy, *Truth Is Victim in Rules Debate: Facts Don't Burden Some Hill Tales of Regulatory Abuse*, Wash Post A1 (Mar 19, 1995) (relating anecdotes that "have the ring of truth, but not the substance"); Jessica Mathews, *Horror in the House*, Wash Post C7 (Mar 5, 1995).

[7] As Roger Parloff pointed out in his review, "the rhetorical power of *The Death of Common Sense* derives from the fact that Howard provides only one set of anecdotal horror stories—those that stem from certain unwise laws and regulations, or from unwise applications of them. He never tells the horror stories that prompted all of these laws and regulations." Roger Parloff, *The Death of Common Sense—And Its Apotheosis*, Am Law 34 (Apr 1995). See also David A. Wirth and Ellen K. Silbergeld, *Book Review: Risky Reform*, 95 Colum L Rev 1857, 1884 (1995) (noting that *Breaking the Vicious Circle* "focuses almost exclusively on cases of regulatory overkill . . . [while] situations that demand more aggressive or rigorous regulatory requirements . . . receive scant attention").

narrative describing the costs and benefits of a single project or rule, scorecards reduce these hundreds of pages to a few summary statistics—costs, benefits, net benefits, and/or cost per life saved. Scorecards then tabulate these summary statistics across scores of rules in order to generate what appears to be a concise, precise, and comprehensive picture of the cost-benefit rationality of programs, agencies, and regulations overall.

While any number of such scorecards are circulating, three sets of scorecards have been particularly influential in shaping the modern debate over the rationality of the administrative state:

- In 1987, an OMB economist named John Morrall published a table which suggests that federal regulations cost up to $72 *billion* per life saved, and that nearly one-third of the forty-four regulations in his table cost over $100 million for every life saved.[8]

- In 1995, John Graham and Tammy Tengs at the Harvard Center for Risk Analysis co-authored a study, entitled *Five-Hundred Life-Saving Interventions and Their Cost Effectiveness*, which reported that regulatory interventions impose wildly disparate costs ranging from less than zero (saving money) to more than $1 *trillion* per life saved.[9] The least cost-effective interventions, they found, are those aimed at controlling toxins.

  In 1996, Graham and Tengs published a second study, *The Opportunity Costs of Haphazard Social Investments in Life-Saving*, which used a computer to see how many additional lives might be saved at constant cost by reallocating funds among some of the interventions examined in their earlier study.[10] The conclusion: sixty thousand additional lives are lost each year by spending money on small or costly risks instead of more cost-effective interventions.[11] Graham calls this "statistical murder."[12]

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[8] John F. Morrall III, *A Review of the Record*, Regulation 25, 30 table 4 (Nov–Dec 1986).

[9] Tammy O. Tengs, et al, *Five-Hundred Life-Saving Interventions and Their Cost-Effectiveness*, 15 Risk Analysis 369 (1995) (calculated by multiplying $99 billion, the highest cost per life-year in the Tengs database, by 15, a conservative estimate of the number of life-years associated with each life saved).

[10] Tammy O. Tengs and John D. Graham, *The Opportunity Costs of Haphazard Social Investments in Life-Saving*, in Robert W. Hahn, ed, *Risks, Costs and Lives Saved: Getting Better Results from Regulation* ch 8 (Oxford 1996).

[11] Id at 177.

[12] Risk Assessment and Cost-Benefit Analysis, Hearings before the House Committee on Science, 104th Cong, 1st Sess 71, 79 (Jan 31, 1995) (testimony of John D. Graham).

- In 2000, Robert Hahn updated his widely cited 1996 study—*Regulatory Reform: What Do the Government's Numbers Tell Us?*—with a new study entitled *Regulatory Reform: Assessing the U.S. Government's Numbers*. These studies examine over 100 major regulations in what Hahn claims is "the most comprehensive assessment to date of the impact of federal regulatory activities on the economy."[13] Both studies reach the same conclusion: though regulations confer a net benefit on society overall, "less than half the rules pass a neutral economist's benefit-cost test" using the government's own numbers.[14]

When three widely cited studies reach the same dramatic conclusion, it should come as no surprise that the impact is enormous. The Morrall table has fueled scathing regulatory critiques by Justice Stephen Breyer, Kip Viscusi, Cass Sunstein, and others.[15] It has appeared in OMB annual reports to Congress, in congressional testimony, in court of appeals opinions, and in the debate over the 1994 House Republicans' Contract with America.[16] Law students receive their baptism in the follies of regulation when they encounter the Morrall table in their administrative law and environmental law casebooks and classroom readings.[17] Scientists and aficionados of science

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13 See Robert W. Hahn, *Regulatory Reform: Assessing the Government's Numbers*, in Robert W. Hahn, *Reviving Regulatory Reform: A Global Perspective* 32 (AEI-Brookings 2000) (hereinafter *Government's Numbers* (2000)); Robert W. Hahn, *Regulatory Reform: What Do the Government's Numbers Tell Us?*, in Hahn, ed, *Risks, Costs and Lives Saved* ch 10 (cited in note 10) (hereinafter *Government's Numbers* (1996)).

14 Hahn, *Government's Numbers* (2000) at 38 (cited in note 13); Hahn, *Government's Numbers* (1996) at 239 (cited in note 13).

15 See, for example, Breyer, *Vicious Circle* at 24–27 (cited in note 3); W. Kip Viscusi, *Fatal Tradeoffs: Public and Private Responsibilities for Risk* 264 table 14-5 (Oxford 1992); Viscusi, 63 U Chi L Rev at 1430–36 table 1 (cited in note 3); Cass R. Sunstein, *Health-Health Tradeoffs*, 63 U Chi L Rev 1533, 1547–48 table 2 (1996); Cass R. Sunstein, *Paradoxes of the Regulatory State*, 57 U Chi L Rev 407, 410 (1990). These sources are cited in Lisa Heinzerling, *Regulatory Costs of Mythic Proportions*, 107 Yale L J 1981, 1983 n 2 (1998).

16 OMB, *Regulatory Program of the United States Government* (Apr 1, 1991–Mar 31, 1992) 12 table 2 (Executive Office of the President 1991); Joint Hearing on the Impact of Workplace and Employment Regulation on Business, Joint Hearing before the Subcommittee on Oversight and Investigations of the House Committee on Economic and Educational Opportunities and the Subcommittee on Regulation and Paperwork of the House Committee on Small Business, 104th Cong, 1st Sess 32 (1995) (testimony of Robert W. Hahn); Department of Energy Risk Management Act of 1995, S 333, 104th Cong, 1st Sess, in 141 Cong Rec S 2041–42 (Feb 2, 1995) (statement of Senator Murkowski); Gillespie and Schellhas, eds, *Contract with America* at 131–35 (cited in note 2). See Heinzerling, 107 Yale L J at 1983–84 n 3 (cited in note 15).

17 See, for example, Stephen G. Breyer, et al, *Administrative Law and Regulatory Policy:*

confront the lunacy of regulation in two articles in the prestigious journal, *Science*, in which leading economists (including Nobel-laureate Kenneth Arrow) rely on the Morrall table to argue for more "rational" approaches to regulation.[18]

Scores of newspapers and magazines across America have reported Tengs/Graham's sensational claim that irrational federal regulation is killing over 60,000 people per year.[19] Graham and others have repeated the claim in testimony before Congress, while members of Congress regularly invoke the Tengs/Graham findings in floor debates.[20] The critique has been picked up in scholarly journals,[21] in a

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Problems, Text, and Cases 158–59 (Aspen 4th ed 1998); Robert V. Percival, et al, *Environmental Regulation: Law, Science, and Policy* 561 figure 4.8 (Aspen 2d ed 1996); W. Kip Viscusi, *Regulating the Regulators*, in Robert N. Stavins, ed, *Economics of the Environment: Selected Readings* 325, 332–33 (Norton 4th ed 2000).

18 See Kenneth J. Arrow, et al, *Is There a Role for Benefit-Cost Analysis in Environmental, Health, and Safety Regulation?*, 272 Science 221, 221 (1996); Richard J. Zeckhauser and W. Kip Viscusi, *Risk within Reason*, 248 Science 559, 562–63 (1990).

19 See Bjorn Lomborg, *Yes, It Looks Bad, But . . .*, The Guardian (London) G2 (Aug 15, 2001); Sebastian Mallaby, *Saving Statistical Lives*, Wash Post A1 (Mar 5, 2001); *Risk vs. Risk: Government Could Save Money and Lives*, Houston Chron A38 (Mar 27, 1999); Jonathan Marshall, *Confused Rules Cost Lives*, San Fran Chron D1 (Aug 7, 1995); Editorial, *Try Again to Fix Regulations*, Boston Herald 26 (July 30, 1995). For magazine and journal articles, see Linda R. Cohen and Robert W. Hahn, *A Solution to Concerns over Public Access to Scientific Data*, 285 Science 535 (1999); Paul Raeburn, *Saving Lives Doesn't Have to Cost a Bundle*, Bus Wk 29 (July 14, 1997). For rare critical appraisals, see Lisa Heinzerling, *Five-Hundred Life-Saving Interventions and Their Misuse in the Debate over Regulatory Reform*, 13 RISK 151, 161 (2002); Lisa Heinzerling, *Don't Put the Fox in Charge of the Hens*, LA Times 15 (July 19, 2001); Joan Claybrook, *Poor Tools for Changing the Rules*, Wash Post A19 (Mar 24, 2001).

20 See Regulatory Improvement Act of 1999, Hearings on S 746 before the Senate Committee on Governmental Affairs, 106th Cong, 1st Sess 34 (1999) (statement of John D. Graham); Regulatory Right to Know Act of 1999, Hearing on HR 1074 before the Subcommittee on National Economic Growth, Natural Resources, and Regulatory Affairs of the House Committee on Government Reform, 106th Cong, 1st Sess (Mar 24, 1999) (statement of Angela Antonelli, Roe Institute for Economic Policy Studies of the Heritage Foundation); Regulatory Improvement Act of 1997, Hearing on S 981 before the Senate Committee on Governmental Affairs, 105th Cong, 1st Sess 27 (1997) (statement of Thomas F. Walton).

For references by members of Congress, see, for example, Regulatory Improvement Act of 1997, S 981, 105th Cong, 1st Sess, in 143 Cong Rec S 6749, 6749 (June 27, 1997) (statement of Senator Thompson); Remarks of Senator Dole, 104th Cong, 2d Sess, in 142 Cong Rec S 3787, 3788 (Apr 22, 1996).

21 See generally Cass R. Sunstein, *Cost-Benefit Default Principles*, 99 Mich L Rev 1651, 1660 n 44 (2001); Cass R. Sunstein, *Which Risks First?*, 1997 U Chi Legal F 101, 103 n 2. See also Mark Geistfeld, *Reconciling Cost-Benefit Analysis with the Principle that Safety Matters More than Money*, 76 NYU L Rev 114, 126–27 n 35 (2001); Robert W. Hahn, *State and Federal Regulatory Reform: A Comparative Analysis*, 29 J Legal Stud 873, 893 n 38 (2000); Richard L. Revesz, *Environmental Regulation, Cost-Benefit Analysis, and the Discounting of Human Lives*, 99 Colum L Rev 941, 972 (1999); C. Boyden Gray, *Obstacles to Regulatory Reform*, 1997 U Chi Legal F 1, 1; Jonathan Baert Wiener, *Comparative Risk Analysis and Public Policy: Risk in the Republic*, 8 Duke Envir L & Pol F 1, 20–21 n 44 (1997). For an example of Graham's own reiteration of the "statistical murder" charge, see John D. Graham, *Legislative Approaches to Achieving More Protection against Risk at Less Cost*, 1997 U Chi Legal F 13, 28.

leading casebook,[22] and in the publications of some of Washington's leading think tanks,[23] while the authors' broader charge—that government regulation is inefficient—has also received wide and credulous media coverage.[24]

Hahn's conclusions likewise have appeared in dozens of major newspapers and news magazines,[25] in testimony before congressional committees,[26] and in publications of scholars,[27] think tanks, lobbying organizations, and regulatory watchdog groups alike.[28]

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22 See Breyer, et al, *Administrative Law and Regulatory Policy* at 161–62 (cited in note 17).

23 See, for example, Robert W. Hahn and Patrick M. Dudley, *Bush Regulatory Czar Deserves High Marks*, Policy Matters 02-05 (AEI-Brookings 2002), online at http://www.aei.brookings.org/policy/page.php?id=10 (visited May 5, 2003); Linda R. Cohen and Robert W. Hahn, *A Solution to Concerns over Public Access to Scientific Data* (AEI-Brookings 1999), abstract online at http://www.aei.brookings.org/publications/abstract.php?pid=101 (visited May 5, 2003), reprinted in 285 Science 535 (1999); *EPA's Cancer Risk Guidelines: Guidance to Nowhere*, Cato Policy Analysis No 263 (Nov 12, 1996), online at http://www.cato.org/pubs/pas/pa-263.html (visited May 5, 2003); Richard L. Stroup, *Superfund: The Shortcut that Failed*, PERC Policy Series Issue No PS-5 (May 1996), online at http://www.perc.org/publications/policyseries/superfund_full.html (visited May 5, 2003).

24 For recent articles on this, see, for example, Nakashima, *Bush's Regulatory 'Czar,'* Wash Post at A35 (cited in note 3); Editorial, *Graham Will Help OMB*, Boston Herald 16 (July 21, 2001); Douglas Jehl, *Regulations Czar Prefers New Path*, NY Times A1 (Mar 25, 2001); Robert Kasten, *America's Worst Regulations*, J Commerce 6A (July 3, 1996); John H. Cushman, Jr., *EPA Plans Radical Change in Cancer Risk*, NY Times A1 (Apr 16, 1996).

25 See Adam Wolfson, *The Costs and Benefits of Cost Benefit Analysis*, Pub Int 93 (Fall 2001); Mallaby, *Saving Statistical Lives*, Wash Post at A19 (cited in note 19); Pietro S. Nivola, *The New Pork Barrel: What's Wrong with Regulation Today and What Reformers Need to Do to Get It Right*, 16 Brookings Rev 6, 8 (Winter 1998); Cindy Skrzycki and Peter Passell, *The Drive to Put Cost Limits on Regulatory Benefits Isn't Dead Yet*, NY Times D2 (Apr 18, 1996). See also Gene Marlowe, *Are We Getting Our Money's Worth?*, J Commerce 9A (July 24, 1997); James D. Johnston, *Let's Review and Prioritize Regulatory Costs*, Detroit News A10 (Mar 21, 1996). For criticism of Hahn's study, see Eban Goodstein and Hart Hodges, *Polluted Data: Overestimating Environmental Costs*, Am Prospect 64 (Nov–Dec 1997).

26 See, for example, Regulatory Right to Know Act of 1999, Hearing on HR 1074 (statement of Angela Antonelli) (cited in note 20). Hahn himself has testified before numerous congressional committees on regulatory matters. See, for example, Elevating EPA to Cabinet Status, Hearing on HR 64, 2438, and 2694 before the Subcommittee on Energy Policy, Natural Resources, and Regulatory Affairs, 107th Cong, 1st Sess 59 (2001) (statement of Hahn and Randall Lutter, AEI-Brookings Joint Center for Regulatory Studies). Testimony criticizing Hahn's methods and findings has been provided by Lisa Heinzerling. See Regulatory Right to Know Act of 1999, Hearing on HR 1074 (statement of Heinzerling) (cited in note 20).

27 A May 2003 Lexis search of law review articles published since 1996 yielded 65 cites to Hahn's *Risks, Costs, and Lives Saved*. See, for example, Sunstein, 99 Mich L Rev at 1657 n 31 (cited in note 21); Eric A. Posner, *Controlling Agencies with Cost-Benefit Analysis: A Positive Political Theory Perspective*, 68 U Chi L Rev 1137, 1181–82 n 115 (2001); Daniel H. Cole and Peter Z. Grossman, *When Is Command and Control Efficient?*, 1999 Wis L Rev 887, 913–14; Eric A. Posner and Matthew D. Adler, *Rethinking Cost-Benefit Analysis*, 109 Yale L J 165, 176 (1999); Jeremy D. Fraiberg and Michael J. Trebilcock, *Risk Regulation: Technocratic and Democratic Tools for Regulatory Reform*, 43 McGill L J 835, 844 (1998); Graham, 1997 U Chi Legal F at 29 n 71 (cited in note 21).

28 See Clyde W. Crews, *Creating a Regulatory Report Card: Toward Maximum Disclosure in*

Together, these studies have contributed mightily to a climate of opinion in which it seems that the only question of interest is how to accomplish sweeping reforms, not whether the regulatory system needs reforming.[29] Hahn himself has been named Director of the prestigious AEI-Brookings Joint Center for Regulatory Studies. Graham has been appointed Director of the Office of Information and Regulatory Affairs (OIRA) at OMB—a position that gives him oversight of all agency regulation. Morrall is a senior official in OIRA. Their world view is now the conventional wisdom, and that wisdom has been built into the law of the land.

But upon what, exactly, is all this based? How solid is the empirical foundation for the anti-regulatory fervor that has gripped Congress, academia, and millions of Americans for over a decade?

Only recently have scholars begun to probe these questions. In 1998, Professor Lisa Heinzerling published the first critical appraisal of the data and methods behind the Morrall table—eleven years after the table first appeared in print.[30] Since then, Heinzerling also has published critical reviews of the Graham and Tengs studies, though without the benefit of the source data for the *Opportunity Cost* study (which produced the 60,000-lives claim), since the authors refused to provide her that data.[31] Professors Thomas McGarity and Ruth Ruttenberg also have published brief critiques of a number of minor "scorecards" in their important study of the uncertainty of regulatory cost estimates.[32] No one has yet critiqued Hahn's scorecards in a systematic way, though his are the most comprehensive and rigorous of

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the Regulatory State, CEI Report to Congress on the Costs and Benefits of Federal Regulations, online at http://www.cei.org/gencon/027,01619.cfm (visited May 5, 2003); Angela Antonelli, *Regulation: Demanding Accountability and Common Sense*, in *Issues 2000: The Candidate's Briefing Book* (Heritage Foundation 2000), online at http://inic.utexas.edu/~bennett/_310/Antonelli.pdf (visited May 5, 2003); William A. Niskanen, *Regulating by Numbers*, Regulation 9, 10 (Spring 1996).

[29] See, for example, Richard B. Stewart, *A New Generation of Environmental Regulation?*, 29 Cap U L Rev 21 (2001). One of Stewart's chief charges is that many environmental regulatory programs "entail costs that substantially exceed benefits," id at 33, a proposition he supports with a cite to Hahn, *Government's Numbers* (1996) (cited in note 13), and to J. Clarence Davies and Jan Mazurek, *Pollution Control in the United States: Evaluating the System* (Resources for the Future 1998), which, in turn, relies significantly on the Hahn and Tengs/Graham scorecards, id at 135, 137, 140–41. For a sampling of other reform proposals, see Robert W. Crandall, et al, *An Agenda for Federal Regulatory Reform* (AEI-Brookings 1997), online at http://www.aei.brookings.org/publications/books/agenda_for_reg_reform.pdf (visited May 5, 2003).

[30] See Heinzerling, 107 Yale L J at 1981 (cited in note 15). This is not to criticize Heinzerling, who did not enter the field until long after Morrall's table was published. The point is that *no one* detected the problems with Morrall's table for over a decade, until Heinzerling came along.

[31] See Lisa Heinzerling and Frank Ackerman, *The Humbugs of the Anti-regulatory Movement*, 87 Cornell L Rev 648, 664 (2002); Heinzerling, 13 RISK at 157 (cited in note 19).

[32] See Thomas O. McGarity and Ruth Ruttenberg, *Counting the Cost of Health, Safety, and Environmental Regulation*, 80 Tex L Rev 1997 (2002).

the three and have circulated widely in the national discourse for almost six years.

This Article builds on the work of Heinzerling, McGarity, and others—along with extensive primary analysis of Hahn's and Tengs/Graham's source data, which I finally obtained—to provide the first comprehensive and integrated assessment of all three of the leading empirical studies behind the "regulatory reform" movement.[33] It examines the data, the analysis, and a sampling of the primary rules on which each of these scorecards are based, seeking to replicate each scorecard's numbers and to determine what, if anything, the numbers leave out.[34]

The standards applied in this Article, it should be emphasized, are those embraced by proponents and practitioners of cost-benefit analysis itself. They are not the only standards that might be applied. More than thirty years ago, Professor Laurence Tribe demonstrated that cost-benefit analysis of any stripe necessarily harbors certain assumptions and value judgments that are ideological and contestable: for example, that the litmus test of "rationality" is substantive and objective, not procedural or historical; and that the proximate goal of regulation is to maximize aggregate social utility, with consideration of people's rights relegated to secondary status.[35] His essays contesting such assumptions remain as cogent today as they were three decades ago.

The motive for judging scorecards by the narrow standards of cost-benefit analysis is not to take issue with those who have critiqued

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33 Heinzerling's article, the pathbreaking work on this subject, focused on the Morrall study and did not take issue with the other prominent analyses which come to the same conclusion. Moreover, the scholarly reaction to her critique has tended to focus narrowly on the validity of discounting lives and life values (which she vigorously attacks), thereby obscuring the more basic issues she has raised (and other issues she might have raised) about the validity of scorecards in other respects. See John J. Donohue III, *Why We Should Discount the Views of Those Who Discount Discounting*, 108 Yale L J 1901 (1999). See also Revesz, 99 Colum L Rev at 946 n 19, 955 (cited in note 21). This narrow focus on discounting risks misses the forest for the trees. The principal issue raised by scorecards is not whether discounting is good or bad, but whether the scorecards are, overall, reliable litmus tests of regulatory rationality.

34 The goal is not to examine every entry, but to audit enough samples to provide a fair picture of how reliable the bookkeeping is. The rules examined in this Article were selected to represent a cross-section of agencies, subject matter, and numerical results, and to detect and illustrate problems with the methodology employed in scorecard analysis. Thus, rules that generated extreme numbers in scorecards were more likely to be scrutinized in this study, but that does not mean that the problems identified in this study are confined to the rules chosen to illustrate them. A flawed methodology applied across the board will generate mistakes across the board.

35 See Laurence H. Tribe, *Policy Science: Analysis or Ideology?*, 2 Phil & Pub Aff 66 (1972); Laurence H. Tribe, *Trial by Mathematics: Precision and Ritual in the Legal Process*, 84 Harv L Rev 1329 (1971).

this mode of analysis at its core, but simply to give the scorecards the benefit of all possible doubt.[36]

How do scorecards fare when judged by the standards of their own professional discipline? This Article will show that they fail badly. Part I reveals that all three studies rely on undisclosed data and non-replicable calculations; use regulatory samples that are biased against a finding of rationality; misrepresent ex ante guesses of costs and benefits as actual measurements; and grossly underestimate the value of lives saved, or the number of lives saved, or both. It turns out that Tengs and Graham's sensational conclusions are not supported by their own data.

These are the avoidable errors. Part II examines a group of equally serious shortcomings that could not have been avoided because they are inherent in the enterprise of compiling numerical scorecards. First and foremost, regulatory scorecards ignore virtually all benefits that are not quantified and/or monetized—thereby excluding most environmental benefits, many health benefits, and all intangible benefits ranging from the avoidance of pain and suffering or familial and societal disruption to the promotion of a public sense of security, fairness, confidence in markets, etc. Scorecards also ignore the impact of regulations on the distribution of social cost and risk, and the fairness of such impacts. Finally, scorecards ignore and conceal the large uncertainties that are present in virtually every regulatory impact assessment. (That, ironically, is the key to their influence: their use of speciously precise numbers lends them a scientific air which impresses the unsuspecting media and the public, but is quite unwarranted by the data.)

In short, the studies examined in this Article are so fundamentally flawed that they prove nothing at all about the rationality of regulation.

These basic flaws, moreover, are not merely flaws in the eye of this beholder. When scorecardists disregard ordinal costs and benefits, as well as distributive and equitable impacts and uncertainties, they do so in violation of widely agreed upon principles of cost-benefit analysis.[37] Yet this Article will show that scorecards cannot follow the precepts of responsible cost-benefit analysis while continuing to do the

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[36] Also, for better or worse, cost-benefit analysis (with all of its built-in value assumptions) has been ratified by Congress—and applied to regulation—in recent years to a degree that Professor Tribe could not have anticipated when he first issued his critique in 1971. See, for example, Unfunded Mandates Reform Act of 1995, 109 Stat 48. This renders cost-benefit analysis an indisputably relevant test—though not the only test—by which regulations and agency programs may be evaluated.

[37] See the discussion of these principles in Parts II.A.2, II.B, II.C, and II.D.

thing that has made them quotable and famous—boiling down huge arrays of complex regulatory analyses to a few summary numbers.

Thus, although scholars to date have treated regulatory scorecards as simply another form of cost-benefit analysis,[38] this Article will demonstrate that, in fact, regulatory scorecards represent a distinct sub-species of cost-benefit analysis that inherently violates the basic rules that govern such analysis. Scorecards cannot be salvaged. They should simply be abandoned.

Part III addresses the inevitable follow-up question of how government regulatory performance should be evaluated, if not by numerical scorecards. This Part argues that the place to begin is with better agency analysis of the costs and benefits of individual rules and regulatory opportunities. Perhaps the most important recommendation in this regard derives from the discovery in Part II that agencies do *not* systematically overstate regulatory benefits, as commonly alleged. On the contrary, agencies often fail to describe benefits fully. Indeed, they often relegate discussion of benefits (particularly non-health benefits) to a few perfunctory sentences in the preambles of final rules. The result is that important benefits often go unnoticed in both scorecards and in the press. Part III thus recommends that agencies take steps to better assess and describe regulatory benefits.

Part III also offers several other suggestions for improving analysis of individual rules, including: correcting obvious (yet long-standing) errors in life and health values; abandoning the pretense that such values are scientifically based; recognizing more clearly and candidly the full range of uncertainties in each analysis; performing many more retrospective studies to validate ex ante estimates; and extending cost-benefit analysis to regulatory opportunities.

At the systemic level, Part III recommends simply abandoning scorecards as a tool for grading government regulatory performance. Instead, Congress should establish an independent "ombudsman" to investigate alleged regulatory failures (and failures to regulate) one intervention at a time—mixing ordinal and quantitative analysis to produce a full picture of costs, benefits, distributive impacts, and all relevant uncertainties. This labor-intensive inquiry will not yield a numerical "score" for government regulation overall. But it will provide what is needed most—an independent and rigorous forum for clarify-

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[38] See, for example, Heinzerling, 107 Yale L J at 1986 (cited in note 15) (treating the Morrall table as symptomatic of deficiencies of cost-benefit analysis generally); Lisa Heinzerling and Frank Ackerman, *Pricing the Priceless: Cost-Benefit Analysis of Environmental Protection*, (Georgetown Envir L & Pol Center 2002), online at http://www.law.georgetown.edu/gelpi/papers/pricefnl.pdf (visited July 2, 2003).

ing, if not resolving, the regulatory controversies that matter most to the public and policy establishment.

Meanwhile, scholars, policymakers, and the public should be aware that we simply do not know how "efficient" or "rational" government regulation is, from a cost-benefit perspective, because the principal tests that have been used to reach such judgments are invalid.

I. A CRITIQUE OF SCORECARDS: THE AVOIDABLE ERRORS

The last two decades have brought forth a spate of studies that purport to offer rigorous assessments of the rationality of government regulation overall. To begin with, there are studies, like Thomas Hopkins's, that dispense with benefits altogether, and merely tote up the costs of regulation.[39] These studies, though widely cited, are so unidimensional that it is hard to imagine what the authors think they have proved. Yes, the cost of regulation is high. So are the costs of national defense, highways, schools, the war on drugs, police, health care, and elections. So what? One cannot arrive at meaningful conclusions about regulation by looking at costs in abstraction from benefits.[40]

Then there are those who look at neither costs nor benefits, but merely count Federal Register pages as evidence that the regulatory burden is large and growing.[41] These authors appear never to have read the Federal Register. For simply reading any Federal Register final rulemaking notice would immediately reveal that the vast majority of the pages concerned with regulation are not devoted to setting forth final rules. They are preambular pages devoted to proposing rules, soliciting comments, explaining the final rule, responding to comments, setting forth analyses of costs and benefits, and so forth. To

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[39] See, for example, Thomas D. Hopkins, *Costs of Regulation: Filling the Gaps* (prepared for Regulatory Information Service Center 1992); Thomas D. Hopkins, *Cost of Regulation* (RIT Public Policy Working Paper 1991).

[40] Similar problems (and others) afflict the annual regulatory cost reports published each year by the Weidenbaum Center (at Washington University) and the Mercatus Center (at George Mason University). For a good discussion of the poor scholarship found in these studies, see McGarity and Ruttenberg, 80 Tex L Rev at 2016–18 (cited in note 32).

[41] See, for example, Mercatus Center Press Release, *President Clinton Sets Record for Midnight Regulations* (Jan 23, 2001), online at http://www.mercatus.org/article.php/138.html (visited May 5, 2003) (noting that at least 25,605 pages of new regulations were published in the Federal Register between November 2000 and January 2001); Clyde Wayne Crews, *Regulatory Budget Check* (Apr 1, 2000) (Competitive Enterprise Institute), online at http://www.cei.org/gencon/005,01746.cfm (visited May 5, 2003) (observing that the Federal Register contained 71,161 pages in 1999, the highest count since the Carter presidency); Angela Antonelli, *The Cost of Federal Regulation*, Heritage Foundation Press Release (Aug 4, 1999), online at http://www.heritage.org/Press/Commentary/ed080499.cfm (visited May 5, 2003) (worrying that the size of the Federal Register has increased from 53,376 pages in 1988, the last year of the Reagan Administration, to 64,549 in 1997).

take an example at random, the Department of Health and Human Service's (HHS) final rule on seafood safety occupies 105 Federal Register pages. These 105 pages consist of 100 pages of explanation followed by 5 pages of rule.[42] Moreover, there is no necessary correlation between the burden of regulation on one hand, and the numbers or length of rules on the other. While a long rule *may* be burdensome, a rule also may be long because it contains complicated concessions to industry. Indeed, long rules may be passed to *ease* prior burdens on industry. Conversely, Congress could eliminate thousands of pages of text by reducing all environmental obligations to a single sentence: "No one may pollute." Do the page counters think that this would make the environmental laws 99.9999 percent less burdensome?

Each year since 1997, OMB has published an *Annual Report to Congress on the Costs and Benefits of Federal Regulation*. OMB generally finds that the monetized *net* benefits of social regulation greatly exceed its costs.[43] As OMB points out, however, the aggregate figures are dominated by a few major rules showing huge net benefits—such as the Environmental Protection Agency's (EPA) standards for lead and particulate matter—which may cover a multitude of bad decisions in other areas.[44] Moreover, OMB's analysis of individual regulations does not pretend to capture the non-monetized benefits of regulations, nor does OMB feel free to impose its own subjective opinion as to whether particular rules "pass" or "fail" cost-benefit tests.[45] Thus, OMB's *Annual Report* does not really serve as a numerical scorecard.

This Part will evaluate the three numerical scorecards that have dominated discussion of regulatory rationality for the last fifteen

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42 See Food and Drug Administration (FDA), Procedures for the Safe and Sanitary Processing and Importing of Fish and Fishery Products, 60 Fed Reg 65096–65201 (1995).

43 OMB, Office of Information and Regulatory Affairs, *Making Sense of Regulation: 2001 Report to Congress on the Costs and Benefits of Regulations and Unfunded Mandates on State, Local, and Tribal Entities* 11 table 2 (2001), online at http://www.whitehouse.gov/omb/inforeg/costbenefitreport.pdf (visited May 6, 2003).

44 See id. OMB observes, "This benefits estimate is dominated by an EPA estimate that the benefits of air pollution reduction are $1.25 trillion. OMB remains concerned about the plausibility of these estimates." Prior reports make clear that the upper range of the EPA benefits estimate derives from EPA's § 812 Retrospective Report, so named because EPA prepared it pursuant to Section 812 of the Clean Air Act Amendments of 1990. See OMB, *Report to Congress on the Costs and Benefits of Federal Regulations* 20 (2000), online at http://www.whitehouse.gov/omb/inforeg/2000fedreg-report.pdf (visited May 6, 2003), referring to EPA, *The Benefits and Costs of the Clean Air Act, 1970 to 1990* (1997), online at http://www.epa.gov/airprogm/oar/sect812/copy.html (visited Oct 14, 2003). As EPA notes in the latter report, "a large proportion of the monetized benefits of the historical Clean Air Act derive from reducing two pollutants: lead and particulate matter." Id at ES-9, ES-7, table ES-4.

45 See notes 226–28 and accompanying text. Instead, OMB inserts a "Not estimated" entry in the benefits column in such cases, with an explanation in the "Other information" column.

years: the Morrall, Tengs/Graham, and Hahn studies. Part A shows that all three studies rely on undisclosed data, arbitrary adjustments to agency data, and non-replicable calculations. Part B demonstrates that all three scorecards employ sampling techniques that are systematically biased against a finding of regulatory rationality. Part C reveals that all three scorecards misrepresent ex ante guesses as actual measurements of costs and benefits, and suggests that reliance on pre-rule predictions probably serves to underestimate net benefits in the majority of cases. Part D shows that Hahn's scorecards systematically understate the value of lives saved by regulation. Part E shows that Morrall and Tengs/Graham inflate cost per life saved by discounting the number of lives saved after a latency period. Part F presents the most surprising discovery of this study: Graham and Tengs's famous (and pessimistic) conclusions about regulation do not follow logically from the authors' own data.

A. Unreliable Data, Arbitrary Adjustments, Non-replicable Calculations

This Part applies to regulatory scorecards the most basic test of scholarship: are the data reliable and the results replicable? It will be seen that all three studies fail this basic test. These shortcomings alone would be sufficient to disqualify these studies in any rigorous peer review. Unfortunately, AEI-Brookings, OMB, and the Harvard Center for Risk Analysis did not submit these studies to anonymous peer review before publishing them. Thus, there was no screening process to detect the fundamental problems of data and method discussed below.

Morrall. Morrall's table purports to be drawn from agency Regulatory Impact Assessments (RIAs). Morrall acknowledges, however, that he "sometimes revised" agency estimates.[46] In fact, it appears he alters them by several orders of magnitude in some cases.[47] Morrall

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[46] Morrall, Regulation at 28 (cited in note 8).

[47] For example, as Heinzerling observes, OSHA estimated that its proposed 1985 formaldehyde exposure regulation would save from six to forty-seven lives over forty-five years. Morrall alters that estimate to one life saved every hundred years. In 1986, EPA estimated that its restrictions on land disposal of certain persistent toxic and bio-accumulative wastes would avert forty cases of cancer, fetal toxicity, reproductive disorders, and other ailments associated with chronic toxic exposure per year. Morrall's table translates that to 2.5 lives saved per year—with no explanation of where that number comes from (it is not found in any agency document). In 1983, EPA issued rules to provide for the control and clean-up of radioactive materials at uranium processing sites. Morrall's figure for the lives saved from that rule (2.1) is less than half of EPA's estimate (roughly 5). See Heinzerling, 107 Yale L J at 2031 (cited in note 15).

Morrall also alters agency cost estimates without acknowledging that he is doing so. His article states, "I generally accepted agency cost estimates without adjustment" and then goes on to explain why he believes there is no need to adjust agency cost numbers. Morrall, Regulation at 29 (cited in note 8). Only by independent investigation did the author learn that Morrall substituted his own number of $1.4 billion per year for the agency estimate of $97 million per year as

justifies these unilateral changes by stating that "regulatory agencies ... tend to overstate the effectiveness of their actions. Where such biases were evident and easily corrected, I made the corrections ... [relying in some cases] on published studies."[48]

This easy-going explanation glosses over several acute difficulties. First, Morrall offers no evidence for his claim that agencies systematically overstate the effectiveness of their actions. Indeed, the discussion later in this Article refutes his charge.[49] Second, Morrall has no training in any of the disciplines (chemistry, meteorology, toxicology, medicine) that would qualify him to substitute his own judgment for that of agency scientists on matters of exposure and risk. Third, Morrall does not even name the other studies upon which he allegedly relied in generating his own numbers, much less establish their superiority over the agencies' analyses.[50] Finally, Morrall's adjustments and calculations are impossible to verify. His primary data, assumptions, and calculations are, by his own admission, "scattered around on yellow legal pads" in his filing cabinets, and are not available.[51]

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the cost of complying with EPA's rule restricting land disposal of toxic, bio-accumulative wastes. Compare Morrall, Regulation at 30 table 4 (cited in note 8), with EPA, Restriction on Land Disposal of California List Wastes: Toxic, Persistent, Bioaccumulative and/or Corrosive, 51 Fed Reg 44714, 44737 (1986). The effect of the cost adjustment, when combined with discounting, is to increase the calculated cost per life saved from $2.38 million (the undiscounted agency figure) to $3.5 *billion*. Morrall also appears to have increased, by a factor of 20, OSHA's estimate of the cost of its proposed formaldehyde rule. See the discussion of the formaldehyde rule in notes 152–57 and accompanying text.

48 Morrall, Regulation at 25, 28–29 (cited in note 8).

49 See Part II.A.1. Even where agencies try to quantify benefits, they often tend to underestimate them. Percival, for example, notes that EPA grossly underestimated, initially, the risks of lead in gasoline and PCBs. Percival, *Environmental Regulation* at 182 (cited in note 17).

50 See Appendix A and Morrall, Regulation at 28–29 (cited in note 8). Despite Morrall's no doubt earnest belief in the superiority of his own judgment, few people outside of OMB are likely to share his confidence that OMB economists know better than agency toxicologists the risks of exposure to PCBs, or that OMB economists are better able than EPA engineers to predict the likely costs of incinerating toxic chemicals in tomorrow's high-tech combustors. Heinzerling offers a striking quotation that reveals the frustration felt by OSHA health experts when confronted with the pseudo-expertise of economists like Morrall:

> [T]he comments we get from the economists at OMB are so ridiculous that they actually become funny. . . . An example is that Dr. Infante and Dr. Rodgers and I met with two economists from OMB and discussed the health hazards of formaldehyde with them, and they adamantly argued with us about the toxicity of formaldehyde. Dr. Infante had to give them an epidemiology lesson, and Dr. Rodgers had to give them a toxicology lesson, and I had to describe how to do risk assessments for them.

107 Yale L J at 2027 (cited in note 15).

51 Telephone Interview with John F. Morrall III (Feb 22, 2002) (transcript on file with author).

Morrall is, of course, a government official and a busy man. Scholarship is not his first vocation. The fact remains that his findings cannot be replicated.

Hahn. Hahn claims—in his title and at least eighteen times thereafter—that he is just "using the government's numbers," overtly distinguishing himself from Morrall in this regard.[52] Buried in a few passages laden with technical jargon is the revelation that Hahn makes numerous adjustments to those numbers—usually in the direction of higher costs and lower benefits. For example, he excludes cost savings from regulations because he believes "those savings are generally questionable."[53] He assigns his own values to avoided risks of death or injury, regardless of agency values. He excludes all but a handful of environmental benefits.[54] He discounts cost and benefit streams at his own "standard" discount rates, regardless of agency practice.[55] Costs and benefits that occur before or after 1996 are discounted forward or back to that arbitrary base year—a practice unique to Hahn that (he admits) has a major effect on numerical outcomes.[56] In the many cases in which agencies indicate a range of costs or benefits, Hahn collapses the range and takes only the mid-point, even where the agency has specified a different point in the range as more plausible.[57]

At a minimum, these adjustments call into question the candor of his "government's numbers" claim. Moreover, it has proven difficult (and in some cases impossible) for me to replicate Hahn's numbers by applying to the numbers set forth in Regulatory Impact Assessments the adjustments he describes.[58]

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52 See Hahn, *Government's Numbers* (1996) passim (cited in note 13). See also id at 211 ("Unlike Morrall, however, this study attempts to avoid introducing adjustments to individual [agency] studies.").

53 Id at 228.

54 See id at 216. For fuller treatment of the nature and consequences of these exclusions, see Part II.A.

55 See id at 216.

56 Hahn, *Government's Numbers* (2000) at 45 (cited in note 13) ("Varying the base year for the present-value calculation significantly affects the magnitude of the estimates.").

57 Hahn, *Government's Numbers* (1996) at 245 n 9 (cited in note 13).

58 Hahn's published study does not even disclose the *names* of the rules it analyzed. Simply getting the list of rules and the spreadsheet of calculated costs, benefits, and net benefits required months of supplication. When Hahn's spreadsheet was finally obtained, it turned out that the adjustments described do not necessarily yield the numbers used. For example, the Coast Guard attributed ecological benefits valued at $230 million to $6 billion, over the period 1991–2015, to its double-hull oil tanker rule. Hahn, Spreadsheet for *Government's Numbers* (2000) (cited in note 13): Selected Rules, cells CB9, CC9 (unpublished spreadsheet on file with author—hereinafter Hahn spreadsheet). Hahn nonetheless assigns the rule a "zero" benefit while claiming he is using the "government's numbers." Id at cells CF9–CH9. The difficulty of replicating Hahn's numbers is compounded by the fact that he neither publishes his calculations nor includes them within the Excel spreadsheet, as Excel users normally do, but simply uses the spreadsheet as a glorified ledger in which to enter his off-the-record calculations. Nor does he anywhere describe the assumptions he made to derive his "low," "base," and "high" value cost-benefit scenarios. *Govern-*

The result, again, is a highly influential set of numbers that cannot be independently verified.

Tengs/Graham. The Tengs/Graham data are drawn from a wide range of public and private sector documents spanning more than a decade, many of which are unpublished. Their stated criteria for inclusion contain no filter to ensure that the studies upon which they rely are of high quality, or even that they are directly comparable.[59]

Moreover, key parameters are calculated in a non-transparent manner that makes replication impossible. One crucial variable, for example, is the estimated percentage implementation of each intervention in the baseline: an intervention deemed capable of saving 50,000 lives at full implementation will save 25,000 additional lives upon reallocation if the baseline estimate is 50 percent implementation, but no additional lives if the analyst believes that baseline implementation is already 100 percent. Unfortunately, the authors provide no documentation of how their anonymous reviewers arrived at the conclusion that, as of 1993, the mandatory seat belt use law was "85 percent" implemented, while the public pedestrian safety information campaign was "45 percent implemented" and selected traffic enforcement programs were "78 percent implemented."[60] These

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ment's Numbers (2000) at 46 (cited in note 13).

[59] The only stated criteria of inclusion are that the study must be in English, examine American experience, and contain separate estimates of full implementation costs and life-saving. See Tengs, et al, 15 Risk Analysis at 370 (cited in note 9).

Spot checks of source documents reveal significant problems in the authors' database and calculations. For example, at least sixteen of the key interventions related to auto safety (accounting for nearly 12,500 additional lives saved in reallocation) are culled from a single non-peer-reviewed National Highway Traffic Safety Administration (NHTSA) study which was nearly fifteen years old when Tengs/Graham pulled it out of obscurity in 1995. See Appendix B-1, rows 14, 16–17, 19, 21, 26–27, 34, 41, 44, 46, 67, 70, 80, 95, 107. See Appendix B-1, summary, for the calculation of additional lives saved by reallocation to fully fund these interventions. The interventions listed in these rows are not assigned a source, but they match those derived from source number 175 in Tengs, et al, 15 Risk Analysis at 373–75, 385 (cited in note 9). That source is NHTSA, Office of Traffic Safety Programs, *Highway Safety Needs Study: 1981 Update of 1976 Report to Congress* (1981) (hereinafter NHTSA Study). During the period between 1981 and 1995, technology evolved substantially, as did government policies and public attitudes on seat belts, speed limits, and drunk driving. Yet these stale, ex ante estimates of hypothetical costs and benefits of various interventions are used as proxies for actual costs and lives saved over a decade later.

[60] See Appendix B-1, rows 14, 17, and 26, respectively. In contrast to their implementation estimates, the authors' data on costs and life-saving can generally be found in the source documents. However, this is not always the case. The authors' data for some important interventions—for example, oxygen for hypoxemia and flu shots—bear no clear relation to numbers appearing in the source documents. For hypoxemia, the authors estimate that full implementation of the named oxygen therapy would save 45,000 additional lives at an incremental cost of $698 million (1993 dollars), see Appendix B-1, row 22, while the source document, Stephen D. Roberts, *Cost-Effective Oxygen Therapy*, 93 Annals Internal Med 499–500 (Sept 1980), contains no

numbers have no basis in the source documents—which often predate these estimates by more than a decade—nor is any explanation given for their derivation. Repeated requests for disclosure of the worksheets used to arrive at these numbers were denied. Such omissions and concealments make it impossible to verify the authors' data or replicate their results.[61]

B. Selection Bias

All three scorecards analyze samples drawn from the larger universe of regulation in order to support broader inferences about that universe. Such inferences are valid only if and to the extent that the samples in question are broadly representative of the population as a whole. This section demonstrates that all three major scorecards fail this basic condition as well.

Morrall. The forty-four rules that appear in the Morrall table may seem like a lot, but they constitute only a tiny fraction of the regulatory universe. How were these particular rules chosen to serve as the litmus test of agency rationality? Morrall himself never explains his selection criterion except to note that he included regulations for which "reasonably complete information" on cost and benefit was available.[62] However, as Heinzerling observes, Morrall omits clearly beneficial final rules for which cost-benefit information was readily available,[63] while including eight rules that were never enacted.[64] Heinzerling also correctly observes that the rules included are any-

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such numbers. The source does observe that "[i]f a half million or so will receive continuous oxygen therapy, the increase in the annual cost of the therapy may be $290 million [equivalent to $509 million in 1993 dollars]," and that yearly mortality for continuous oxygen therapy is about 11 percent as contrasted to 20 percent for those on nocturnal oxygen therapy. Id. Multiplying 500,000 by the 9 percent survival differential yields the 45,000 figure used by the author. But the Tengs/Graham cost figure cannot be derived from the source data by any obvious means, and the 500,000 figure itself is not, in any case, an appropriate full implementation number, since the passage just quoted makes clear that the source document author is using 500,000 as an arbitrary benchmark, not as an estimate of full implementation use. Id. Likewise, the flu vaccine numbers used by the authors cannot be found—or derived by obvious means—in the source documents the authors cite. Compare Appendix B-1, row 20, with Office of Technology Assessment, *Cost Effectiveness of Influenza Vaccination* (Dec 1981) (unpublished manuscript on file with author).

61 The consequences of the authors' casual treatment of implementation rates may be seen in the confusion it created afterwards. Tengs recently declared that only 20 of the 185 interventions in the *Opportunity Costs* database were assigned a zero implementation rate in the baseline. Hearing on the Nomination of John D. Graham before the Senate Committee on Government Affairs, 107th Cong, 1st Sess 682 (2001). Yet the spreadsheet supplied by Tengs to this author lists 60 such interventions. See Appendix B-1, column F. Heinzerling has alleged that 79 of the environmental "interventions" in the *Opportunity Costs* database were never implemented. See Heinzerling, 13 RISK at 157–58 (cited in note 19).

62 Morrall, Regulation at 27 (cited in note 8).

63 Heinzerling cites EPA's phase-down of lead in gasoline and its regulations controlling common air pollutants as examples. See Heinzerling, 107 Yale L J at 2016 (cited in note 15).

64 Id.

thing but a random walk down regulatory Main Street. Of the sixteen EPA regulations on Morrall's list, fourteen have to do with four pollutants—asbestos, benzene, arsenic, and radionuclides—that have generated some of the most heated and litigated controversies in all of environmental law.[65] Nowhere does Morrall even attempt to demonstrate that the rules appearing in his table represent a fair sampling of the regulatory universe.[66] Moreover, his focus on proposed or enacted rules (as opposed to regulatory opportunities) introduces a further anti-regulatory bias, as will be seen in the following discussion of Hahn's scorecard.

Hahn. Hahn's scorecard improves on Morrall's by adopting an objective selection criterion: Hahn examines all major federal regulations promulgated within a specified period. Hahn, however, follows OMB in defining "major rules" as those that cost more than $100 million per year. This filter effectively excludes from the database the most cost-effective interventions of all: interventions that yield major benefits without imposing major costs. The result is an in-built sampling bias against regulation.[67]

An equal or greater source of bias is that both Morrall and Hahn focus on rules, actual or proposed. They choose not to examine rules that were never issued but would be cost-effective if they had been. This is a serious shortcoming. Basic environmental economics teaches that efficient resource allocation requires internalizing externalities (through regulation, Pigouvian taxes, or marketable permits) in all cases where significant externalities arise.[68] This means that underregulation can be just as inefficient—in the sense of producing a misallocation of resources—as overregulation. By systematically excluding all cases of underregulation, Hahn and Morrall introduce yet a further skew toward a finding of overregulation.

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65 See, for example, the cases and controversies collected in note 71.

66 As Heinzerling notes, the cost-ineffective "bottom" of the Morrall table is heavily stocked with regulations that he and others at OMB had heavily criticized. Heinzerling, 107 Yale L J at 2015 (cited in note 15).

67 The "major rule" selection criterion also filters out minor rules that are not subject to OMB review and detailed agency cost-benefit analysis. If such rules are systematically less cost-effective than major rules (a point which has not been established empirically), the result would be a contrary skew toward a higher grade for government regulation. It is thus difficult to determine, in Hahn's case, the direction of the selection bias, much less the magnitude. There is no reason to assume, however, that opposing sources of bias simply cancel each other.

68 See Maureen L. Cropper and Wallace E. Oates, *Environmental Economics: A Survey*, 30 J Econ Lit 675, 681 ("The basic theoretical result ... is that the efficient resolution of environmental externalities calls for polluting agents to face a cost at the margin for their polluting activities equal to the value of the damages they produce.").

Tengs/Graham. Tengs/Graham avoid this skew by examining regulatory opportunities as well as implemented regulations. They also avoid problems of subjective sampling by defining their sample in objective terms: (1) a life-saving intervention must be analyzed in a written study; (2) the study must be in English; (3) the study must be about American experience; and (4) the study must be supported by an estimate of full implementation cost and full-implementation lives saved.

Unfortunately, this approach solves certain problems of bias only by creating others. As the authors acknowledge, their "dataset may not represent a random sample of all life-saving interventions" because "those economic analyses that researchers have chosen to perform and journal editors have chosen to publish may be disproportionately expensive or inexpensive."[69] It is extreme results, after all, that are typically deemed most interesting and publishable. Moreover, authors who choose to publish estimates of full-implementation costs and benefits, as opposed to actual costs and benefits, likely do so because they have concluded that full implementation is either quite a good idea or quite a bad one. The bias toward extremes in sampling yields a corollary bias in favor of greater life-saving through reallocation.[70]

In practice, Tengs/Graham's publication bias appears to have generated a sampling distortion that operates much like Morrall's selection bias. For example, anyone familiar with environmental policy will immediately recognize that the toxin control portion of the Tengs/Graham sample (comprising more than half of the 185 interventions in the sample) is dominated by just seven substances—asbestos, arsenic, benzene, ozone, radionuclides/radon, and vinyl chloride—that have generated some of the most contentious disputes in all of environmental law.[71] There is no reason to assume that the saga of efforts

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69 Tengs, et al, 15 Risk Analysis at 372 (cited in note 9).

70 Indeed, as seen in note 60 and accompanying text, even the numbers for baseline costs and lives saved were generated not by looking directly at actual costs and lives, but by multiplying full implementation costs and lives by reviewers' estimates of the "percent implementation" of the program. For the 104 programs implemented at either 0 or 100 percent in the baseline scenario, this is not a source of error. But for the remaining 82 programs, the indirect approach produces a needlessly inexact estimate of costs and lives saved in the baseline.

71 See, for example, *Whitman v American Trucking Associations, Inc*, 531 US 457 (2001) (discussing EPA's National Ambient Air Quality Standards for particulate matter and ozone); *Industrial Union Department, AFL-CIO v American Petroleum Institute*, 448 US 607, 614–15 (1980) (holding that the Secretary of Labor is required under the Occupational Health and Safety Act (OSHA) to issue a benzene emission standard only after making an initial inquiry to confirm that the standard is "reasonably necessary or appropriate" and the substance being regulated can cause a "significant health risk"); *Columbia Falls Aluminum Co v EPA*, 139 F3d 914, 915 (DC Cir 1998) (holding that EPA's use of an inaccurate predictor of toxic mobility in promulgating its arsenic rule was arbitrary and capricious); *Sierra Club v EPA*, 1996 US App LEXIS 30422, *5–6 (DC Cir) (upholding EPA's decision to permit the Nuclear Regulatory Commission to regulate radionuclide emissions from nuclear reactors as not unreasonable); *Leather Indus-*

to regulate these seven chemicals typifies the experience of the thousands of pesticides and other toxic chemicals that EPA and Occupational Health and Safety Administration (OSHA) routinely oversee in the marketplace.[72] Yet these seven substances account for more than ninety of the ninety-eight toxin control interventions, and 99 percent of the toxin control baseline costs in the sample.[73]

What would have been the right approach to regulatory sampling? Clearly, the database should have included either a comprehensive review or, more likely, a truly random sample of major and minor rules and rule candidates. While finding a proper method for sampling rule candidates is obviously a difficult enterprise,[74] this does not excuse biased regulatory sampling. Whatever the reasons for the bias, the fact remains that scorecards based on non-random and biased sampling do not support broad inferences about the rationality of regulation overall.

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tries of America, Inc v EPA, 40 F3d 392, 394 (DC Cir 1994) (upholding in part a challenge to EPA's regulation of heavy metal sludge contaminants, including arsenic); *Corrosion Proof Fittings v EPA*, 947 F2d 1201, 1229 (5th Cir 1991) (striking down EPA's comprehensive asbestos ban); *National Resources Defense Council, Inc v EPA*, 824 F2d 1146, 1166 (DC Cir 1987) (remanding a vinyl chloride emissions standard to EPA for failing to evaluate the standard's estimated effect on people's health).

For the dispute over radon regulation, see Gina Kolata, *How Much Radiation is Too Much?*, NY Times F1 (Nov 27, 2001); Robert W. Hahn and Jason K. Burnett, *The EPA's Radon Rule: A Case Study in How Not to Regulate Risks*, AEI-Brookings Joint Center for Regulatory Studies: Regulatory Analysis 01-01 (AEI-Brookings 2001), online at http://www.aei.brookings.org/publications/reganalyses/reg_analysis_01_01.pdf (visited May 6, 2003).

72 Focusing obsessively on seven atypical substances may be thought to overstate the costs of regulation, in view of the fact that these substances have been so controversial and hotly litigated on grounds of cost. On the other hand, the relative efficiency of actual spending on these substances may reflect the impact of searching judicial review which has restrained agencies from regulating some of these substances as stringently as they would like. For example, the *Corrosion Proof Fittings* decision may have restrained EPA from imposing high costs to phase out asbestos in all uses. See 947 F2d 1201. This makes it impossible to determine the magnitude, or even the direction, of the bias in sampling of toxics. But that just deepens the quandary created by their sampling methods. All that one can say with confidence is that the toxic control interventions that appear in the Tengs/Graham studies are not representative of toxic regulation overall. Indeed, Heinzerling points out that thirty-one of the ninety environmental measures in the Tengs/Graham database were undertaken (or not) under statutory provisions (Section 6 of the Toxic Substances Control Act) that have been effectively defunct for over a decade. See Heinzerling, 13 RISK at 153–57 (cited in note 19).

73 Significantly, Hahn and Morrall would have treated these ninety-eight interventions as just eight interventions since they appear in only eight rules.

74 Relying exclusively on the published literature does not work for the reasons described above. A better approach might have been to convene an inter-agency (or non-governmental) task force analogous to the EPA working group that Administrator Lee Thomas convened in 1986–87 with a mandate to survey the universe of rules and regulatory opportunities as an aid to setting priorities for future regulation. See EPA, 1 *Unfinished Business: A Comparative Assessment of Environmental Problems* v–vi (1987) (unpublished manuscript on file with author).

C. The Ex Ante Fallacy

Every year football pundits on pregame shows take turns guessing the score or the point spread of the Super Bowl that is soon to follow. But then the game happens, and newspapers report the results of the game. Fortunately, there is no record of any occasion in recent history when a newspaper has committed the blunder of confusing the pre-game guesses with the actual score of the game.

Yet this sort of blunder is virtually universal in scorecards where conclusions are routinely described as if they represent actual measurements of costs and benefits when, in fact, the numbers consist exclusively of analysts' educated guesses about what future costs and benefits might be in a variety of hypothetical scenarios.

For example, Graham and Tengs report that "the annual resources consumed by those interventions total approximately $21.4 billion. For such a sum, we avert approximately 56,700 premature deaths and save 592,000 years of life annually."[75] In fact, the baseline and reallocation numbers for all but seventeen of the interventions that affect the *Opportunity Costs* results are derived exclusively from ex ante guesses about cost or lives saved in a hypothetical full implementation scenario.[76] Moreover, many of those estimates were already more than a decade old by the time the Tengs/Graham study was published.[77] By relying on aged guesstimates, Graham and Tengs ignore, in these cases, ten to twenty years of actual experience.

Morrall and Hahn likewise describe their findings as actual costs and benefits when, in fact, Morrall and Hahn derive their data exclusively from regulatory impact statements issued long before the rule

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75 Tengs and Graham, *Opportunity Costs* at 172 (cited in note 10).

76 The only estimates not based on ex ante guesses about implementation rates are for interventions that are fully implemented in the baseline scenario. Of these, the only interventions that matter to the analysis—that is, that save additional lives in reallocation—are those that are fully implemented in the baseline but are zeroed out in the reallocation to release funds for saving lives elsewhere. Inspection of Appendix B-1 reveals that there are seventeen such intervenetions listed below row 101, the last intervention that is funded in the reallocation.

77 See Tengs, et al, 15 Risk Analysis at Appendices A–B (cited in note 9) (listing sources for cost per life estimates used in both that and the smaller *Opportunity Costs* study). For example, the numbers for twelve traffic safety education interventions come from a 1981 study (No 175 in Tengs/Graham's database) that draws on data from the 1970s. The numbers for the life-saving potential of universal influenza vaccination come from a 1981 study. See Office of Technology Assessment, *Cost Effectiveness of Influenza Vaccination* (cited in note 60). The huge life-saving potential of nocturnal oxygen for hypoxemia patients (which saves twenty-three thousand additional lives in the reallocation scenario) derives from a two-page editorial published in a medical journal in 1980. See Roberts, 93 Annals Internal Med at 499–500 (cited in note 60). The numbers for eleven interventions relating to pollution control at paper mills were drawn from a 1990 study (No 844), which was itself a study of EPA assessments made during the 1970s and early 1980s. See R.A. Luken, *Efficiency in Environmental Regulation: A Benefit-Cost Analysis of Alternate Approaches* 10–11 (Kluwer 1990) (describing the age of sources).

in question took effect.[78]

Confusing predictions with actual results has two deleterious effects. First, it creates a bogus appearance of precision that renders the scorecards highly quotable—and fundamentally misleading.[79] Second, ex ante predictions likely understate net benefits in many cases. The reason is not, as commonly believed, that costs of any given policy are necessarily overestimated or benefits underestimated in agency assessments.[80] The reason is found in the static nature of cost-benefit estimation.

Cost-benefit calculations made in the course of rulemaking or rule advocacy are snapshots of a hypothetical future. They generally assume the policy will be applied without adjustment for the duration of the planning period. This assumption makes reasonably good sense when applied to the evaluation of specific projects—like dams, roads, and commercial developments—which are essentially irreversible once installed.[81] Most regulations, by contrast, may easily be modified, eased by waivers, subcategories, and variances, or repealed at some fu-

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[78] See Morrall, Regulation at 25, 27 (cited in note 8); Hahn, *Government's Numbers* (2000) at 32, 38 (cited in note 13).

[79] Of course, ex ante estimates may serve as relevant indicators of decision rationality if all understand that the latter is being judged solely by the facts available to the agency at the time it made its decision. See *Citizens to Preserve Overton Park v Volpe*, 401 US 402, 419–20 (1971) (establishing this as the standard for judicial review of agency rules). The problem with this standard is that the facts available to the agency during rulemaking normally do not permit it to anticipate how often (and in what cases) waivers and variances, rule modification, and enforcement discretion will be used to reduce unexpected regulatory burdens.

[80] Some authors point out, correctly, that hard-to-quantify benefits tend to be understated in agency cost-benefit estimates. See Thomas O. McGarity, *Reinventing Rationality: The Role of Regulatory Analysis in the Federal Bureaucracy* 131 (Cambridge 1996). Others point out, equally correctly, that agencies tend to overestimate those benefits that they do quantify when they adopt conservative risk assumptions in evaluating proposed regulations. Morrall, Regulation at 29 (cited in note 8); Albert L. Nichols and Richard J. Zeckhauser, *The Perils of Prudence: How Conservative Risk Assessment Distorts Regulation*, Regulation 13, 13 (Nov–Dec 1986). The *net* effect of these opposing biases may well depend on the facts of each case. On the cost side, analysts likewise disagree on whether the costs of any given policy tend to be understated or overstated. See Part II.A.1.f. One of the few actual comparisons of cost predictions with actual experience suggests that ex ante cost estimates are sometimes understated, sometimes overstated, and sometimes about right. See Winston Harrington, Richard D. Morgenstern, and Peter Nelson, *On the Accuracy of Regulatory Cost Estimates*, Discussion Paper 99-18, 2 (Resources for the Future 1999), online at http://www.rff.org/CFDOCS/disc_papers/PDF_files/9918.pdf (visited May 6, 2003). See also William D. Nordhaus, *From Porcopolis to Carbopolis: The Evolution from Pork Bellies to Emissions Trading*, in Richard F. Kosobud, ed, *Emissions Trading: Environmental Policy's New Approach* 61, 66 (John Wiley & Sons 2000) (noting that while sulfur dioxide reduction costs were overestimated, chlorofluorocarbon control costs were, if anything, underestimated).

[81] One might, of course, ease the impact of a dam by installing fish ladders or controlling water flow in various ways. This is tinkering around the edges, however. Generally speaking, the costs and benefits of a dam are what they are, once the dam is built, and there is not much (short of removing the dam) that future decisionmakers can do about it.

ture time. These dynamic feedback loops allow regulators to adjust the impact of regulations, as applied, so that high net benefit regulations stay in place, while low or negative net benefit regulations are repealed, modified, or eased by variances.

Predictions that ignore dynamic policy adaptation will tend to understate the net benefits of regulation. To take just one example, EPA's Final Great Lakes Water Quality Guidance aims to curtail emissions of persistent, bio-accumulative toxic pollutants into the Great Lakes.[82] EPA anticipated an annualized compliance cost of between $60 and $380 million per year (1994 dollars).[83] But EPA also said that it expected actual costs to be near the low end of the range because final decision authority for implementing the Guidance was being delegated to states and tribes who would retain discretion to provide waivers and variances in cases where strict compliance would impose excessive costs.[84] Yet Hahn's scorecard ignores this corrective mechanism. It mechanically adopts the mid-point estimate of $218 million, thereby assuming that EPA will rigidly apply its rules in many cases, even when EPA has expressly stated its intention *not* to do that.[85] In theory, the autopilot fallacy might be avoided by confining the database to retrospective cost-benefit studies. These, however, are few and far between, for two reasons that McGarity and Ruttenberg have well explained in a recent article.[86] First, retrospective analyses are surprisingly difficult: causal connections between regulation and impact are hard to establish in practice, and even retrospective studies require a counterfactual and hypothetical analysis of what the world would have been like absent the regulation. Second, agencies have little or no incentive to probe, in detail, the possibility of their own prior analytical mistakes. As a candid EPA analyst once asked, rhetorically, "How is my career going to be advanced by doing a study that shows that three years ago the agency made a wrong prediction?"[87]

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82 EPA, Final Water Quality Guidance for the Great Lakes System, 60 Fed Reg 15366 (1995).

83 Id at 15381.

84 Id.

85 See Appendix C, Row 70. The cost number listed in the seventh column, $2,764 million, represents the present value of a twenty-year stream of costs that, according to Hahn's spreadsheet, are assumed to be $218 million annually. The $218 million figure is stated as the assumed annual cost in cell AH-9 of the spreadsheet (on file with author).

86 McGarity and Ruttenberg, 80 Tex L Rev at 2039–40 (cited in note 32).

87 Id at 2040. See also Harrington, Morgenstern, and Nelson, *Accuracy of Regulatory Cost Estimates* at 2 (cited in note 80) ("[E]x post studies of the cost of regulation are quite scarce.").

The most comprehensive such analysis is unquestionably EPA's seven-year retrospective study of the costs and benefits of the Clean Air Act, mandated by Section 812 of the Clean Air Act Amendments of 1990. See EPA, *Benefits and Costs* (cited in note 44). However, that study does not examine costs and benefits at the level of individual regulations, and therefore sheds no light on the accuracy of ex ante Regulatory Impact Assessments. One study that directly compared ex ante and ex post regulatory cost estimates found that ex ante estimates exceeded actual

The result is a dearth of retrospective studies that forces scorecardists to rely on ex ante guesses about regulatory costs and benefits. This in no way justifies, however, the current practice of reporting such guesses as if they were actual costs and benefits—thereby grossly overstating the reliability of the figures and, probably, understating net benefits.

D. Undervaluing Life and Health Benefits (Hahn) and Overstating Cost per Life (Tengs/Graham and Morrall)

Hahn, as we have seen, assigns a "standard" value of $5 million per statistical life saved, with $3 million and $7 million values used in sensitivity analysis. He then discounts the value of lives saved in the future—for example, after a latency period following exposure to a carcinogen—at 5 percent per year.[88] Such practices are now commonplace in agency analysis as well.[89] Some scholars have objected on ethical grounds to the practice of monetizing, and then discounting, the value of reducing risk to human life.[90] Others have defended the inevitability of the first and the propriety of the second.[91] Rather than reopen that argument, the discussion that follows assumes that regulators will continue to monetize and discount for the foreseeable future.[92] This Part simply reviews findings of Professors

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costs for twelve rules, underestimated costs for six rules, and were roughly accurate for the remaining seven rules. Harrington, Morgenstern, and Nelson, *Accuracy of Regulatory Cost Estimates* at ii (cited in note 80).

88 Hahn, *Government's Numbers* (2000) at 39 (cited in note 13).

89 See, for example, OMB, Memorandum for the Heads of Departments and Agencies from Jacob J. Lew, Director, *Guidelines to Standardize Measures of Costs and Benefits and the Format of Accounting Statements*, M-00-08, at 6 (Mar 22, 2000), online at http://www.whitehouse.gov/omb/memoranda/m00-08.pdf (visited Oct 18, 2003) (calling on agencies to "monetize quantitative estimates [of costs and benefits] whenever possible," to "discount [monetized] benefits and costs that occur in different time periods," and to "provide a clear explanation of the rationale behind" any regulatory choice that is based on "unquantifiable benefits or costs"); OMB, Memorandum for the Heads of Departments and Agencies from Mitchell E. Daniels, Jr., *2001 Discount Rates for OMB Circular No. A-94*, M-01-14, at Appendix C (Mar 7, 2001) (prescribing a 3 percent real interest rate for long-term cost-effectiveness analysis). While OMB has not required that agencies all use the same life value, agencies typically assign a value of less than $7 million per life saved. See OMB, *Guidelines* at 12–13.

90 See, for example, Heinzerling, 107 Yale L J at 2042–56 (cited in note 15); Heinzerling and Ackerman, *Pricing the Priceless* at 11–16 (cited in note 38); Lisa Heinzerling, *The Rights of Statistical People*, 24 Harv Envir L Rev 189 (2000).

91 See, for example, Donohue, 108 Yale L J 1901 (cited in note 33); Morrall, Regulation at 28–29 (cited in note 8).

92 The standard answer to arguments that risk to life should not be assigned a monetary value is that society implicitly assigns such a value every time it chooses to tolerate any risk at all. Regarding life as infinitely valuable would require attempting to eliminate every conceivable risk to life no matter how minute or costly to avoid—a policy that would impoverish society so much that few people, if any, would choose it. Compare Heinzerling and Ackerman, *Pricing the*

Revesz, Shapiro, Glicksman, and others—as well as work-in-progress by this author—which suggest that the risk-to-life values in current use are not empirically well-grounded, and are probably far too low by their own logic.[93]

Briefly, Hahn draws his risk-to-life values from a collection of contingent valuation and labor market studies which are largely the same studies upon which EPA and other agencies also rely.[94] Contingent valuation studies, as many scholars have pointed out, elicit hypothetical answers to hypothetical questions, with no way to verify that such polls measure people's real values.[95] Such studies are inherently unreliable. Labor market studies, on the other hand, observe actual market behavior in the form of wage-premiums accepted by workers in high risk jobs: the yearly wage-risk premium divided by annual job risk yields the implicit value of risk-to-life accepted by these workers. Despite the advantage of having access to actual behavior, labor market studies exhibit serious drawbacks of their own:

1. The labor market studies upon which Hahn and the agencies rely have not been quality-controlled to a level remotely commensurate with the weight they now carry. In fact, as Appendix D reveals, these studies employ different data, methods, assumptions, and models to yield implicit values of a statistical life (VSLs), which range from less than $1 million to nearly $18 million, measured in 2000 dollars.[96] Neither Hahn nor the agencies have ever supplied a full and convinc-

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Priceless at 11–16 (cited in note 38), with Viscusi, *Fatal Tradeoffs* at 3–5 (cited in note 15).

93 See Cass R. Sunstein, et al, *Predictably Incoherent Judgments*, 54 Stan L Rev 1153, 1196–97 (2002) (criticizing contingent valuation techniques); Revesz, 99 Colum L Rev at 962–87 (cited in note 21) (criticizing simple extrapolations from labor market studies); Peter A. Diamond and Jerry A. Hausman, *Contingent Valuation: Is Some Number Better than No Number?*, 8 J Econ Persp 45, 46 (Fall 1994) (arguing that contingent valuation techniques do not measure the preferences they attempt to measure).

94 Specifically, he writes, "I used standard willingness-to-pay estimates based on labor market studies of risk-dollar tradeoffs for fatal and nonfatal risks." Hahn, *Government's Numbers* (2000) at 39 n 24 (cited in note 13). For this, Hahn cites W. Kip Viscusi, *The Value of Risks to Life and Health*, 31 J Econ Lit 1912 (1993), which presents the same results as Viscusi's book, *Fatal Tradeoffs* (cited in note 15).

95 This is only one of the many serious problems that plague contingent valuation studies. For a trenchant critique by a Nobel-laureate economist raising issues unanswered by defenders of the practice, see Amartya Sen, *The Discipline of Cost-Benefit Analysis*, 29 J Legal Stud 931 (2000). It is true that the 1992 National Oceanic and Atmospheric Administration (NOAA) Panel on Contingent Valuation provisionally endorsed Contingent Valuation Method (CVM), subject to strict guidelines, for purposes of deriving non-use values of ecosystems, in light of the fact that such values cannot be derived by another means. Neither expressly nor impliedly, however, did the Panel endorse the use of CVM for life valuation for which alternative, revealed-preference estimation methods are available. NOAA, Report of the NOAA Contingent Valuation Panel, 58 Fed Reg 4601 (Jan 15, 1993).

96 See Appendix D, columns A and C, listing studies relied on by EPA; EPA, *Guidelines for Preparing Economic Analyses*, EPA 240-R-00-003, 89 exhibit 7-3 (2000). Viscusi draws on many of the same studies and attributes much of the variability in VSLs to differences in assumptions and the design of various studies. Viscusi, *Fatal Tradeoffs* at 34–59 (cited in note 15).

ing explanation of why estimated life values vary by more than an order of magnitude, or why certain studies and/or values were preferred over others.[97]

2. Labor market studies generally assume, without proof, that the workers in the database enjoy a free and unfettered choice of jobs with various risks, and that they accurately assess the risks of the jobs they are taking.[98] Such assumptions raise considerable doubt as to whether existing studies yield valid estimates of occupational VSLs.

3. The values that labor market studies elicit are derived from different contexts and are different values than those that regulators are required to consider in assigning monetary numbers to regulatory risks. For example, it is generally agreed that: (a) high-risk jobs are typically voluntarily assumed and self-select for risk tolerance;[99] (b) high-risk workers have incomes that are far below that of the average beneficiary of regulations under review;[100] (c) workplace risks are typi-

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97 EPA makes no distinction among the studies in its database. It simply takes the "central tendency" of these studies while noting, "Further research on synthesizing the results of these studies . . . may provide better estimates." EPA, *Guidelines for Preparing Economic Analyses* at 90 (cited in note 96). The Department of Transportation, which houses the Federal Aviation Administration and NHTSA, has chosen a life value of $3 million (2002 dollars) with no public discussion. See Memorandum to Assistant Secertaries from Kirk K. Van Tine, General Counsel, Revised Departmental Guidance on Treatment of Value of Life and Injuries in Preparing Economic Valuations (Jan 29, 2002) (unpublished memorandum on file with author). Viscusi notes that "most of the reasonable estimates of the value of life are clustered in the $3 to $7 million range," *Fatal Tradeoffs* at 73, when, in fact, more than half of the values in his own table fall outside that range. Id at 52–53 table 4-1. Other scholars have performed meta-analyses that try, in various ways, to control for quality and adjust for differences among methods, assumptions, and databases. See, for example, Janusz R. Mrozek and Laura O. Taylor, *What Determines the Value of Life?: A Meta-Analysis*, 21 J Pol Analysis & Mgmt 252 (2002); Ted R. Miller, *The Plausible Range for the Value of Life—Red Herrings Among the Mackerel*, 3 J Forensic Econ 17 (1990). But this, without more, simply adds a new dimension of uncertainty about the assumptions and methods of the meta-analyses.

98 Viscusi, *Fatal Tradeoffs* at 38 (cited in note 15). Even if workers accurately estimate the risks they are assuming, labor market studies supply no evidence that high-risk workers enjoy ready access to less risky job alternatives, as would be necessary to permit the inference that the wage premiums reflect a voluntary decision. See Sidney A. Shapiro and Robert L. Glicksman, *Risk Regulation at Risk: Restoring a Pragmatic Approach* 98–100 (Stanford 2003); McGarity, *Reinventing Rationality* at 147–48 (cited in note 80).

99 As OMB observes: "the use of occupational-risk premiums [without adjustment] can be a source of bias because the risks, when recognized, may be voluntarily rather than involuntarily assumed, and the sample of individuals upon which premium estimates are based [blue-collar workers in high-risk occupations] may be skewed toward more risk-tolerant people." OMB, Draft 2003 Report to Congress on the Costs and Benefits of Federal Regulations, Notice, 68 Fed Reg 5492, 5519 (Feb 3, 2003). See also Mrozek and Taylor, 21 J Pol Analysis & Mgmt at 264 (cited in note 97) (finding self-selection effects dominant at very high-risk jobs); Cropper and Oates, 30 J Econ Lit at 714 (cited in note 68) (citing studies showing that voluntary risks and involuntary risks are valued differently).

100 See, for example, Viscusi, 31 J Econ Lit at 1930 (cited in note 94). Income matters because it is well-known that willingness to pay to avoid risk (and/or willingness to accept risk in

cally safety risks which accrue to individuals in the prime of life, while many regulatory risks involve cancer, a uniquely dreaded disease that primarily afflicts the elderly.[101] On balance, Professor Revesz has concluded that the failure to incorporate necessary adjustments may underestimate regulatory VSL by as much as a factor of six.[102] Yet, astonishingly, the regulatory life-values employed by Hahn (and agencies) are lifted directly from old labor market studies without adjustments of any kind, other than for inflation.

Besides underestimating regulatory VSL, Hahn further skews his results by discounting the value of lives saved in the future at a baseline rate (5 percent) which is well above the "consumption" rate of interest (2–3 percent) that many economists believe is the appropriate rate for discounting future benefits to consumers in an open economy.[103] Tengs/Graham and Morrall do not monetize life values and hence do not discount the value of lives. However, they discount the *number* of lives saved in future years.[104] The effect of this practice on cost-effectiveness calculations can be dramatic. Consider, for example, a regulation that costs $1,000 now to save 100 lives in 20 years. "Discounting lives" has the effect of increasing the calculated cost per life saved by a factor of 3 (at the 5 percent discount rate employed by

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exchange for compensation) tends to rise with real income levels. In addition, income levels have risen considerably since the date of the wage-risk studies (many of which use data that are more than two decades old). Note that calling for an income adjustment does *not* mean that social regulators should value rich people's lives more highly than poor people's in practice. The social value of a life does not depend on the income of the person. The point is simply that the decision to use a single life value for all people in society in no way justifies drawing that value exclusively from the low-income segment of society, or from a lower-income time period, with no adjustment to reflect the higher incomes of others, or income growth.

[101] Though the propriety of adjusting life value for remaining life expectancy may be questioned (it implies that older people's lives are worth less than the lives of others), Revesz believes accounting for this difference would reduce the measured life-saving value of social regulation by about 50 percent in the case of cancer fatalities that accrue to elderly people after a twenty-year latency period. See Revesz, 99 Colum L Rev at 981 (cited in note 21). Accounting for the "dread factor" associated with cancer, on the other hand, would approximately double the value of cancer risk avoidance, according to Revesz. Id at 972–73.

[102] Id at 962–74 (noting that the first two sets of distinctions clearly point to an upward adjustment, while the effect of the third set of differences is ambiguous).

[103] Compare Hahn, *Government's Numbers* (2000) at 39 (cited in note 13), with Kenneth J. Arrow, et al, *Benefit-Cost Analysis in Environmental, Health and Safety Regulation: A Statement of Principles* 13–14 (AEI 1996) (hereinafter *Annapolis Principles*) ("The rate at which future benefits and costs should be discounted to present values generally will not equal the rate of return on private investment. The discount rate should instead be based on how individuals trade off current for future consumption."). See also Revesz, 99 Colum L Rev at 979 (cited in note 21) (contrasting justifications for OMB's use of the marginal pre-tax rate of return on private investment with GAO, CBO, and EPA's use of the consumption rate of interest as discount rates for cost-benefit analysis).

[104] Tengs and Graham, *Opportunity Costs* at 169 (cited in note 10) (stating that "costs, lives, and life-years saved should all be discounted to their present value at a rate of 5 percent"); Morrall, Regulation at 28 (cited in note 8) ("For the sake of consistency, I adjusted these temporal variations using a uniform 10-percent discount rate for both the benefits and the costs.").

Tengs/Graham) or a factor of 7 (at the 10 percent rate employed by Morrall).[105]

What is wrong with discounting numbers of lives saved? One obvious problem is that death does not recognize human accounting conventions and death does not discount. As a result, if 1,000,000 people are exposed to a toxic chemical that produces a 1:10,000 probability of fatal cancer among those exposed, then the odds are quite high that approximately 100 people (not 37, or 14) will lose their lives to cancer. Moreover, whatever the interior logic to some economists of discounting monetary values for risk to life, the average reader of the Tengs/Graham articles or the Morrall table (and, I suspect, the majority of senior policymakers) are unlikely to understand that the physical reality of 100 lives saved in 20 years is, in fact, being treated as 37, or 14, lives saved today. In short, discounting lives is misleading and therefore objectionable simply as a matter of English usage.[106] A far better approach would have been simply to follow the guideline embodied in OMB's later advice to agencies:

> As a first step, you should consider presenting the streams of benefits and costs over time. These "raw" streams of benefits and costs can help you—and your reader—better understand the effects of alternative regulatory actions.[107]

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[105] Specifically, discounting lives at 5 percent has the effect of reducing the calculated number of lives saved to $100/(1.05)^{20}$, or 37 lives. The $1,000 expenditure yields a cost per life of $27, which is roughly 3 times the $10 cost per life obtained without discounting. The factor of 7 difference over 20 years, mentioned above, is calculated in the same manner, substituting a 10 percent rate. Discounting lives at 10 percent for *40* years, as Morrall appears to have done, has the effect of reducing the 100 lives saved to only 2, thereby increasing the cost per life saved by a factor of 50. Heinzerling offers an excellent analysis of the impact of discounting in inflating Morrall's cost per life saved estimates in *Mythic Proportions*, 107 Yale L J at 1985 nn 8–10 (cited in note 15).

[106] Morrall has defended his practice of discounting lives in the following terms: "Discounting costs but not benefits leads to absurd results, such as that a rule saving 100 lives a decade from now is more desirable than a rule of equal cost saving 99 lives right away, and that all rules yielding continuous benefits are worth any amount of immediate costs." Morrall, Regulation at 28 (cited in note 8). Both arguments fail. The choice between 100 lives saved a decade from now and 99 lives saved today may seem obvious to Morrall. But, obvious or not, it is fundamentally a moral choice, not an economic one, which can and should be preserved for policymakers by simply announcing the number and timing of lives saved, free of discounting. Morrall's second argument—that, without discounting, "all rules yielding continuous benefits are worth any amount of immediate costs"—ignores basic precepts of regulatory evaluation. All regulations yield streams of costs and benefits that are, for analytical purposes, truncated at the end of some stipulated planning period. Hahn, for example, assumes that the rules he studies will be in effect for twenty years, meaning that costs are truncated after twenty years, and benefits are truncated after twenty years plus whatever the assumed latency period is. Hahn, *Government's Numbers* (2000) at 40 (cited in note 13). So trivial benefits do not and cannot, in practice, accumulate to infinity over a period of infinity.

[107] OMB, *Guidelines* at 6 (cited in note 89).

By drawing life-values from labor market studies without quality controls and without necessary adjustments to reflect relevant differences, and then discounting those values at excessive discount rates, existing scorecards underestimate regulatory benefits while grossly overstating the precision and reliability of their numbers.

E. Logically Unsupported Conclusions (Tengs/Graham)

The Morrall and Hahn studies may use unreliable data and dubious methods, but at least their conclusions follow from their data. The same cannot be said of the Tengs/Graham studies. These studies make three main assertions: (a) irrational regulation kills (the 60,000 lives claim); (b) the existing pattern of regulation is grossly inefficient; and (c) EPA and OSHA toxic control regulations are the worst of the lot.[108] Yet the discussion that follows will show that their own data do not establish any of these propositions.

1. Tengs/Graham's data do not prove "statistical murder."

Although the statistical murder charge is sensational and widely repeated, it rests entirely on two counterfactual assumptions. The first is that the United States government operates under a fixed national regulatory budget for allowable compliance cost, so that every private-sector dollar spent to reduce Risk A is a dollar taken away from efforts to mitigate Risk B. The second is that there is some mechanism in place for reallocating to better uses the savings achieved by zeroing out high-cost uses. In fact, there is no such compliance cost budget, and no such reallocation mechanism.[109] The reality is that we live in a

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[108] See Tengs and Graham, *Opportunity Costs* at 172 (cited in note 10) (claiming that an additional 60,200 lives could be saved by rationally reallocating resources to high-value life-saving interventions); Tengs, et al, 15 Risk Analysis at 371, 372 (cited in note 9) (claiming that "efficiency in promoting survival requires that the marginal dollar spent be the same across all programs," whereas in the authors' sample the marginal cost per life saved ranged from less than zero to more than $10 billion per life-year saved); id at 371 (claiming that the median toxic control intervention costs $2.8 million per life-year, compared to $42,000 for the median medical intervention and $48,000 per life-year for the median injury reduction intervention).

[109] Nor has Graham ever proposed establishing such a reallocation mechanism in his capacity as President Bush's regulatory czar. Regulatory critics *have* proposed creating the regulatory budget that claims of statistical murder assume. See, for example, Robert W. Hahn, *Achieving Real Regulatory Reform*, 1997 U Chi Legal F 143, 153 ("Congress should introduce a binding regulatory budget on an experimental basis."); Susan Lee and Daniel Roth, *The Mandate Mandarins*, Forbes 196, 200 (Dec 16, 1996) (reporting introduction of legislation to impose a regulatory budget to limit compliance costs that federal agencies may impose). With such a budget in place, it would be true that a dollar spent on Risk A necessarily would be subtracted from Risk B. Congress and agencies would be forced into a painful triage, with lives at stake, which might produce more "efficiency." Of course, it also would force agencies either to ignore large, newly discovered risks or cancel programs in place to make room in the risk budget cap. To date, Congress has not seen fit to create a regulatory budget. Undaunted, Graham and others simply assume such a budget exists by crafting a theory of "statistical murder" into which the assumption

$9 trillion economy of which only a small fraction is spent on regulatory risk reductions. If money spent cleaning up hazardous waste sites might save more lives if redirected to combat smoking, then so might a portion of the $36 billion spent each year on lottery sales,[110] the $92 billion spent on alcoholic beverages,[111] the $7.6 billion spent on spectator sports,[112] or the $54 billion spent on tobacco.[113] By the logic of Tengs/Graham, lottery sales "kill" 4,500 people every year, while spectator sports "kill" 950 statistical people.[114] Indeed, by the logic of Graham and Tengs, every highly paid baseball player or corporate CEO is a statistical murderer since, like regulators, they consume resources that might be devoted to risk reduction.[115]

Heinzerling finds an implicit political agenda in Graham's selective focus. As she points out, Tengs and Graham

> do not ask, for example, whether the billions of dollars in subsidies to the mining, logging, ranching and farming industries might be better spent on, say, smoking cessation and childhood immunizations. They do not even ask whether money spent subsidizing tobacco itself might be better spent on smoking cessation programs.[116]

Noting its selective focus is not the only way to appreciate the fallacy of Tengs/Graham's 60,000 lives claim. Another way is simply to examine the actual interventions that, starved of funds in Tengs/Graham's baseline scenario, do most of the new life-saving in reallocation. Appendix B-1 reveals that just two interventions—continuous (versus nocturnal) oxygen for hypoxemic obstructive lung disease and influenza vaccines for all citizens—account for over forty-two thousand of the sixty thousand additional lives saved by reallocation.[117] Yet few would suggest that the nation's failure to provide continuous oxygen for hypoxemic obstructive lung disease is somehow caused by excessive regulation of benzene or other interventions at

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is smuggled.

110 US Census Bureau, *Statistical Abstract of the United States: 2000* 325 table 519 (GPO 120th ed 2000).

111 Id at 761 table 1283, Food and Alcoholic Beverages Sales by Sales Outlet: 1995 to 1998.

112 Id at 253 table 418, Personal Consumption Expenditures for Recreation: 1990 to 1998.

113 Id at 457 table 723, Personal Consumption Expenditures in Current and Real (1996) Dollars by Type: 1990 to 1998.

114 These figures assume an $8 million marginal cost of saving a life.

115 Heinzerling makes the same point using the examples of soft drinks, fad diets, leaf blowers, and Nicoret gum. See Heinzerling, 13 RISK at 162 (cited in note 19).

116 Id.

117 See Appendix B-1, rows 20 and 22.

the "cost-ineffective" bottom of the list.[118] The two sorts of interventions do not compete with each other. Addressing low risks with expensive regulations may be inefficient in some sense, and it may therefore be a waste of money. But it is not killing anyone.

Of course, inefficient regulation may be undesirable, even if it does not kill. The question then arises whether Tengs/Graham at least establish a pattern of inefficient overregulation of small risks. The next section will show that they do not.

2. Tengs/Graham do not establish pervasive overregulation of small risks.

In *Five-Hundred Interventions*, Graham and Tengs uncover a wide disparity in the median cost of regulatory interventions when measured in cost per life saved. From this, they conclude that the existing pattern of regulation is inefficient because "efficiency in promoting survival requires that the marginal benefit per dollar spent be the same across programs."[119]

This statement reflects a fundamental misapprehension of basic economics. Contrary to Tengs/Graham's assertions, efficiency does not require that all regulatory "investments" exhibit the same marginal return. There is, for example, nothing inefficient about a portfolio of regulation that includes both "automatic shoulder seat belts in cars" (at $94,000 per life-year saved) and "automatic fire extinguishers in airplane lavatory trash receptacles" (at $279,000 per life saved).[120] One cannot, after all, put fire extinguishers in more than all receptacles or install automatic belts in more than all cars. Thus, an efficient portfolio of regulatory investments may (and most likely will) contain programs showing a wide range of cost per life saved. The efficiency criterion

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[118] See Appendix B-1, rows 170–87. Other scholars have postulated a different linkage between regulatory spending and mortality, whereby money spent on low-risk interventions reduces personal income and health care expenditures, thereby increasing mortality overall. See, for example, Ralph L. Keeney, *Mortality Risks Induced by Regulation*, 8 J Risk & Uncertainty 95, 102–04 (1994) (arguing that regulations' reduction in disposable income might cause shifts in individual purchasing behavior, increased stress, and less healthy behaviors like smoking, which in turn raise mortality); W. Kip Viscusi and Richard J. Zeckhauser, *The Fatality and Injury Costs of Expenditures*, 8 J Risk & Uncertainty 19 (1994) (finding that regulatory expenditures increase occupational risk by 3 to 4 percent of costs). Estimates of the marginal expenditure that would lead to the loss of one statistical life range from $3 million to $70 million. See W. Kip Viscusi, *Risk-Risk Analysis*, 8 J Risk & Uncertainty 5, 8 table 1, 12 (1994). If we take $8 million per life as the threshold of "efficient" spending, then about $2.6 billion of the $21 billion total spending in the Tengs/Graham database is inefficiently spent. This corresponds to between 78 and 867 lives lost due to inefficient expenditures under "income effect" hypotheses—still significant, but a far cry from the 60,000 "statistical murders" alleged by Tengs and Graham. Moreover, even the more attenuated linkage between income/health care spending and mortality is most likely illusory, for reasons set forth in Part II.A.1.g.

[119] Tengs, et al, 15 Risk Analysis at 372 (cited in note 9).

[120] See Appendix B-1, rows 30 and 43, respectively.

does not preclude this. It simply precludes putting low-benefit programs into effect while leaving higher-benefit programs unimplemented.[121]

A second problem with *Five-Hundred Interventions* has been well documented by Heinzerling: the authors include in their database all sorts of interventions that are not regulatory programs at all, and that in fact were never implemented or even proposed by any government official.[122] Obviously, one cannot draw conclusions about the efficiency of government regulation from data that fail to distinguish between real and hypothetical programs, or between government programs and private-sector actions.

Opportunity Costs stands on firmer ground.[123] It cures the probative shortcomings of the former study by generating, for each intervention, an estimate of the degree of implementation along with published estimates of the full-implementation costs and life-saving.[124] This

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[121] The life-saving maximization problem is essentially a constrained optimization problem in which the constraint is that no single intervention can be more than 100 percent implemented. Once the implementation level for any intervention reaches 100 percent, it is necessary to allocate any remaining risk reduction dollars to the next-most cost-effective intervention, and so on. The result over many interventions may well be a wide range of costs per life saved even in the optimized allocation. Indeed, Tengs/Graham's *Opportunity Costs* study contains just such a "rational" reallocation. As seen in Appendix B-1, their "efficient" reallocation of life-saving dollars produces a portfolio of interventions that display costs per life saved ranging from negative $8.5 billion to positive $8 million.

[122] Heinzerling and Ackerman, 87 Cornell L Rev at 653–55 (cited in note 31) ("[T]hey include many life-saving interventions that have never been implemented by any agency; indeed, they include many interventions that have never even been *proposed* by any agency.").

[123] Heinzerling has criticized the latter study as well for including non-implemented interventions. See Heinzerling, 13 RISK at 156 (cited in note 19) (stating that only eleven of ninety environmental measures studies were ever implemented); Heinzerling and Ackerman, 87 Cornell L Rev at 663 (cited in note 31) (repeating the same observation). This criticism misapprehends what *Opportunity Costs* is trying to do. The purpose of that study is to see how many additional lives or dollars could be saved by reallocating funds from partially or fully implemented (but cost-ineffective) programs to non- or partially implemented (but cost-effective) interventions. Reallocation would be impossible if all interventions in the database were required to be fully funded in the baseline. Moreover, unimplemented and exorbitantly expensive interventions do not skew the analysis because they do no work. They are not implemented in the baseline; they remain unimplemented in the reallocation; they add nothing to the total of lives or money saved by reallocation. The same is true of highly effective interventions that are fully implemented in both scenarios. Thus, the only interventions that matter to the reallocation exercise are (a) high-cost interventions that are at least partially implemented in the baseline and (b) lower-cost interventions that are not fully implemented in the baseline. All savings in lives and/or cost come from reallocating compliance expenditures from group (a) to group (b). Nor is there merit to Heinzerling's objection, id at 663, that *Opportunity Costs* reallocates funds among government and non-government interventions (such as hospital practices) without distinction. In practice, virtually all hospital practices (and other life-saving or endangering private sector activities) are potential subjects for government regulation and hence fair game for reallocation.

[124] Regrettably, the implementation estimates are unpublished, leaving the general reader with no way to determine which interventions are implemented and which are not, or to verify

produces the baseline spending scenario reproduced in Appendix B-1: $21.35 billion spent to save 56,700 lives.[125] The authors then use their linear optimization model to calculate that 60,200 additional lives might be saved at the same cost, or $31 billion conserved without additional loss of life, through an optimal reallocation of compliance spending.[126] The opportunity to save 60,200 additional lives at no extra charge through reallocation seems like a telling indictment of our propensity to lavish regulatory compliance dollars on small risks.

Close inspection of the authors' data reveals a rather different picture, however. Appendix B-1 reveals that the authors have included in their baseline eleven non-implemented interventions that, when fully implemented in reallocation, save $9.5 billion more than they cost.[127] By contrast, if we take $8 million per life as the threshold of efficient life-saving expenditure, only about $2.6 billion is spent on "inefficient" life-saving interventions.[128] In other words, for the interventions in the Tengs/Graham *Opportunity Costs* database, nearly four times more money is wasted by failing to regulate than is lost by overregulating.[129]

Moreover, the *Opportunity Costs* study is hardly a robust demonstration of systemic over- *or* underregulation. As seen, two-thirds of

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implementation estimates. See discussion in Part I.A.

125 See Appendix B-1, cells G188 and H188.

126 Tengs and Graham, *Opportunity Costs* at 172 (cited in note 10). While the authors provided a spreadsheet setting forth their baseline scenario, they did not provide a spreadsheet setting forth their reallocation pattern of spending. This author's attempt to replicate their reallocation generated a number for total additional life saving (60,906) that is very close to Tengs/Graham's number (60,200), but is not exactly that number. The discrepancy of less than 2 percent is most likely explained by differences in the way this author and Tengs/Graham defined "clusters" of competing interventions which save lives by alternative means in identical situations. Obviously, only one intervention in each cluster can be fully implemented in reallocation. The other interventions must be zeroed out—otherwise, life-saving from reallocation will be double or triple counted. Unfortunately, the authors' spreadsheet is not always clear as to which interventions are being grouped together in clusters.

127 See Appendix B-1, rows 3–13 of column C and the summary. The $9.5 billion value in the summary is derived by subtracting the sum of cells G3 through G13 (total baseline spending on negative-cost interventions) from the sum of cells I3 through I13 (total reallocation spending on negative-cost interventions). This is the amount released for life-saving elsewhere by fully implementing negative-cost interventions in the reallocation scenario.

128 Appendix B-1, summary. For a defense of the $8 million threshold, see Part I.D. The $2.6 billion figure is derived by summing the baseline cost of all interventions which display a marginal cost per life (Column D) of more than $8 million. These interventions are listed in rows 104 through 187. $2.6 billion represents the sum of baseline spending (Column G) on these interventions. It should be noted, however, that the total spending on "inefficient" interventions is highly sensitive to the stipulated threshold of efficiency. At a threshold of $7 million per life, $17 billion (almost 80 percent of total baseline spending) is "inefficiently" spent. See Appendix B-1, summary. The lack of robustness is due to the fact that one intervention—South Coast of California ozone control—accounts for *$15 billion* in baseline spending at an estimated cost of $7.5 million per life saved. See Appendix B-1, row 101.

129 See also Appendix B-1, rows 103–87.

the 60,000 additional lives saved through reallocation in that study are associated with just two interventions.[130] Nearly 95 percent of the 60,000 additional lives are saved by fully implementing just nine interventions, of which three are medical, five are traffic-related, and one is environmental.

On the expenditure side, table 2 of Appendix B-2 reveals that optimization results in the reallocation of about $17.7 billion, of which *90 percent* is generated by just eight interventions. Indeed, over half of the $17.7 billion is supplied by the opinion of a single author that it would be much more cost-effective to ban residential growth in tsunami-prone areas than to construct sea walls to control the damage.[131]

These few interventions do yield startling numbers. While few will be amazed by news that many more lives might be saved on the road, the possibility of saving 42,000 additional lives a year with just two medical measures, if true, is surprising. One wonders why this was not the headline of their article. In fact, the authors do not even mention these amazing life-saving opportunities in their published report. Nor has Graham, an author of the study and the current regulatory "czar" of the Bush Administration, done anything in office to further the cause of oxygen for hypoxemics, to advocate flu vaccines for all, or to promote a ban on residential growth in tsunami-prone areas. One wonders whether he believes his own data, or if he is even aware of them.

The major point for present purposes, however, is that the *Opportunity Costs* results are not robust. They are dominated by a handful of interventions that certain authors believe should, or should not, have happened. They do not establish a pervasive pattern of gross overregulation of small risks. Indeed, if they reveal any pattern at all, it is one of significant underregulation, with no evidence that over-control is somehow causing underregulation.

If the Tengs/Graham data fail to prove systemic overreaction to small risks, we are left with the final question of whether *Opportunity Costs* at least establishes that toxic regulations are singularly prone to inefficient overregulation.

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[130] See note 117 and accompanying text. See also table 1 of Appendix B-2.

[131] See Appendix B-2, table 2, rows 3 and 139. The source for these data is given in Tengs, et al, 15 Risk Analysis at 389 (cited in note 9).

3. Tengs/Graham's data do not prove that toxic-related regulations are particularly inefficient.

Appendix B-3a contains the authors' spreadsheet numbers for all non-toxic-related interventions. Appendix B-3b contains the authors' spreadsheet numbers for the toxic control interventions in their sample. If we again take $8 million per life as our provisional threshold of efficiency, these appendices indicate that about 4 percent of the funds spent on toxic-exposure-related interventions were spent inefficiently in the baseline case, whereas 63 percent of the non-toxic-related interventions were spent inefficiently. In other words, the authors' own data suggest that toxic control programs are fifteen times more efficient than their non-toxic counterparts in their overall pattern of spending to save lives.

How do we reconcile the relative efficiency of spending on toxic control with the authors' findings in *Five-Hundred Interventions* that toxic control interventions exhibit median costs per life saved orders of magnitude higher than interventions in other areas?[132] The answer is straightforward. As Appendix B-3b reveals, most of the high-cost interventions for toxics in the sample are either not implemented, or implemented at low compliance-cost levels. Non-toxic-related interventions, on the other hand, are much more likely to be implemented notwithstanding an inordinately high cost.

This Part has shown that the Morrall, Hahn, and Tengs/Graham scorecards contain a range of methodological errors: concealed data, arbitrary and non-transparent calculations, non-replicable conclusions, selection bias, confusion of ex ante guesses with ex post measurements, systematic undervaluation of life and health benefits, and/or inferences unsupported by data. These errors—which might have been avoided through more careful analysis or reporting—are sufficient in themselves to undermine these scorecards as a basis for claims about government regulation.

II. CRITIQUE OF THE TESTS: GENERIC DEFECTS

Besides the avoidable errors discussed in the preceding Part, the Hahn, Morrall, and Tengs/Graham scorecards also exhibit a number of analytical defects that appear to be endemic to the scorecard enterprise. This Part discusses three such shortcomings: (A) disregard of whole categories of unquantified costs and benefits (and, amazingly, many benefits that agencies quantified); (B) disregard of distributive

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132 Tengs, et al, 15 Risk Analysis at 371 (cited in note 9) ("[T]he median medical intervention costs $19,000/life-year (n=310); the median injury reduction intervention costs $48,000/life-year (n=133); and the median toxin control intervention costs $2,800,000/life-year (n=144).").

impacts; and (C) failure to disclose the true level of uncertainty in the analysis.

A. Disregarding Unquantified (and Some Quantified) Costs and Benefits

Perusing Hahn's unpublished spreadsheet of regulatory costs and benefits (reproduced in Appendix C) yields a startling discovery. Forty-one of the 136 rules in his database—30 percent of all the rules—are assigned a zero benefit. These rules, it should be emphasized, are not rules for which it is claimed that costs equal benefits. These are rules alleged to offer no benefit whatsoever.

The list of zero benefit rules includes:

- a rule requiring that owners and operators of oil tankers develop plans to respond to large oil spills (row 28);
- a rule requiring double hull construction for oil tankers like the Exxon Valdez (row 29);
- a rule to implement 1990 Clean Air Act Amendments that require certain sources of air pollutants to hold permits and comply with permit conditions (row 51);
- a rule requiring the public reporting of releases of certain toxic chemicals from manufacturing facilities (row 67);
- a Clean Water Act rule aimed at protecting sensitive coastal areas from non–point source water pollution (row 73);
- a Clean Water Act rule establishing technology-based water pollution discharge standards for electroplating and metal finishing point sources (row 76);
- a rule to protect agricultural workers from exposure to harmful pesticides (row 78);
- a rule establishing financial responsibility requirements for owners and operators of underground storage tanks (row 88);
- three rules establishing national primary drinking water standards to limit public exposure to toxic pollutants in drinking water (rows 91, 94, and 95);

- a regulation banning the manufacture and sale of products containing PCB, a highly toxic and bioaccumulative substance (row 98);

- a Food and Drug Administration (FDA) rule establishing requirements for the safe handling of seafood in commercial processing operations (row 100);

- an HHS rule requiring improvements in clinical laboratory practices (row 102); and

- a proposed rule to prevent or reduce oil spills from non-transportation-related onshore oil handling facilities (row 127).[133]

It turns out that Hahn, with a few narrow and limited exceptions, has assigned a zero value to any benefit that the government's regulatory impact assessment does not quantify and monetize.[134] Hahn also zero-values benefits that are quantified and monetized in an agency regulatory impact assessment (RIA), unless they happen to fall into one of his select categories of recognized benefits—even as he insists that he is using the government's numbers.[135]

The omissions of unquantified variables are not confined to zero-benefit rules. Rules that display a positive number in the benefits column turn out, on closer inspection, to have had whole categories of important benefits excluded from the tally.[136] The result is forty-one zero-benefit rules and an indeterminate number of other rules for which whole categories of benefits have been summarily excluded.

Morrall and Tengs/Graham adopt an even more extreme accounting convention: by evaluating every regulation solely in terms of cost

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133 The zero benefit entries listed above are represented by a "-" in column 8 of each indicated row in Appendix C.

134 All unquantified benefits are assigned a zero value. As seen in more detail below, Hahn monetizes the value of a benefit that the agency has quantified but not monetized in the case of benefits involving (1) avoidance of cancer, heart disease, or lead poisoning; (2) avoidance of accidental death or injury; and (3) pollution from any of four named air pollutants.

135 The exceptions (which Hahn monetizes regardless of whether the agency does so) are health benefits of reducing emissions of a small group of air pollutants—carbon monoxide, hydrocarbons, nitrogen oxides, particulate matter, and sulfur dioxide—on a per-ton-of-reduction basis. These benefits are counted only if the agency has quantified the lives saved, illnesses or injuries averted, or tons of a certain air pollutant removed. All other benefits are zero-valued. Hahn, *Government's Numbers* (2000) at 40 (cited in note 13).

136 See, for example, EPA, Final Water Quality Guidance for the Great Lakes System, 60 Fed Reg 15366 (cited in note 82). See also notes 180–82 and accompanying text.

per life saved, they manage to exclude non-life-saving benefits entirely.

These scorecards also omit certain unquantified costs: costs of record keeping and enforcement, diversion of management time, lost productivity, diminished competitiveness (though most studies find competitiveness effects of most regulations are small), and so forth.[137] Agencies pay scant heed to these costs, and scorecards neglect them altogether. Yet they clearly exist.

Perhaps the best way to appreciate the nature and consequence of cost and benefit omissions is to examine a sample of the actual cases in which they occur. Section 1 documents the nature and consequence of these omissions for the analysis of particular regulations. Section 2 shows that the categorical exclusion of unquantified variables is both endemic to scorecards and inconsistent with basic principles of cost-benefit analysis.

1. A taxonomy of excluded costs and benefits.

My audit of the rules in Hahn's database reveals seven common situations in which benefits and/or costs are likely to have been omitted: (a) quantified and/or monetized benefits that the scorecard does not recognize; (b) procedural benefits; (c) interlocking benefits; (d) benefits that are hard to measure; (e) statutorily mandated benefits; (f) indirect costs; and (g) costs associated with risk-risk tradeoffs. Examination of these rules suggests (though it does not prove) that the omissions are most significant on the benefit side of the ledger.

a) Quantified but unrecognized benefits. Morrall and Tengs/Graham exclude all benefits other than human life-saving, regardless of whether an agency has quantified and/or monetized them. Hahn likewise excludes benefits that agencies have quantified and monetized, but that do not fit into one of his arbitrary categories—even as he insists that he is using the "government's numbers."[138] A few examples drawn from rules in Hahn's database may serve to illustrate the nature and consequence of such exclusions.

Agricultural worker protection. In 1992, EPA promulgated an agricultural worker protection standard for pesticides. Noting that the rule would help protect 3.9 million agricultural workers across the

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137 See Part II.A.1.f.

138 See Morrall, Regulation at 31 (cited in note 8) ("To elide the controversies and uncertainties of choosing a single dollar figure for the value of saving a life, I have chosen a second-best measure of desirability, cost-effectiveness, measured by cost per life saved."); Tengs and Graham, *Opportunity Costs* passim (cited in note 10); Hahn, *Government's Numbers* (2000) passim (cited in note 13).

United States who are exposed to pesticides in their work, EPA predicted the following benefit:

> [A]voiding 8,000–16,000 physician-diagnosed (non-hospitalized) acute and allergic pesticide poisoning incidents, [while] avoiding about 300 hospitalized acute and allergic pesticide poisoning incidents, and avoiding potentially important numbers of cancer cases, serious developmental defects, stillbirths, persistent neurotoxic effects and nondiagnosed acute and allergic poisoning incidents.[139]

Hahn's scorecard, however, does not recognize any "health benefit" other than "reducing the risk of cancer, heart disease, and lead poisoning."[140] Since avoiding stillbirths, persistent neurotoxic effects, and pesticide poisoning does not fit within any of these categories, the regulation is assigned a zero benefit. Protecting 3.9 million workers from the risk of acute pesticide poisoning thus fails Hahn's cost-benefit test.[141]

Seafood safety. In 1995, the FDA adopted a final regulation—the "Seafood HACCP [Hazard Analysis Critical Control Point] rule"—to ensure the safe and sanitary processing of fish and fishery products.[142] The rule was strongly supported by the seafood trade association, which informed FDA:

> [The association] strongly supports the adoption of a comprehensive regulatory program by the FDA . . . using HACCP principles. HACCP systems have been applied successfully by individual firms in our industry, and they have been shown to be a very cost-effective way of controlling safety hazards.[143]

The agency's preamble to the regulation notes:

> [F]oodborne illnesses tend to be significantly under-reported to health authorities. Consequently, precise data on the numbers and causes of foodborne illness in this country do not exist. FDA does know, however, that illness from seafood does occur and that a wide variety of hazards have been identified that could cause illness from seafood.[144]

Listed examples include ciguatera poisoning, hepatitis A, Norwalk virus, Vibrio vulnificus (a disease derived from eating an organ-

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139 EPA, Worker Protection Standard for Agricultural Pesticides, 57 Fed Reg 38102, 38145 (1988).

140 Hahn, *Government's Numbers* (2000) at 86 n 17 (cited in note 13).

141 See Appendix C, row 78.

142 60 Fed Reg 65096 (cited in note 42).

143 Id at 65102.

144 Id at 65103.

ism of the same name that inhabits raw molluscan shellfish in the Gulf of Mexico), salmonella, paralytic shellfish poisoning, scombrotoxin, and nine other foodborne diseases.[145] FDA estimated that its seafood safety rule would avert from 20,000 to 60,000 foodborne illnesses a year, which the agency valued at $45 to $116 million per year, with additional benefits expected in the form of (1) $20 million in annual cost savings by exporting firms who no longer would need to pay fees for European Union inspection services; (2) additional cost savings (unquantified) that would result from there being fewer recalls and fewer enforcement actions; and (3) revenue gains (unquantified) from increased consumer confidence in U.S. seafood at home and in export markets.[146] The rule was expected to cost about $60 million in the first year and about $40 million in subsequent years.[147] FDA therefore found "that the estimated benefits exceed the estimated costs."[148] Hahn, however, counts avoiding seafood illness as a "zero benefit" since it does not involve cancer, heart disease, or lead poisoning. That is how the FDA's seafood safety rule—which virtually everyone supported—managed to acquire a zero benefit and fail Hahn's "neutral economist's cost-benefit test."[149]

Prevention of oil spills. In 1992, the Coast Guard estimated that its oil tanker double hull requirement would yield benefits ranging from $1.1 to $6 billion in avoided oil spills over the transition period 1990–2015.[150] But because Hahn's system counts only certain kinds of benefits—avoiding cancer, heart disease, lead poisoning, injuries from accidents, and environmental pollution by one of four air pollutants—the benefit of avoiding major oil spills is valued at zero, even though the government's number is in excess of a billion dollars.[151]

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145 Id at 65186 table 6a, Estimate of Annual Cases Averted.

146 Id at 65185 table 7, Annual Cost of Seafood Illness, and 65185 table 8, Estimate of the Efficacy of Mandatory HACCP at Reducing Foodborne Disease in the Third Year. See also id at 65187–88 (discussing benefits for consumer confidence and reduced enforcement).

147 Id at 65182.

148 Id at 65191.

149 See Appendix C, row 100.

150 Coast Guard, Double Hull Standards for Vessels Carrying Oil in Bulk, 57 Fed Reg 36222, 36232 (1995).

151 See Appendix C, row 29. In this particular case, zeroing out an important benefit did not change the result, since the Coast Guard's RIA predicted that the statutorily mandated rule would impose costs in excess of the expected monetized benefit. See id (predicting that the rule will raise transport costs by about half a penny per gallon, but that, based on historic accident and loss rates and clean-up costs, the rule will cost more than $24,000 per barrel of oil spill averted, producing a net discounted *cost* of $2.1 billion over the period 1990–2015, and over $1 billion per year thereafter). The point made by this example is not that all rules pass cost-benefit analysis, but that Hahn's scorecard does not count all the benefits.

Formaldehyde exposures in the workplace. Zeroing out unquantified benefits is not unique to Hahn. Morrall practices it, too, with consequences that can best be illustrated by examining the rule at the bottom of Morrall's table: OSHA's proposed formaldehyde exposure rule, which, according to Morrall, would cost an incredible $72 *billion* per life saved.[152] How could any rational agency even propose such a preposterously expensive rule? The answer is found in a combination of Morrall's questionable accounting and the agency's concern with unquantifiable risks.

The rule in question involved a proposal to reduce the Permissible Exposure Level (PEL) for formaldehyde in the workplace from 3.0 parts per million (ppm) to either 1.0 or 1.5 ppm.[153] OSHA anticipated that employers would meet this goal primarily by installing ventilators in work areas where formaldehyde is present in high concentrations. In addition to these "engineering" precautions, employers would be asked to better monitor exposures and conduct exposure risk and reduction training programs for employees.

The rule would apply principally to manufacturers in five different manufacturing industry categories—hardwood veneer and plywood, particleboard and medium density fiberboard, furniture and fixtures, synthetic resins, and ferrous and nonferrous foundries.[154] OSHA predicted that compliance with the 1.5 ppm PEL would cost these industries about $22.5 million per year, while compliance with the 1.0 ppm limit would cost $36 million per year.[155] Unfortunately, OSHA does not provide the perspective of total revenues for the affected industries, which makes it difficult to get a clear idea of how burdensome such costs might be. But rough calculations based on Census data for the value of aggregate shipments by producers in the industrial categories named in the OSHA rule suggest that total revenues for these industries in 1985 were probably in the neighborhood of $30

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[152] Morrall, Regulation at 30 table 4, The Cost of Various Risk-Reducing Regulations per Life Saved (cited in note 8).

[153] Department of Labor, Occupational Exposure to Formaldehyde, 50 Fed Reg 50412 (1985). Respirators (which are uncomfortable and therefore are prone to misuse or non-use) would be prescribed only as a last resort for use in cases where ventilators are shown to be infeasible or ineffective. Id at 50464.

[154] Standard Industrial Classification (SIC) codes for these industries are 2435 (hardwood veneer and plywood); 2492 (particleboard); 2499 (fiberboard); 2821 (plastics, resins, and elastomers); and 332/336 (ferrous and nonferrous foundries). Id at 50463 table 10, Number of Establishments and Employees Exposed to Formaldehyde.

[155] Id at 50464. All figures are in 1985 dollars. OSHA's exact figures are $38.9 million capital cost and $17 million annual operating cost (1.5 ppm standard) and $57.8 million capital cost and $28.3 million operating cost (1.0 ppm standard). Figures cited in the text above were derived by annualizing capital costs at 7 percent over 10 years and adding these annualized capital costs to the annual operating cost. My annualization of capital cost used the standard formula: Annualized Cost (AC) = Capital Cost x r x $(1+r)^n/((1+r)^n-1)$, where r is the annualization rate, and n is the period of annualization.

billion.[156] So the estimated cost of OSHA's proposed formaldehyde exposure protection rule comes out to about 0.1 percent of revenues.

On the benefit side, OSHA predicted that the 1.5 ppm standard would avert anywhere from 5 to 42 fatal cancers over a career of exposure, while the 1.0 ppm standard would avoid 6 to 52 fatal cancers. But OSHA's proposed rule preamble also devotes many pages to the clinical evidence of the non-cancer benefits of a lower standard: reducing or avoiding burning eyes or noses, sore or burning throats, asthma attacks, chronic bronchitis, allergic reactions, dermatitis, and skin sensitization. OSHA noted that over 500,000 American workers are regularly exposed to formaldehyde at concentrations that have been found to cause one or more of these illnesses or discomforts. Is avoiding such discomforts and health hazards for 500,000 American workers—as well as 6 to 52 lifetime cancers—"worth" the expenditure of roughly 0.1 percent of revenues for a $30 billion group of industries? Will installing ventilators in the workplace also reduce employee exposure to other irritating and possibly hazardous chemical vapors besides formaldehyde? These are the central questions of the formaldehyde rulemaking. They are quite unlike (they are far more nuanced than) the question implicitly posed by the Morrall table: how could OSHA be so stupid as to propose a rule that will cost $72 billion for every life saved?[157]

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[156] US Census Bureau, 1994 Annual Survey of Manufactures: Value of Product Shipments, online at http://www.census.gov/prod/www/abs/value.html (visited May 7, 2003). Total revenues cited in the text are obtained by adding the 1992 value of product shipments cited in the table for each of the industry and product class codes cited in note 154, and then converting that value to 1985 dollars to adjust for inflation during the intervening period, using the consumer price index. This yields an accurate value for 1992 shipments of these product categories measured in 1985 dollars. The relevant statistic, however, is the value of shipments for these products in 1985 when the rule was issued, and that value is not readily available. However, an approximate value for 1985 shipments can be obtained by deflating 1992 constant dollar shipments by 2 percent per year (the average rate of real income growth) over the seven-year period, 1985–1992. That adjustment yields the value cited in the text above. Of course, these aggregate revenues for entire industry categories may be over-inclusive. Also, some producers and industries might be more severely affected than others in these categories, so it is nearly certain that some producers would experience costs somewhat higher than 0.7 percent of revenues.

[157] Where does Morrall's $72 billion figure come from in any case? Apparently, Morrall began by assuming that the rule would save only six cancer deaths (the low end of the agency range) over a forty-year career with an assumed forty-year latency period. Nowhere does Morrall provide a medical justification for assuming a forty-year latency period for cancer. Dividing 6 by 40 yields 0.15 lives saved per year. Discounting the stream of 0.15 annual lives at 10 percent for the 40-year latency period yields 0.01 discounted lives saved per year, which is the figure that appears in the "Annual Lives Saved" column in the Morrall table. Morrall, Regulation at 30 (cited in note 8). But dividing the annual cost of $36 million by 0.01 yields a cost per life of "only" $3.6 billion per life. To arrive at his $72 billion cost per life, Morrall must have arbitrarily multiplied the agency's cost figure by a factor of 20.

Suppose, now, one uses the agency's cost figures, takes the mid-point of the agency's cancer

The preceding examples could be multiplied. They illustrate a central problem with scorecards. Scorecards exclude whole categories of benefits, thereby producing (in many cases) little more than cartoon caricatures of the rules they purport to analyze.

b) Procedural benefits. Procedural rules pose particular problems for scorecards because they do not directly save lives, avoid illness, or confer environmental benefits. They merely support other policies that do. Yet scorecards treat all such rules as having zero benefit, with consequences that can best be appreciated by considering a few examples.

Toxic chemical release reporting. In 1988, EPA issued a final rule implementing a statutory requirement calling for the public reporting of significant releases of toxic chemicals from large manufacturing facilities.[158] The final rule (issued in the last year of the Reagan Administration) is silent as to the anticipated benefits of this statutory mandate. Scholars, however, have noted that reported releases of toxic chemicals declined dramatically—from 7 billion pounds in 1989 to 2.5 billion in 1997—in the aftermath of the reporting requirement.[159] Hahn nonetheless assigns the rule a zero benefit.[160]

Operating permits for air polluters. In 1992, EPA issued a rule (mandated by the 1990 Clean Air Act Amendments) that required covered sources to hold operating permits that set out in a single document what each source's air pollution control obligations were. The rule also required that such sources of air pollution pay a fee to support state monitoring and enforcement efforts.[161] EPA described the benefits of the rule in the following terms:

> The title V permit program will enable the source, States, EPA, and the public to understand better the requirements to which the source is subject, and whether the source is meeting those requirements. Increased source accountability and better enforcement should result. . . . [Also] an important benefit is that the permit program ... will ensure that States have resources neces-

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benefit range (twenty-nine lives), assumes a latency period of, say, twenty years, and does not discount the number of lives saved, for reasons discussed in Part I.D. The cost per life saved under this scenario is $61.7 million—still a high number, but a far cry from $72 billion.

158 See EPA, Toxic Chemical Release Reporting: Community Right-to-Know, 53 Fed Reg 4500 (1988).

159 *Release of Toxic Chemicals in 1989 Reached 5.7 Billion Pounds, EPA Reports*, 22 Envir Rptr (BNA) 223 (1991) (reporting that between 1987 and 1988, U.S. manufacturers dropped the amount of total toxic chemicals released by 18 percent, from 7 billion to 5.7 billion pounds); *EPA 1997 Toxics Release Inventory: Public Data Release Report* 3–8 table 3-1 (1999), online at http://www.epa.gov/tri/tridata/tri97/pdr/index.htm (visited July 2, 2003) (listing the drop in total on- and offsite toxic releases between 1995 and 1997 as 38.8 million pounds).

160 See Appendix C, row 67.

161 See EPA, Operating Permits Program, 57 Fed Reg 32250 (1992).

> sary to develop and administer the program effectively [by requiring sources to pay the cost of the program]. . . . Greater compliance may result in an improvement in air quality.[162]

But such benefits cannot be reduced to numbers, so the rule is assigned a zero value in Hahn's benefit column, thereby chalking up another (artificial) regulatory failure.

Such, indeed, is the fate of all procedural rules in Hahn's database, including: an EPA rule expressing a preference for treatment over containment in Superfund cleanups; an EPA rule calling for states to develop programs for coastal non–point source pollution control; two EPA rules establishing criteria and procedures for determining conformity of state and federal transportation plans with Clean Air Act requirements; a follow-on EPA rule adding certain chemicals to the Toxic Release Inventory; an EPA rule imposing financial responsibility requirements for owner/operators of underground oil storage tanks; an EPA rule establishing procedures for the pre-manufacture notification, review, and possible testing of toxic substances entering the stream of commerce; and an HHS rule calling for certain improvements in clinical laboratory practices.[163]

While the benefits of procedural rules may be impossible to quantify, it surely is misleading to value such benefits at zero, and even more misleading to claim that in doing so one is simply using the "government's numbers." The "0" that appears in the benefits column of the Clean Air Act permits rule is not an EPA number. It is Hahn's number.

c) Interlocking benefits. Sometimes it is hard to disentangle the consequences of interrelated rules. In such situations, agencies may assign the benefits of one rule to another—never thinking, of course, that the result will be another "failure" in some scorecard. This circumstance is well illustrated by EPA's effort to control coliform contamination of drinking water.

Regulating E. coli contamination of drinking water. In 1989, EPA promulgated a rule establishing a maximum contaminant level of zero for total coliform in drinking water and calling on public water systems to enhance their monitoring and testing of drinking water for coliform.[164] In explaining its decision, EPA observed:

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162 Id at 32251.

163 See note 133 and accompanying text (noting zero benefit entries in Appendix C).

164 EPA, Drinking Water; National Primary Drinking Water Regulations; Total Coliforms (Including Fecal Coliforms and E. Coli), 54 Fed Reg 27544 (1989).

> The remedial measures necessary to comply with the total coliform rule will also fulfill some or all of the surface water treatment requirements or the forthcoming groundwater disinfection requirements. As with costs, for accounting purposes, EPA is attributing all health benefits resulting from compliance with this rule to the surface water treatment requirements and the disinfection rule for groundwater systems, rather than the total coliform rule, because the interrelationships among them make it impossible to clearly distinguish which benefits are attributable to each rule.[165]

Hahn responds by assigning the rule a zero value and non-zero cost, thereby chalking up yet another regulatory failure.[166] But the failure in this case—as in many other cases—lies in the accounting, not the regulation.

d) Benefits that are hard to quantify or monetize. Of all the risks that regulations address, the risks of accidents are the easiest to quantify because the chain of causality is clear. Cancer risks are well understood in some cases (for example, tobacco) but remain unclear in many others.[167] Non-cancer health risks are murkier still. Non-cancer risk assessment is widely understood to be still in its infancy.[168] Ecological risk assessment is the most difficult of all: ecosystems are too diverse and complex to permit any but the most rudimentary ecological risk assessments in most cases.[169]

A similar hierarchy of data and knowledge can be found in the area of benefits valuation. The implicit value assigned in the marketplace to the avoidance of occupational risks of accidents can be

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165 Id at 27560.

166 See Appendix C, row 95.

167 EPA's landmark report on comparative risk, *Unfinished Business* (cited in note 74), reports the results of a large-scale comparative risk assessment organized into four groups to compile comparative risk information about four kinds of risk: cancer, non-cancer, ecological, and welfare effects. The authors note that "the cancer work group faced an easier task in comparing risks . . . than did the other work groups [because a] basic method for assessment of carcinogenic risk has been adopted by the Agency." Id at 21. See also id at 24–25 (noting the massive uncertainties that nonetheless remain in cancer risk assessment).

168 See id at Appendix 2, Report of the Non-Cancer Risk Work Group at 1-1 to 1-2:

> There are thousands of different chemicals in the environment that may cause adverse human health effects. . . . EPA therefore has had great difficulty in analyzing non-cancer health effects. . . . Most program offices do not actually assess risks from non-carcinogens. . . . Most programs merely evaluate the extent to which a regulatory option prevents exposures above the RfD [reference dose or acceptable daily intake] without an explicit calculation of risk.

169 Id at 43 ("No generally applicable methodology for evaluating economic risk currently exists"). See also id at Appendix III, Report of the Ecological Risk Work Group at 5 (noting that due to massive data gaps and conceptual uncertainties ecological risk assessment "only rarely is quantitative and almost never probabilistic").

monetized reasonably well through labor market studies of wage premiums paid in accident-prone industries.[170] Involuntary accident risks are harder to value, however. Cancer and non-cancer illnesses are harder still, due to their diversity, latency, and lack of clear and direct causal link between exposure and consequence.[171] Ecological amenities are virtually impossible to value fully and reliably. Theorists have developed a host of different approaches, but none, as yet, commands a consensus.[172]

When scientific and economic uncertainties combine in a regulatory setting, the agency finds itself in a dilemma. If it tries to assign a number to the benefit, the number may be attacked as inadequately supported. If the agency assigns a partial number—representing the portion of the benefit the agency is able to quantify more or less rigorously—the number for that portion may be taken as the number for the whole benefit. And if the agency does not assign a number, then it risks having the benefit overlooked altogether.

The dilemma can best be appreciated by looking more closely at a few examples drawn from the scorecards. It will be seen that scorecards systematically zero out whole categories of unquantifiable benefits. It will also be observed, however, that agencies aggravate the problem by frequently inadequate and, indeed, perfunctory treatment of benefits in their own analysis.

The municipal waste combustor (MWC) rule. In 1995 EPA issued emissions guidelines for existing municipal waste incinerators and new

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[170] See Viscusi, *Fatal Tradeoffs* at 34–74 (cited in note 15). As seen in Part I.D, however, even these studies produce a rather wide range of implicit life values.

[171] See Heinzerling, 13 RISK at 163 (cited in note 19) (noting that often, "life-saving benefits, other than the prevention of cancer, are ignored because cancer prevention is often the only life-saving benefit that can be quantified"). Indeed, neither EPA nor Viscusi has been able to identify a single labor market study that implicitly values cancer risks specifically. See Viscusi, *Fatal Tradeoffs* (cited in note 15); EPA, *Guidelines for Preparing Economic Analyses* at 76, 89 (cited in note 96) ("Hedonic wage studies tend to focus on accidental deaths occurring among prime aged males while deaths associated with environmental risk often occur among the elderly and may involve an extended latency period. Furthermore, elevated risks in hedonic wage studies are voluntarily accepted while environmental risks are involuntarily borne.").

[172] EPA, *Guidelines for Preparing Economic Analyses* (cited in note 96), noted in 2000 that "[a]lthough the economics literature is replete with benefit studies, the coverage is patchy considering the broad range of services and stressors addressed by EPA. Especially rare in the literature are examples of wide-scale changes, very small changes, or the consequences of long-term ecological and economic change." Id at 98. The most eloquent statement of the Guidelines on this point is implicit and inadvertent. EPA devotes a total of three pages in a two-hundred-page analysis to ecological benefit valuation. These three pages do not actually offer guidelines. They offer only a brief summary of five different approaches to ecological benefits valuation, without endorsing *any* of them as valid. Id at 998–99.

source performance standards for new combustors.[173] EPA predicted the following incremental benefits from the rule:

Table 1
Predicted Emissions Reduction Benefits of Proposed Emissions Guidelines (Existing Sources) and Standards (New Sources)[174]

Pollutant	New Source Standards	Existing Source Guidelines
Particulate Matter	34%	50%
Acid Gases (Sulfur Dioxide and Hydrogen Chloride)	58%	87%
Nitrogen Oxides	1%	30%
Dioxins	33%	99%
Cadmium	53%	70–80%
Mercury	72%	70–80%
Lead	81%	70–80%

EPA's estimates for particulate matter, acid gases, and nitrogen oxides were translated into emissions tonnage reductions for which Hahn's scorecard supplied a monetary benefit value.[175] However, one of the primary objectives of the rule was to achieve greater controls on the highly toxic and bioaccumulative heavy metals (cadmium, mercury, lead) and dioxin, which hitherto had not been regulated.[176] As EPA noted in the preamble to the final rule:

> The absence of sufficient exposure-response and valuation information precludes a comprehensive benefits analysis for many of the MWC pollutants.... The total benefits would be higher if benefits from reductions of other pollutants were valuated.[177]

EPA's (unpublished) economic impact analysis warns that because some benefits are unquantifiable based on available data, "applying the benefit-cost methodology to evaluating the regulatory alternatives

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173 EPA, Standards of Performance for New Stationary Sources and Emission Guidelines for Existing Sources: Municipal Waste Combustors, 60 Fed Reg 65387 (1995).

174 EPA, Emissions Guidelines: Municipal Waste Combustors, 59 Fed Reg 48228, 48238 (1994) (existing combustors); EPA, Standards of Performance for New Stationary Sources: Municipal Waste Combustors, 59 Fed Reg 48198, 48207 (1994) (new combustors).

175 See Appendix C, row 32 (estimating a benefit of $2.2 billion over 20 years).

176 59 Fed Reg at 48239 (cited in note 174).

177 Id.

examined in this analysis is limited to comparing some of the benefits with most of the costs."[178]

EPA's concern was prescient: Hahn's scorecard picks up the value of reducing the ancillary pollutants—particulate matter, nitrogen oxides, and sulfur dioxide—while zeroing out all of the benefits that had provided the primary impetus for the rule.[179] However, EPA shares a measure of blame for the omission. While EPA devotes several pages to documenting the toxicity of heavy metals and dioxins in the abstract, nowhere (not even in the two-hundred-page Economic Impact Assessment buried in its docket room) does EPA address the fundamental, priority-setting questions facing risk managers in that rule: (1) Are current levels of emissions of heavy metal and dioxin creating a significant human health or ecosystem risk? (2) What portion of total emissions, and total risk from emissions, is accounted for by hazardous waste combustors?

While it may be unfair (given data limitations) to ask for numbers in response to these questions, surely courts, policymakers, and the public are entitled to some explanation of why agency risk managers deem emissions from waste combustors a significant risk. We are left with a record that fails to fully prove the rationality of the rule. But that certainly does not justify Hahn's assertion (as manifest in his negative net benefit number) that the rule is demonstrably irrational.

Great Lakes Water Quality Guidance. An excellent illustration of both the risk-characterization dilemma and the way agencies aggravate it may be found in the Great Lakes Water Quality Guidance. In 1995, EPA promulgated guidelines for the Great Lakes states aimed particularly at controlling persistent pollutants such as mercury, cadmium, lead, PCBs, DDT, dioxin, chlordane, heptachlor, dieldrin, pentachlorobenzene, and mirex.[180] These persistent pollutants bioaccumulate in the food chain and are toxic at very low levels of chronic exposure. So EPA established ambient limits for concentrations of these and similar pollutants in the Great Lakes and their feedwaters, and instructed the bordering states to develop implementation strategies to achieve these limits.[181]

On the cost side, EPA estimated that the incremental costs of complying with these measures might range from $60 to $240 million

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178 EPA, Office of Air and Radiation, and Office of Air Quality Planning and Standards, *Economic Impact Analysis for Proposed Emissions Standards and Guidelines for Municipal Waste Combustors*, EPA-450/3-91-029, at 8-3 to 8-9 (March 1994).

179 See Appendix C, row 32.

180 60 Fed Reg 15336 (cited in note 82).

181 Id at 15368–71.

(in 1994 dollars), with the low end of the range being more likely in light of the flexibility and discretion left to states.[182] But how does one go about monetizing all the life-saving, health-enhancing, recreational, and non-use values that are enhanced by reducing the discharge of persistent, bioaccumulative toxins into the Great Lakes?

EPA ultimately concluded that available data permitted reliable quantification only of the benefits of reduced incidence of fatal cancer to sports anglers and Native American subsistence fishermen who eat fish that they themselves have caught in the Great Lakes. So the agency assigned a number to this very narrow and partial benefit. That number, after extensive manipulation, became Hahn's number—$12 million—for the *total* benefit of the rule spread over twenty years.[183] All other benefits of eliminating the yearly discharge of six to eight million toxic-equivalent pounds of pollutants into the Great Lakes were assigned a value of zero.[184]

Not until 1999, when EPA revisited the rule, did the rulemaking record make clear what had been overlooked five years earlier. In that year EPA proposed a follow-up rule to prohibit the use of "mixing zones" (in other words, dilution areas) in calculating water-quality based effluent limits for discharges of persistent pollutants into the Great Lakes and their feedwaters. The idea was to limit the ability of dischargers to simply dilute discharges as opposed to cleaning up the effluent before discharge. This time, EPA went to some lengths to describe in words (if not numbers) the benefits of reducing bioaccumulative toxic loading in the Great Lakes: reducing human risks of cancer, neurotoxicity, fetotoxicity, endocrine effects, hematological effects, reproductive dysfunction, sensory and equilibrium disturbances, hyperactivity, aggressiveness, impairment of peripheral vision, impairments of hearing and speech, and so forth.[185] Since these toxins accumulate in mother's milk, EPA emphasized the special risks to children: possible low birth weight, small head circumference, skeletal anomalies, malformations such as scoliosis, cranio-facial abnormalities, delayed bone development, and so forth. The agency also mentioned impacts of bioaccumulative toxins on a range of nonhuman animals and plants.[186]

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182 Id at 15381.

183 See Appendix C, row 70.

184 60 Fed Reg at 15382 (cited in note 82); Hahn spreadsheet, Row 9, columns BH–BT (cited in note 58). The manipulation reflected in those columns involves discounting the number of lives saved to reflect the assumed latency period of cancer, and valuing those lives at the standard value assigned by Hahn as opposed to the range of values chosen by the agency.

185 EPA, Proposal to Amend the Final Water Quality Guidance for the Great Lakes System to Prohibit Mixing Zones for Bioaccumulative Chemicals of Concern, 64 Fed Reg 53632, 53638–39 (1999).

186 Id.

However, the agency's assessment offers no indication of whether the probabilities of such impacts are high, medium, or low, or how widespread or severe such impacts might be. The rule was not considered a "major rule" in any case (because of its small economic impact), and both the rule and the benefits information it contained were excluded from Hahn's database. The fact remains that if all these non-cancer and ecological benefits existed for the mixing zone rule, they must certainly also have existed for the main water quality guidance issued four years earlier. Why did EPA not *mention* (much less attempt to quantify) such benefits then? It cannot be the case that the benefits were discovered after the original rule. The health and ecosystem risks of persistent bioaccumulative chemicals have been generally known since Rachel Carson's best-selling exposé, *Silent Spring*, was published in 1962.[187] Indeed, the chemicals addressed by the guidance include several of the very same chemicals—DDT, chlordane, dieldrin, heptachlor—that Carson campaigned against forty years ago. EPA deserves some blame for a characterization of risk and benefit that was perfunctory at best. But even the most detailed narrative description of risk would have made no difference to the scorecards, which are equipped to deal only with numbers.

Requiring proper handling of toxic petroleum refinery sludge. Oil refineries around the country generate between 150,000 and 300,000 tons of sludge every year—sludge that contains lead, chromium, arsenic, benzene, toluene, benzo(a)pyrene (BaP), and several other known poisons at "concentrations that are tens to thousands of times higher than standard EPA health-based and ecological protection reference levels."[188] According to EPA, this toxic sludge is quite often stored in unlined pits upgradient from wells and rivers or over "relatively shallow aquifers" causing contamination to spread considerable distances underground. In 1990, EPA issued a rule officially classifying this sludge as hazardous waste—a move that ended the practice of (legally) storing sludge in unlined ponds.[189] Henceforth, oil refineries would have to properly manage their toxic sludge, through incineration, treatment, or storage in sealed containers, "or by some other means that precludes the migration of toxic pollutants into ground waters or surface waters."[190]

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187 Rachel Carson, *Silent Spring* (Riverside 1962).

188 EPA, Hazardous Waste Management Systems: Identification and Listing of Hazardous Waste; CERCLA Hazardous Substance Designation—Petroleum Refinery Primary and Secondary Oil/Water/Solids Separation Sludge Listings, 55 Fed Reg 46354, 46388 (1990).

189 Id.

190 Id at 46392.

The common sense of this rule is so manifest that one might reasonably wonder why EPA should have been forced to undertake a massive study in order to justify it. Nonetheless, EPA dutifully performed the required RIA to examine both the costs and the benefits of the rule. That assessment perfectly illustrates the epistemological hierarchy discussed earlier.

On the benefit side, EPA undertook a detailed exposure and risk assessment for people living downgradient from oil refineries—something that was not done in the waste combustor rule examined above. The risk assessment predicted that baseline (pre-rule) practices were causing one to three cancer cases per year, with the risks to the most exposed individuals ranging from 1/10,000 to an alarming 1/100.[191] In addition, EPA concluded that 6,400–32,000 people could be exposed to drinking water concentrations of lead and/or chromium in excess of their respective health effect thresholds, thereby incurring risks of kidney and/or liver damage from chromium ingestion as well as neuro-toxicological damage from lead.[192] However, EPA was unable to ascertain—on the basis of reliable scientific data—either the probable number of non-cancer health harms or their severity. Nor was EPA able to predict the non-carcinogenic health effects, if any, from the other toxins mentioned. The ecological benefit of the rule gets one sentence:

> An additional benefit, not quantified in this RIA, is that pollutant loadings to surface waters and wetlands through groundwater migration and transport at 56–102 refineries (about 75 percent of sludge generators) should also be substantially reduced or eliminated as a result of this rule.[193]

At the end of the presentation of its findings, EPA offers something that all regulatory assessments should provide—a Summary of Analytical Limitations and Qualifications. EPA first lists the factors that tend to overestimate benefits. For example, the agency employed conservative groundwater transport and dose-response models that might tend to overstate risk. In addition, EPA assumed that downgradient people who get their water from wells would drink two liters of untreated water per day, and that all wells within a specified distance downgradient from the refinery would be contaminated. This is, of course, a very conservative assumption, as is the assumption that no other federal, state, or local regulations would intervene to mitigate harm.[194]

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191 Id at 46391.
192 Id at 46392.
193 Id at 46393.
194 Id at 46393–94.

On the other hand, EPA made a number of assumptions that it thought "may tend to underestimate benefits."[195] For example, the agency examined the effects of only a few of the many toxic chemicals present in oil refinery sludge. EPA ignored background exposures that might add to the harm of refinery exposures. EPA considered one exposure pathway (drinking), while ignoring inhalation, dermal contact, and the risk of food chain contamination from using contaminated surface water to irrigate crops.[196] No ecological damages were quantified, even though, in EPA's words,

> surface waters exist downgradient within 1200 meters at 75 percent of refineries and [ ] other wetlands (swamps, bogs, etc.) are equally nearby at over 25 percent of refineries. [Moreover] ... several chemicals present in the sludge are known to bioaccumulate and/or concentrate in the benthic layers which is critical to the invertebrate elements of the food chain.[197]

Such disclaimers are both reassuring and exasperating. Reassuring because they are relevant and honest. Exasperating because they do not tell the decisionmaker what she needs to know: is the agency assessment, on balance, an overestimate, underestimate, or reasonably accurate estimate of the benefits of the rule? Hahn is not troubled by such Gordian knots. He simply assigns the entire rule a zero benefit.[198]

e) Statutorily mandated benefits. Risk assessments and cost-benefit analyses can be extraordinarily time consuming and expensive, without necessarily yielding a clear picture of costs and benefits at the end of the day. Agencies are understandably reluctant to spend vital agency resources—and taxpayer dollars—perfecting such assessments when Congress has already made the relevant determination on other grounds, or has ordered the agency to make the determination on other (for example, health- or technology-based) grounds. Two examples will serve to illustrate what happens when agencies try to save money and time in such circumstances.

The SARA implementation rule. In 1990, EPA promulgated a rule revising the National Contingency Plan to implement the Superfund Amendments and Reauthorization Act of 1986 (SARA).[199] SARA es-

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195 Id at 46394.

196 Id.

197 Id.

198 Appendix C, row 85.

199 EPA, National Oil and Hazardous Substances Pollution Contingency Plan, 55 Fed Reg 8666 (1990) (hereinafter SARA Rule). For Hahn's treatment of the same rule, see Appendix C, row 66.

tablished, among other things, a presumption in favor of cleaning up hazardous waste sites rather than building perimeters around them.

EPA offers no published explanation of the benefits of this rule apart from a reference to an unpublished consultant's report buried in EPA's docket room.[200] The agency did, however, devote three Federal Register pages to the estimated *costs* of the rule.[201]

EPA gave two reasons for failing to quantify the benefits of this rule. First, "[c]urrent program information was insufficient in several areas necessary to develop reasonable estimates of quantified benefits" for each of the several thousand individual waste sites scattered around the country.[202] Second, the rule was statutorily mandated in any case, meaning that the relevant cost-benefit determination had already been made—by Congress.[203] Under these circumstances, EPA concluded that the benefits of a full cost-benefit analysis did not justify the high analytical costs.[204]

The result in Hahn's scorecard: a $21 billion cost, and a zero benefit.[205]

Water pollution standards for the electroplating and metal finishing industries. In 1983, EPA issued a rule setting forth effluent limitations guidelines, pretreatment standards, and new source performance standards for electroplating and metal finishing point sources under the Clean Water Act.[206] The preamble to the rule contains a section entitled "Costs, Effluent Reduction Benefits, and Economic Impact,"

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200 See SARA Rule, 55 Fed Reg at 8811 (cited in note 199), citing EPA, Policy and Analysis Staff, Office of Solid Waste and Emergency Response, *Regulatory Impact Analysis in Support of the Proposed Revisions to the National Oil and Hazardous Substances Pollution Contingency Plan*, Docket No NCP-R2-8-1 (1988) (unpublished manuscript on file with author) (hereinafter *Proposed SARA Rule Staff Analysis*). The benefits mentioned in that report include: reduced health hazards from exposure to waste migrating off-site; recreation benefits from cleaner water off-site; the option value of clean water; and a reduced challenge to containment in later years. *Proposed SARA Rule Staff Analysis* at 3-24 to 3-25.

201 SARA Rule, 55 Fed Reg at 8810–12 (cited in note 199).

202 EPA, *Office of Solid Waste and Emergency Response, Regulatory Impact Analysis of Revisions to CERCLA and the National Contingency Plan* 1-1 to 1-2 (1989) (unpublished manuscript on file with author).

203 In EPA's words: "This report also does not present a formal benefits analysis.... Because the Superfund is financed by a tax authorized by Congress, Congress determined implicitly that the benefits of cleaning up hazardous waste sites were worth the expenditures of the Superfund." *Proposed SARA Rule Staff Analysis* at 1-2 (cited in note 200).

204 Though EPA did not mention it overtly as a reason for not quantifying benefits, it seems clear that another reason for not quantifying the benefits of the SARA Rule is found in the fact that the rule is really a procedural rule. In essence, the rule establishes a presumption in favor of treatment, which may be reversed on the basis of later (and much more manageable) risk assessment and cost-benefit analysis of options for handling each individual site. As seen above, the benefits of procedural rules are difficult, if not impossible, to quantify. See Part II.A.1.b.

205 See Appendix C, row 66.

206 EPA, Electroplating and Metal Finishing Point Source Categories: Effluent Limitations Guidelines, Pretreatment Standards and New Source Performance Standards, 48 Fed Reg 32462 (1983).

which devotes several pages to a lengthy, quantitative analysis of the costs of the rule, followed by exactly three sentences on the benefit:

> The Agency concludes that the final regulation is economically achievable, and the impacts are justified in light of the effluent reductions achieved. The metal finishing regulation will remove an additional 20 million pounds per year of metals and cyanide and 10 million pounds per year of toxic organics.... Executive Order 12291 does not require a [full-blown] Regulatory Impact Analysis where its consideration would conflict with the development of regulations pursuant to a court order, as with this metal finishing regulation.[207]

The result in Hahn's scorecard was a $4 billion cost (over twenty years) and a zero benefit—another failed regulation.[208]

f) Indirect costs and cost savings. The scorecardists' omission of unquantified variables is not confined to the benefits column. Economists have long recognized that government regulations bring with them an array of indirect costs and cost savings that tend to be overlooked to varying degrees in agency RIAs and scorecards alike.

The list of omitted indirect costs includes: (1) government costs of monitoring, inspection, and record keeping; (2) corporate costs for legal advice, shifted management focus, disrupted production, and diverted investment; and (3) consumer price increases, welfare loss from product substitution, possible unemployment or wage reduction, diminished returns to shareholders on invested capital, and/or retarded product innovation.[209]

Regulations may also generate cost *savings* through: (1) stimulation of product or process innovation to minimize waste; (2) improvements in worker health and productivity; and/or (3) reduction or avoidance of liability for damages.[210]

How important are these omitted costs and cost savings? Because indirect costs are seldom discussed in agency regulatory analyses, they cannot be readily illustrated with narratives drawn from the pream-

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[207] Id at 32472.

[208] See Appendix C, row 76. See also 57 Fed Reg at 36235 (cited in note 150) ("This [environmental evaluation] makes only a limited assessment of the specific environmental consequences of the double hull requirement since, even without this rule, double hull construction is required by [the existing statute].").

[209] Adapted from Adam B. Jaffe, et al, *Environmental Regulation and the Competitiveness of U.S. Manufacturing: What Does the Evidence Tell Us?*, 33 J Econ Lit 132, 139 table 9 (1995). Obviously, these are *categories* of potential cost or cost saving. They do not necessarily apply to every regulation or industry, and they certainly do not apply equally to all.

[210] See id.

bles of rules, as the previous discussion has done for unquantified benefits. However, some insight into their nature and likely magnitude can be gleaned from the extensive literature on the link between regulation and "competitiveness"—a linkage that captures the net effect of most of the direct *and* indirect costs and cost savings of interest here.[211]

In an important survey of the empirical work on point, Adam Jaffe, et al, concluded that "overall, there is relatively little evidence to support the hypothesis that environmental regulations have had a large adverse effect on competitiveness, however that elusive term is defined."[212] One major reason for this slight impact, according to the authors, is that direct compliance costs are very low as a percentage of production costs—less than 2 percent of the value of shipments in industries with "high abatement costs" and less than 0.5 percent of the value of shipments in other industries.[213] Most *indirect* costs—such as loss of productivity, employment, price increases, and loss of consumer welfare—are derivative of *direct* compliance costs. Therefore, one would expect low direct costs generally to produce low indirect costs as well, yielding a low competitive and consumer impact overall.[214]

Professors Michael Porter and Claas van der Linde attracted a great deal of attention a decade ago when they advanced the thesis that environmental regulations may actually *enhance* corporate competitiveness (and, by extension, consumer or shareholder welfare) by providing management an incentive to re-examine and re-engineer their production process with health, safety, resource conservation, and waste reduction in mind.[215] While mainstream economists have

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211 See id at 138–39 (citing costs listed above as indicative of potential impacts on "competitiveness"). Jaffe claims that there were over one hundred studies of the regulation-competitiveness link as of 1995. Id at 135. The two categories not conceptually encompassed by the "competitiveness" impacts are government costs and consumer impacts. Government costs are hard to measure because salaried legislators and regulators perform a range of lawmaking, monitoring, and enforcement functions that vary widely in their particulars from year to year. It is therefore extremely difficult to allocate their collective salaries to any particular activity. However, government costs of monitoring and enforcement are generally thought to be small relative to overall costs of compliance. See Richard D. Morgenstern, et al, *The Cost of Environmental Protection*, RFF Discussion Paper 98-36 9 (May 1998) ("Our results, in fact, allow us to statistically reject the hypothesis that the economic cost of an additional dollar of reported environmental expenditure is much more than one dollar."). Consumer impacts, though conceptually different from competitiveness impacts, probably move in parallel with such impacts in the sense that both arise mainly from direct compliance costs in the first instance.

212 Jaffe, et al, 33 J Econ Lit at 157 (cited in note 209).

213 Id at 141 table 6.

214 In addition, indirect regulatory costs can be hard to identify, particularly in cases where firms respond to regulations by changing their products or production processes to reduce waste generation. The cost of efficiency-enhancing changes may or may not be captured as a regulatory compliance cost, and the efficiencies that result may or may not be captured as an environmental cost saving. As Jaffe puts it, "we may have found little relationship between environmental regulations and competitiveness simply because the data are of poor quality." Id at 158.

215 See Michael E. Porter and Claas van der Linde, *Toward a New Conception of the Envi-*

viewed the so-called "Porter hypothesis" skeptically—it rests principally on anecdotal evidence and implies that firms are ignorant of opportunities to increase profits until a regulation comes along[216]—what is important for present purposes is what is *not* disputed: the competitive impacts (and, by inclusion, the indirect impacts) of regulation are generally small.[217] There is no evidence that omitted costs simply cancel out omitted benefits, thereby excusing the disregard of both.

Nonetheless, the scorecardists' omission of unquantified costs in scorecards is more understandable than their treatment of benefits in one respect: agencies do not normally offer a narrative description of the various costs that are being overlooked in particular cases. So at least scorecards are not *distorting* agency analysis—while claiming to summarize it—when they fail to mention unquantified costs.

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ronment-Competitiveness Relationship, 9 J Econ Persp 97, 98 (Fall 1995) (suggesting that "properly designed environmental standards can trigger innovation that may partially or more than fully offset the costs of complying with them"); Michael E. Porter, *The Competitive Advantage of Nations* 648 (Free Press 1990) (suggesting that the Japanese Energy Conservation Law of 1979 stimulated start-ups and spurred product improvements by raising energy efficiency standards).

216 See Jaffe, 33 J Econ Lit at 155 (cited in note 209). In a 1995 article devoted to rebutting the Porter hypothesis, Palmer, Oates, and Portney reported the results of telephone interviews with vice presidents or corporate directors for environmental protection at four firms cited by Porter and van der Linde: "While each manager acknowledged that in certain instances a particular regulatory requirement may have cost less than expected, or perhaps even paid for itself, each also said quite emphatically that, on the whole, environmental regulation amounted to a significant *net* cost to his company." Karen Palmer, Wallace E. Oates, and Paul R. Portney, *Tightening Environmental Standards: The Benefit-Cost or the No-Cost Paradigm?*, 9 J Econ Persp 119, 127 (Fall 1995). The authors also reported the results of a Census Bureau survey of manufacturers that specifically asked respondents to estimate both their pollution abatement and control expenditures and the "cost offsets" (in other words cost savings) associated with these expenditures. In 1992, the expenditure estimates totaled $102 billion while the cost savings amounted to $1.2 billion, less than 2 percent of estimated environmental expenditures. Id at 127–28.

Of course, surveys of corporate executives are not necessarily dispositive of the issue. Capital and operating costs of pollution control equipment are readily apparent to managers while any cost savings associated with a product or process change appear nowhere on the balance sheet or income statement of the corporation, and therefore tend to recede from memory. Under such circumstances, it would hardly be surprising if corporate managers tended to underestimate cost savings when asked for an off-the-cuff opinion in a telephone survey. In the last analysis, as Jaffe concedes, while Porter has not proved his hypothesis, economists have not marshaled the hard empirical evidence necessary to refute it either. See Jaffe, 33 J Econ Lit at 157 (cited in note 209) ("While economists have good reason to be skeptical of arguments based on non-optimizing behavior where the only support is anecdotal, it is also important to recognize that if we wish to persuade others of the validity of our analysis we must go beyond tautological arguments that rest solely on the postulate of profit-maximization.").

217 See Jaffe, 33 J Econ Lit at 157 (cited in note 209). However, as Jaffe emphasizes earlier in the same review, his analysis is limited to the manufacturing sector. The competitive impacts of regulation may loom considerably larger in the (much less examined) natural resource extraction sectors: forestry, fishing, mining, oil extraction, etc. See id at 136.

g) Risk-risk tradeoffs. In addition to their monetary costs, risk-reducing regulations may create new risks of their own. Professor Sunstein has compiled numerous examples of these "ancillary risks."[218] Fuel economy standards, designed to reduce environmental risks, may make cars smaller and less safe. Removing contaminated soil from Superfund sites creates the possibility of accidents in transit or contamination of the site to which the soil is removed. The intense regulation of nuclear power has encouraged a shift to coal, which has aggravated acid rain and global warming.[219] Some economists have argued that even the funds expended to comply with regulations reduce the sum of money available for life-saving health care, thereby costing statistical lives. Proponents of this view argue that the value of lives lost by regulation through the income effect ought to be deducted from the life-saving benefits of regulation.[220]

Sunstein also has compiled a number of reasons, good and bad, for agencies' failure to quantify such risk-risk tradeoffs in their regulatory assessments. Agencies may be unaware of the ancillary risk. The ancillary risk may fall outside the agencies' expertise or jurisdiction. Some statutes bar agencies from considering ancillary risks in certain decisions. The agency may find the ancillary risk too complex or too speculative to warrant a major delay in the regulation of the primary risk. Of course, agencies may sometimes ignore ancillary risks out of

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218 Sunstein, 63 U Chi L Rev at 1535 (cited in note 15).

219 These and many other examples may be found in id at 1535–36, 1556.

220 Id at 1543–51, 1562 (surveying literature devoted to assessing the claim that regulatory expenditures can cost lives and calling for courts to adopt an interpretive principle that agencies can incorporate assessment of health-health tradeoffs in decisionmaking absent a clear legislative statement otherwise). While few would dispute the existence of physical risk-risk tradeoffs, the idea that regulatory expenditures costs lives per se is hotly contested on at least three grounds. First, it is obviously counterintuitive. Second, it rests on empirical studies of questionable validity that generally correlate higher income with lower mortality and then assume, illogically, that higher income somehow causes lower mortality. (In fact, both may correlate with some omitted third factor, such as education levels.) For a critique of the empirical basis of the expenditure-mortality link, see V. Kerry Smith, Donald J. Epp, and Kurt A. Schwabe, *Cross-Country Analyses Don't Estimate Health-Health Responses*, 8 J Risk & Uncertainty 67 (1994). Third, simply as a logical matter, it is highly implausible to suggest that regulatory expenditures amounting to, at most, a few percent of disposable income could so reduce discretionary income as to deny people access to life-saving health care to a degree that would implicate their longevity. Such a causal nexus is plausible, if at all, only for poor people who have no access to health insurance or subsidized care, and who are subject to significant regulatory costs that have been passed on to them in the form of higher-priced goods. No empirical studies of which I am aware have documented such a confluence of circumstances. Ultimately, then, the regulatory expenditure-mortality link rests on little more than a suggestive statistical correlation that lacks grounding in a persuasive model of causation. Moreover, if lack of adequate access to health care is a source of mortality and access to good health care is the goal, it makes far more sense to reform our medical system to directly ensure such access, rather than to try to achieve the same goal indirectly through an attenuated and speculative link to regulatory reform. See Paul R. Portney and Robert N. Stavins, *Regulatory Review of Environmental Policy: The Potential Role of Health-Health Analysis*, 8 J Risk & Uncertainty 111, 118–19 (1994).

simple myopia, or in capitulation to special interests or irrational public pressures, or out of a desire to bolster the regulatory record supporting a preferred primary regulation.[221]

Whatever the reason, risk-risk tradeoffs are typically slighted in agency assessments and scorecards alike. These tradeoffs count as unquantified "costs" of regulation, the omission of which tends to *overstate* the net benefits of regulation.

2. Are these exclusions defensible?

One possible line of defense to the exclusion of significant costs and benefits in scorecards may be to argue that it is not the scorecardists' fault. If the government does not bother to quantify and monetize the benefits of the regulations it enacts, what is the scorekeeper supposed to do? The agency, on this view, holds the keys to its reputation in its own hand.

There are at least three main problems with this line of defense. The first is that, as we have seen, current scorecards do not always count even the benefits that agencies have monetized.[222]

The second problem with the only-numbers-matter theory is that it is flatly inconsistent with what the scorecardists publicly claim they are offering. Whatever the reason for the government's failure to assign a number to all costs and benefits, one cannot claim to have discerned "the" costs and benefits of a regulation while excluding whole categories of unmeasured costs and benefits. And one certainly cannot claim to be using the "government's numbers" while supplying streams of zeroes that are found nowhere in any agency analysis. When a scorekeeper assigns a "zero" to a benefit that an agency described but lacked data to quantify or monetize, that zero is not the government's number. That is the scorekeeper's number.

The third, and most fundamental, problem with numbers-only scorecards is that not all costs and benefits can be reduced to numbers, certainly not to numbers that are empirically defensible. In most cases, launching a regulation marks the beginning of an exploration of territory that is scientifically and economically unknown. Therefore, rule analyses are not and cannot be what scorecardists implicitly assume them to be: final declarations of exactly what one will find at the end of the process. That is why a cardinal principle of cost-benefit analysis holds that:

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221 See Sunstein, 63 U Chi L Rev at 1555–57 (cited in note 15).

222 See Part II.A.1.a.

> [n]ot all impacts of a decision can be quantified or expressed in dollar terms. Care should be taken to assure that quantitative factors do not dominate important qualitative factors in decisionmaking.[223]

No one disputes this principle.[224] Scorecards simply do not practice it.

Of course, scorecardists cannot be expected to factor into their analysis information of which regulatory evaluators are themselves unaware. If EPA is ignorant of the existence of water pollution risks of MBTE when it issues its regulation requiring that fuel additive, one cannot reasonably expect Hahn to include them in his scorecard. Unidentified costs and benefits plague *every* mode of regulatory analysis.

The culpability of scorecards is found, not in their failure to detect previously unidentified costs and benefits, but in their omission of costs and benefits that agencies identify and describe narratively, but do not pretend to be able to quantify or monetize. These are the omissions that violate cardinal principles of cost-benefit analysis, that are unique to scorecards, and that call the viability of scorecards into serious question.[225]

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223 Arrow, et al, *Annapolis Principles* at 10 (cited in note 103).

224 Indeed, Hahn is a co-author of these very words. Id.

225 Almost as troubling as the fact of such omissions is the scorecardists' failure to disclose them properly. Hahn makes no mention in his Executive Summary of the fact that whole categories of health and non-health benefits have been zeroed out in his analysis. One must read the fine print of his methodology section, the footnotes, and the unpublished spreadsheet (along with the preambles to the rules referenced in the spreadsheet) to appreciate the significance of what Hahn is not counting. See, for example, Hahn, *Government's Numbers* (2000) at 94 n 71 (cited in note 13):

> I included only air pollution reduction benefits because the agencies did not generally quantify any benefits from pollution reduction other than from air pollution reduction [Not true—see Part II.A.1.a.]. According to EPA, those [unquantified] benefits are large and may therefore significantly affect the results of the regression. Pollution reduction benefits can change the cost-effectiveness estimates by orders of magnitude and in some cases can even change the sign of the estimates.

This caveat appears in an endnote at the back of his book. Hahn's presentation of his results in the news media has never, to my knowledge, been accompanied by a similar caveat.

Tengs and Graham acknowledge—once, in the penultimate paragraph of *Five-Hundred Interventions*—that "we recognize that many of these interventions have benefits other than survival." Tengs, et al, 15 Risk Analysis at 372 (cited in note 9). This recognition, unfortunately, does not lead to any exploration of its logical implications, and, again, never surfaces in media reports.

Morrall points out that "many regulations were projected to yield benefits in addition to saving lives, such as reducing non-fatal injuries and property damage." He claims that he "accounted for" these benefits by "converting non-lifesaving health benefits into an index equivalent to additional lives saved. . . . 50 non-fatal hospitalizations avoided, or two permanent disabilities avoided, were assumed to be equivalent to one death avoided." Morrall, Regulation at 28 (cited in note 8). But he does not count non-health benefits at all. Nor does he tally health benefits other than those which avoid hospitalization or permanent disability. And he offers no explanation of the rationale, if any, that underlies his seemingly arbitrary illness/fatality conversion ratios.

Could better scorecard methodology avoid such problems? The answer is clearly no. The point of scorecards, after all, is to come up with the number of rules that generate positive net benefits, or that cost less than some threshold amount per life saved. Without the numbers, how does one keep score?

The dilemma facing scorecards is well illustrated in OMB's *Annual Report to Congress on the Costs and Benefits of Federal Regulations*.[226] Each year OMB compiles its estimates of the costs and benefits of regulations. Unlike the scorecards discussed in this article, however, OMB also includes a column entitled "Other Information" in which unquantified costs and benefits are narratively described.[227] These entries, of course, preclude final declarations about whether the rules in question pass or fail cost-benefit tests, and OMB therefore offers no statistic on that point. OMB has avoided the problem of ignoring unenumerated benefits but, in so doing, has surrendered the function of a scorecard. OMB's candor also comes at the price of quotability: OMB's reports have received far less media coverage than the more sensational scorecards.[228]

The discussion so far has focused on the exclusion of intangibles because it is perhaps the most serious of the inherent problems of method that scorecards confront. But it is by no means the only one. Additional tradeoffs between brevity and realism can be found in the way scorecards deal with distributive impacts.

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226 See, for example, OMB, Office of Information and Regulatory Affairs, *Making Sense of Regulation* (cited in note 43).

227 Id at 22–28 table 4.

228 A recent Lexis search of the Lexis Major Paper database turned up a total of eight cites to OMB annual reports over a period of eight years. Of these, six are by Cindy Skrzycki of the Washington Post and two are in other publications. Moreover, the main message of these articles tends to be not the horrors of regulation, but the difficulty of measuring costs and benefits accurately. See Cindy Skrzycki, *OMB to Revisit Costs, Benefits of Rules*, Wash Post E1 (May 29, 2001); Cindy Skrzycki, *The Regulators: Paying by the Rules; OMB's Cost Analyses Questioned*, Wash Post E1 (Feb 4, 2000); Cindy Skrzycki, *The Regulators: The Costs and Benefits of Cost-Benefit Analysis*, Wash Post E1 (Aug 6, 1999); Bonner R. Cohen, *Lawmakers Target the Regulatory Monster*, J Commerce 9 (June 3, 1999); Cindy Skrzycki, *OMB Tries to Add Up the Bill for Federal Rules*, Wash Post E1 (Feb 12, 1999); Cindy Skrzycki, *Bringing Brainpower to the Commentary on Rules*, Wash Post G1 (Oct 9, 1998); Murray Weidenbaum, *Streamlining the Regulatory Tangle*, Christian Sci Monitor 19 (May 21, 1998); Cindy Skrzycki, *Stacks and Stones at the Labor Relations Board*, Wash Post G1 (Oct 31, 1997).

B. Disregarding Distributive Impacts

A particularly telling criticism of cost-benefit analysis is its tendency to overlook the distributive and equitable impacts of regulatory decisions.[229] This section will show that while cost-benefit analysis is in principle capable of both considering and deferring to such concerns, scorecards are inherently *incapable* of doing so.

Most cost-benefit analyses treat risks and costs as fungible commodities whose distribution can be largely ignored. The lives saved are statistical lives; the resources expended are society's resources. Indeed, I found no formal discussion of distributive impacts in *any* of the regulatory impact analyses cited in this Article.

In purely statistical terms, a 1:100,000,000 risk imposed involuntarily on 10,000,000 people is statistically interchangeable with a 1:10 risk of death imposed involuntarily on a single person. Common sense and basic fairness suggest otherwise. If a 1:100,000,000 risk is a tiny and widely dispersed risk that seems a reasonable price to pay for the benefit of modern living (assuming the activity brings a clear benefit), a 1:10 risk of death is essentially a game of Russian roulette that society has no *right* to force anyone to play for any amount of social economic gain. Likewise, though the point is more debatable, a regulation that costs a million consumers one dollar each is probably preferable to one of similar aggregate cost that eliminates one hundred jobs. Analysis that fails to consider the distribution of impacts (be they costs or benefits) misses an important part of the picture.

Closely related to the distribution of impacts are questions about the identity of the risk or cost bearers. Once again, aggregate statistics conceal potentially important issues of who pays the cost of regulation, and who benefits. Some would argue that a risk that falls disproportionately on minorities or the poor (who often lack adequate access to health care) should be weighted more heavily, other things equal, than one whose burdens are more equitably distributed. Likewise, some assert that a regulation whose costs fall disproportionately on the poor should be registered as more "costly" than a regulation that does not place additional burdens on the poor or disadvantaged.[230] Others maintain that regulations that disproportionately benefit the

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229 See, for example, Heinzerling and Ackerman, *Pricing the Priceless* at 23–25 (cited in note 38) (noting that a "fundamental defect of cost-benefit analysis is that it tends to ignore, and therefore to reinforce, patterns of economic and social inequality" while disregarding "questions of rights and morality" that are not reducible to monetary terms).

230 See EPA, *Guidelines for Preparing Economic Analyses* at 139–71 (cited in note 96) (calling for analysis of the impact of regulatory costs on employment, profitability, plant closure, competitiveness, and small businesses, as well as "disproportionate" impacts on minorities, low-income populations, children, and any risk to individuals "above generally accepted norms"—but without identifying any weighting mechanism to reflect distributive justice concerns).

poor, the aged, or the afflicted should be assigned a *lower* value than those favoring the well-off, the young, and the healthy.[231]

Single-rule analyses are able, in principle at least, to take account of the distributive impacts. Indeed, widely agreed canons of cost-benefit analysis call on analysts to examine such impacts wherever they are significant—though actual examples of this happening are rather hard to find.[232] In any case, proponents of cost-benefit analysis recognize that considerations of fairness ought to be considered side by side with utilitarian arguments. And they recognize that the former may, on occasion, trump the latter.[233]

Given this recognition, it is not quite fair to assert that cost-benefit analysis inherently requires the wholesale subordination or obfuscation of equitable concerns. But it is fair and, indeed, necessary to say that the scorecards discussed in this Article pay absolutely no attention to the distribution of cost or risk in society, or to any ethical concerns, and it is hard to see how they could. The scorecard enterprise by its very nature requires tabulating costs per life saved or net

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231 See, for example, W. Kip Viscusi, *Equivalent Frames of Reference for Judging Risk Regulation Policies*, 3 NYU Envir L J 431, 447 (1994) ("[T]he United States Department of Transportation should want to place a higher value on the well-being of the lives of airline passengers than those killed in motor-vehicle crashes because the airline passengers have a higher income."). Lawrence Summers, then chief economist at the World Bank and the current president of Harvard University, wrote in 1991:

> The measurements of the costs of health impairing pollution depend . . . on the foregone earnings from increased morbidity and mortality. From this point of view a given amount of health impairing pollution should be done in the country with the lowest cost, which will be the country with the lowest wages. I think the economic logic behind dumping a load of toxic waste in the lowest wage country is impeccable and we should face up to that.

Lawrence Summers, *Internal World Bank Memo*, in Heinzerling and Ackerman, *Pricing the Priceless* at 24 (cited in note 38). Heinzerling elsewhere observes, astutely, that the recent emphasis on measuring "Quality-Adjusted Life Years (QALY)" preserved, rather than lives saved, is a backhanded way of privileging the young, the well-off, and the healthy over the older, the poor, and the infirm. See Heinzerling, 24 Harv Envir L Rev at 193 (cited in note 90).

232 See Arrow, et al, *Annapolis Principles* at 8 (cited in note 103) ("[A] good cost-benefit analysis will identify important distributional consequences of a policy."); OMB, *Guidelines* at 16 (cited in note 89) ("If . . . distributive effects are important, you should describe the effects of various regulatory alternatives quantitatively to the extent possible, including their magnitude, likelihood, and incidence of effects on particular groups."); EPA, *Guidelines for Preparing Economic Analyses* at 139 (cited in note 96) (devoting Chapter 9 to guidance for conducting distributional analyses).

233 See Arrow, et al, *Annapolis Principles* at 7 (cited in note 103) ("Agencies should not be bound by a strict benefit-cost test. . . . There may be factors other than economic benefits and costs that agencies will want to weigh in decisions, such as equity within and across generations."); Robert M. Solow, *Reply to Steven Kelman*, in Robert N. Stavins, ed, *Economics of the Environment: Selected Readings* 367, 368 (4th ed 2000) ("Treatises on the subject make clear that certain ethical or political principles may irreversibly dominate the advantages and disadvantages capturable by cost-benefit analyses.").

benefits across large numbers of rules, and then compressing the tabulation into a few summary statistics. This renders it difficult if not impossible for scorecards to take account of differences in the distribution of risks, costs, or benefits. The enormity of the task facing scorecards will become even more evident when we turn to the treatment of uncertainty.

C. Concealing Uncertainty

One of the most striking features of the Hahn, Morrall, and Tengs/Graham scorecards—and, one suspects, a key to their great influence—is the precision of their numbers, which they typically report to three or four significant digits.[234]

Yet the appearance of precision is highly misleading. A large, though esoteric, literature already documents the data gaps and other uncertainties confronting efforts to estimate, and then monetize, physical risks to human health and ecosystems.[235] A growing literature attests to the huge uncertainties facing regulatory cost predictions as well.[236] Yet scorecardists present their results (particularly in the media) with the routine confidence of a draper measuring curtains.[237]

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234 See, for example, Hahn, *Government's Numbers* (2000) at 43 table 3-5 (cited in note 13) (reporting the net benefits of final rules promulgated under the Clean Air Act from 1981 through mid-1996 at $586.9 billion). How, one wonders, can he be so sure that they are not $587.2 billion? Or $627.4 billion? Or any number between, say, $500 billion and $700 billion? Tengs and Graham inform the reader at one point that "all estimates are rounded to three significant figures to stress their approximate nature." Tengs and Graham, *Opportunity Costs* at 182 n 1 (cited in note 10). The authors apparently fail to realize that "rounding to three significant figures" implies accuracy to one-tenth of one percent.

235 See, for example, William D. Ruckelshaus, *Risk in a Free Society*, 14 Envir L Rep 10190, 10190–91 (1984) (discussing the difficulties of extrapolating low-dose human risks from high-dose animal tests, and of establishing that any particular environmental risk has caused a particular human harm). See generally Celia Campbell-Mohn and John S. Applegate, *Learning from NEPA: Guidelines for Responsible Risk Legislation*, 23 Harv Envir L Rev 93, 99–102 (1999); Mark Eliot Shere, *The Myth of Meaningful Environmental Risk Assessment*, 19 Harv Envir L Rev 409, 413–17 (1995); John P. Dwyer, *Limits of Environmental Risk Assessment*, 116 J Energy Engineering 231, 234–40, 243 (1990); David D. Doniger, *Federal Regulation of Vinyl Chloride: A Short Course in the Law and Policy of Toxic Substances Control*, 7 Ecol L Q 497, 508–14 (1978).

236 It is generally known, for example, that indirect and/or unanticipated costs tend to increase burdens above expected levels, while learning curves, economies of scale, and corporate innovations tend to constrain cost impacts and may, on occasion, even improve productivity. See, for example, Jaffe, 33 J Econ Lit at 139–40 (cited in note 209) (offering taxonomy of direct and indirect costs and cost savings and noting that "[e]ven estimates of direct, compliance expenditures vary greatly"). See also Harrington, Morgenstern, and Nelson, *On the Accuracy of Regulatory Cost Estimates* (cited in note 80) (cataloguing unreliability of existing cost estimates and sources of cost estimation errors); McGarity and Ruttenberg, 80 Tex L Rev at 1998–99 (cited in note 32) (finding that actual regulatory costs were often significantly less than predicted costs, although still uncertain); Goodstein and Hodges, Am Prospect at 64 (cited in note 25) (finding that in eleven of twelve cases in which retrospective cost studies were performed, regulators had initially overestimated costs of regulations); David M. Driesen, *The Societal Cost of Environmental Regulation: Beyond Administrative Cost-Benefit Analysis*, 24 Ecol L Q 545, 600–01 (citing exam-

The scorecardists' failure to disclose uncertainties fully cannot be excused by weaknesses in agency assessments. Agencies quite often report ranges of estimates and disclose major sources of uncertainty in their estimates, in keeping with good practice.[238] It is the scorecardists who largely omit this important step.

Again, basic principles of cost-benefit analysis require full documentation of major sources of uncertainty, with sensitivity analysis to explore the impact of altering fundamental assumptions.[239] The authors

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ples of cost over-estimation).

237 Hahn's own writings in *The Washington Post* perfectly exemplify the way his and other scorecardists' conclusions are routinely presented in the media:

> Many of the regulations that deal with the environment, health, safety and employment . . . meet this common-sense test [of benefits exceeding costs]. But many don't. By our estimate, more than half the social regulations issued between 1982 and mid-1996 flunked a cost benefit test. Getting rid of those regulations would have increased the size of the economic pie by $300 billion.

Robert W. Hahn and Robert E. Litan, *Putting Regulations to a Test*, Wash Post A23 (July 30, 1997). The rest of the piece is spent detailing his proposals for "reform." Id. Hahn's primary analysis is only slightly more nuanced. He offers numerical ranges to reflect different assumptions, but his ranges reflect only the impact of different values for life values and discount rates. Hahn, *Government's Numbers* (2000) at 46, 59 (cited in note 13). In fact, Hahn's only acknowledgment of uncertainty is in reference to (1) the discount rate (within the range of 3–7 percent), (2) the appropriate base year (he chooses 1996 but admits he had trouble choosing), and (3) two sentences buried in a section devoted mainly to other matters and labeled "The relative efficiency of regulations." In these sentences he acknowledges that: "technological advances and scientific discoveries may reveal that agencies understated the benefits of existing rules," and "variation in the assumptions agencies and program offices use to estimate benefits and costs affects the results of such analytical exercises." Id at 54. Morrall and Tengs/Graham offer no sensitivity analysis whatsoever.

238 See, for example, 55 Fed Reg at 46391–93 (cited in note 188) (predicting a range of cancer case avoidance, disclosing uncertainty in non-cancer benefits, and reviewing factors that tend to overestimate and underestimate benefits); 57 Fed Reg at 38145 (cited in note 139) (providing a range of costs and benefits, and a description of unquantifiable benefits); 60 Fed Reg at 65185 (cited in note 42) (same).

239 See Arrow, et al, *Annapolis Principles* at 10 (cited in note 103) ("Best estimates should be presented along with a description of the uncertainties."). OMB's guidelines treat the issue much more fully:

> The principles of full disclosure and transparency apply to the treatment of uncertainty in developing risk, benefit, and cost information—just as it does with the other elements of economic analysis. You must identify data, models, and their implications for risk assessment in the risk characterization. You must also explicitly identify and evaluate the inferences and assumptions chosen and assess the effects of these choices on the analysis.

OMB, *Guidelines* at 15 (cited in note 89). OMB also confronts, and squarely rejects, the misguided practice—ubiquitous in scorecards—of taking point estimates (usually the mid-point of a range) as "best" estimates without knowledge of underlying probability curves: "If the uncertainty in the estimates—for example, fundamental scientific disagreement or lack of knowledge—prevents construction of a scientifically defensible probability distribution, you should describe the benefits and costs under plausible alternative assumptions." Id.

of scorecards do not deny the validity of this canon. The problem is that they do not implement it.

The reasons for such omissions are not hard to imagine. Proper disclosure of ranges to reflect uncertainties would render many interventions numerically indeterminate: either because the high end of the cost range would overlap the low end of the benefit range—or vice-versa—or because important, unquantified costs or benefits would vitiate the relevance of numerical ranges. In either event, scorecards would no longer be able to provide a clear "score" for the regulation in question. They would cease, in essence, to be scorecards. That is why this Article suggests that the obfuscation of uncertainty is an inherent—not merely a contingent—defect of scorecards.

D. Assuming Efficiency Is All That Matters

The discussion so far has assumed something that scorecards (and most economists) regularly take for granted: "good" regulations are those that maximize net benefits or cost per life saved as determined by experts. While this Article generally does not contest this crudely utilitarian premise, for the reasons stated in the Introduction, the deeply problematic nature of that premise should not go entirely without mention.

One major difficulty with assuming that the right policy is one that maximizes aggregate net benefits may be illustrated with a simple example. Automobile accidents kill over 40,000 Americans—about thirteen times the death toll of the World Trade Center bombings—*every year.*[240] It is highly likely that a cross-section of experts assigned to consider the issue would agree that at least some of the many billions of dollars now being spent searching diaper bags and grandmothers in airports would actually save more lives per dollar if diverted to programs for improving auto safety. Yet this is virtually unthinkable in the current climate. The American public is accustomed to auto risks and terrified of terrorism. We want everything done that can be done to stop the latter. Other threats, at other times, likewise have dominated public consciousness for a period leading to rather expensive public responses—cryptosporidium, AIDS, toxic waste in basements, microwave towers, and cancer. Experts have known for

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[240] Following are motor vehicle death statistics for the period 1991–1998, the latest year for which complete data are available:

Year	1991	1992	1993	1994	1995	1996	1997	1998
Deaths	43,536	40,982	41,893	42,524	43,363	43,649	43,458	43,501

National Center of Health Statistics, Historical Tables on Leading Causes of Death, 1900–1998, online at http://www.cdc.gov/nchs/data/statab/lead1900_98.pdf (visited Sept 26, 2003).

over a decade that they rank risks differently than the public does.[241] The question is, so what? What follows from the fact that public fears and wishes are, at times, "inefficient" in the opinion of experts? To the extent that there is psychological value in minimizing public fear (as opposed to risk)—or democratic virtue in accountability to the public—then the best regulation may not always be the most cost-effective one.[242]

By the same token, the best regulation is not necessarily the one that caters most to the public fear du jour. A tension exists between the dueling goals of rationality and democracy in regulation. One way to resolve it may be through better educating the public. Another way might be through better educating experts about the things that matter to the public. The optimal strategy may well depend on the facts of each particular case. But if that is so, it is certainly problematic to assume, as scorecardists do, that accountability is weightless in the scales, and that public risk and benefit perceptions are always of zero significance when they differ from those of the "experts."

Besides ignoring public preferences, the simplistic utilitarianism of scorecards also inherently occludes all questions of individual rights. All agree that society may not condemn an innocent individual to certain death, even for a monetary gain in excess of the monetary value of a statistical life. That is why those who defend the valuation of statistical lives take such pains to point out that they are assigning a monetary value only to small increments of risk—increments that some individuals have shown themselves willing to assume in marketplace behavior.[243]

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241 See Leslie Roberts, *Counting on Science at EPA*, 249 Science 616, 616–18 (1990) (reporting results of two EPA task forces that found that agency experts rank environmental risks very differently from the American public). For the original reports, see EPA, *Unfinished Business* (cited in note 74); EPA, Science Advisory Board, *Reducing Risk: Setting Priorities and Strategies for Environmental Protection* 12 (1990).

242 Finkel has also adduced a number of plausible reasons why the subjective comparative risk assessments of experts may not necessarily be more plausible than the heuristic judgments of laypersons. See Adam M. Finkel, *A Second Opinion on an Environmental Misdiagnosis: The Risky Prescriptions of* Breaking the Vicious Circle, 3 NYU Envir L J 295, 318–21, 328–31 (1995).

243 See, for example, Viscusi, *Fatal Tradeoffs* at 19–20 (cited in note 15); Hahn, *Government's Numbers* (2000) at 39 n 23 (cited in note 13). For insightful discussions of the difficulty cost-benefit analysts face in accommodating rights-based concerns, see Tribe, 2 Philosophy & Pub Aff at 90–94 (cited in note 35) (discussing the difficulties of using policy analysis to assign legal rights); Steven Kelman, *Cost-Benefit Analysis and Environmental, Safety, and Health Regulation: Ethical and Philosophical Considerations*, in Daniel Swartzman, et al, eds, *Cost-Benefit Analysis and Environmental Regulations: Politics, Ethics and Methods* 137, 143–44 (Conservation Foundation 1982) (noting the difficulty of monetizing non-market rights and the various attempts economists have employed to do so); Heinzerling and Ackerman, *Pricing the Priceless* (cited in note 38) ("[C]ost benefit analysis cannot produce more efficient decisions because the process of reducing life, health, and the natural world to monetary values is inherently flawed.").

It is necessary, however, to follow this concession to its logical conclusion. If society may not impose certain death on an individual, then it follows that society also may not impose a very high likelihood of death on an individual.[244] In other words, bringing a sense of rights into the picture indicates, at a minimum, that there is a threshold of risk that government may not allow one set of individuals to impose upon another through market or non-market activity, whatever the social gain.[245] Likewise, our system of contract and tort law recognizes individual rights by limiting the ability of an individual to impose physical and economic losses on others, without compensation. Finally, the present generation may be seen as holding certain ethical obligations to future generations.[246]

In principle, as seen above, rule- or project-specific cost-benefit analysis can meet these democratic and right-based concerns by detailing the impact of each regulation on the distribution of risk and loss, and by allowing ethical considerations to trump the numerical analysis whenever the physical or economic impact crosses a certain threshold.[247] But purely quantitative analyses cannot do so, and neither can strictly numerical scorecards.

This Part has shown that the Morrall, Tengs/Graham, and Hahn scorecards ignore all considerations of public preference and individual rights. They also violate basic principles of cost-benefit analysis that require consideration of significant, unquantified costs and benefits; consideration of distributive and cumulative impacts; and full disclosure of the uncertainties, sources of uncertainty, and the consequences of varying important default assumptions. Moreover, we have seen that numerical scorecards cannot *possibly* conform to these basic principles of sound cost-benefit analysis and still do what scorecards claim to do, which is to compress a vast range of human experience into a few small numbers. While regulatory scorecards may be faulted on political and ethical grounds, it is important to understand that scorecards fail to pass muster even by the interior logic of economic cost-benefit analysis itself.

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244 This observation leaves aside, for present purposes, the moral issues raised by a military draft, or absence thereof.

245 Congress has expressly recognized this fact in passing statutes that require EPA, for example, to regulate residual emissions of any toxic air pollutant causing a risk of more than one in a million to the "the individual most exposed to emissions from a source." Clean Air Act, 42 USC § 7412(f)(2)(A) (2000).

246 For the leading discussion of inter-generational equity, see Edith Brown Weiss, *In Fairness to Future Generations: International Law, Common Patrimony, and Intergenerational Equity* (Transnational 1988).

247 See Part II.B.

III. TOWARD A RESPONSIBLE APPROACH TO GRADING GOVERNMENT REGULATION

Before any lost traveler can find his way home, he must first come to the realization that he *is* lost, and that he needs to seek direction. Before any problem can be fixed there must come, first, recognition that there is a problem that needs fixing.

This Article is not, fundamentally, about furnishing remedies but about diagnosing a serious problem of evidence and proof at the heart of the regulatory reform movement—a problem that arises from the failure of studies that attempt to reduce regulatory analysis to a few summary numbers. Nonetheless, the preceding discussion does yield a number of affirmative insights into how regulatory performance ought to be evaluated, if not by simplistic scorecards. This Part pulls together those insights.

Part A discusses the implications for agency analysis of individual rules. Part B addresses the implications of this Article for the evaluation of regulatory performance overall.

A. Implications for Agency Analysis

Some will, no doubt, be tempted to find in the shortcomings of scorecards another argument for rejecting cost-benefit analysis per se. Such a reaction is especially understandable given the similarity of the scorecard abuses documented in this Article to those that other scholars have criticized in the analysis of individual rules over the last three decades.[248] As Professor McGarity asks in a recent essay, why continue a practice that has proven itself over the years notoriously prone to abuse?[249] Despite the considerable force of McGarity's argument, I do

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248 See, for example, Thomas O. McGarity, *A Cost-Benefit State*, 50 Admin L Rev 7, 50–78 (1998) (criticizing Professor Cass Sunstein's optimistic assessment of the 104th Congress's regulatory reform legislation); Shapiro and Glicksman, *Risk Regulation at Risk* at 4–13 (cited in note 98) (contrasting cost-benefit analysis with a pragmatism-based approach to environmental and health risk regulation); Driesen, 24 Ecol L Q at 550–51 (cited in note 236) (criticizing cost-benefit analysis in the context of the "polluter pays" principle); Lisa Heinzerling, *Markets for Arsenic*, 90 Georgetown L J 2311, 2313 (2002) (criticizing an EPA rule reducing arsenic levels and arguing that "the entire project of setting environmental standards based on decisions ostensibly made in commercial markets is misguided"); Heinzerling and Ackerman, *Pricing the Priceless* at 1 (cited in note 38) (criticizing cost-benefit valuation of life, health, and environmental values); Howard Latin, *Ideal versus Regulatory Efficiency: Implementation of Uniform Standards and "Fine-Tuning" Regulatory Reform*, 37 Stan L Rev 1267 (1985) (arguing that ideally efficient reforms need to meet real-world tests of practicability, and that technology-based regulation often does this better than cost-benefit analysis).

249 As McGarity puts it, rather bluntly, in responding to Professor Sunstein's defense of cost-benefit analysis: "It is critical to understand that many of the 'experts' to whom Professor Sunstein would assign the important task of 'objectively' assessing and monetizing regulatory

not go so far as to recommend the wholesale rejection of cost-benefit analysis at this point, for three reasons.

First, cost-benefit analysis is a fait accompli. So long as millions of Americans (and a majority of the House and Senate) are concerned with the rationality of government regulations, they will continue to demand cost-benefit analysis as a way of addressing their concerns.

Second, cost-benefit analysis, at least in theory, fills a gap that other approaches leave open. Technology-based standard-setting, for example, begs the question of whether the "best available" technology is safe enough, or whether another approach would be much cheaper, or pose fewer risks of some other kind. Cost-benefit analysis offers a theoretical framework for addressing such questions in an orderly way.[250]

Third, and most important, the analysis of this Article neither supports nor refutes broad conclusions about the practice of cost-benefit analysis per se. This Article has focused on multi-rule scorecards that, as seen, raise particularly acute and inherent difficulties.[251] Though the deficiencies of scorecards do not inspire much confidence in cost-benefit analysis as a genre, conclusively proving the invalidity of the latter would require a broader critique than this Article undertakes.

Though this Article does not take a position on cost-benefit analysis overall, the preceding analysis does suggest several important recommendations for the conduct of cost-benefit analysis at the agency level, assuming it continues to be done:

1. The evidence refutes the widespread belief of regulatory skeptics that agencies routinely overestimate the benefits of regulations they propose or enact.[252] While agencies may, in some cases, adopt quite conservative assumptions in assessing cancer risks and cancer reduction benefits, non-cancer health and ecological benefits are frequently relegated to a few perfunctory sentences. Important data about benefits are often buried in unpublished regulatory impact as-

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benefits are not fair-minded scholars like Professor Sunstein, but self-promoters . . . many of whom have devoted their careers to criticizing health, safety, and environmental regulation." Thomas O. McGarity, *Professor Sunstein's Fuzzy Math*, 90 Georgetown L J 2341, 2369 (2002).

250 However, McGarity, Shapiro, Latin, and others have argued that technology-based regulation may offer a more structured and rational approach to regulation in the context of large uncertainties about regulatory costs and benefits. See Sidney A. Shapiro and Thomas O. McGarity, *Not So Paradoxical: The Rationale for Technology-Based Regulation*, 1991 Duke L J 729, 729; Latin, 37 Stan L Rev at 1267 (cited in note 248).

251 See Part II.

252 Contrast agency elision of benefits of rules discussed in Part II.A with Morrall, Regulation at 25 (cited in note 8) (stating that "regulatory agencies . . . tend to overstate the effectiveness of their actions"); Hahn, *Government's Numbers* (2000) at 35 (cited in note 13) ("[A]gencies are likely to overstate net benefits."); Nichols and Zeckhauser, Regulation at 13 (cited in note 80) (discussing how conservative risk assessment distorts regulation by overstating benefits).

sessments that are then incorporated by reference in the final rule.[253] This is a serious disservice to public understanding of regulatory matters. Even in cases where the data do not permit full quantification of regulatory costs or benefits, agencies need to do a much better job of narratively explaining the significance of costs and benefits (particularly unquantified costs and benefits), and the reasons underlying the agency's determination that the benefits justify the costs.[254]

2. While agencies cannot avoid valuing risk to human life (at least implicitly), the life and health values in current use are empirically questionable, and probably too low. At a minimum, adjustments should be made to reflect the involuntariness of certain risks, the effect on risk preferences of income distribution and growth, and heterogeneity of risk tolerance.

3. Ultimately, agencies should consider simply abandoning the pretense that the monetary values assigned to non-monetary impacts are numerically rigorous and scientifically based. They are not, nor need they be. Government agencies have a rightful normative function that they should exercise openly—without seeking to conceal their exercise of discretion behind a gauzy veil of numbers.[255]

4. When conducting cost-effectiveness analysis (which looks at cost per life saved), agencies should cease the semantically misleading practice of discounting the number of lives saved.[256]

5. All analyses that involve monetizing and/or discounting non-monetary values should include a clear and prominent statement of the *physical* costs and benefits of the rule—the risks created as well as the lives saved, illnesses avoided, and ecological harms prevented or remedied—along with the timing and distribution of such costs and benefits. Readers can then reach their own judgment as to whether benefits justify costs, without the loss of information that results when primary data are altered through assumptions supplied by economists.[257]

6. Agency cost-benefit assessments should include a full discussion of all relevant uncertainties. These uncertainties will often preclude simple, numerically determined declarations about whether benefits will exceed costs. Rather than feeling obligated to pretend to adhere to a certainty that does not exist, agencies should be prepared

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253 See Part II.A.1.

254 See id.

255 See id.

256 See Part I.D.

257 Much of the current controversy over life valuation and discount rate might have been avoided (or marginalized) by this simple expedient, which OMB has endorsed. See Part I.D.

to acknowledge such indeterminacies when they arise. The presence of large uncertainties often counsels for incremental decisionmaking through flexibility mechanisms such as variances, waivers, and preservation of later implementation discretion. These mechanisms are already routinely employed. Agencies should carefully analyze the potential significance of such mechanisms in characterizing the costs and benefits of each rule. Agencies also should incorporate—as they now do not—a discussion of the consequences of erring in the direction of under- and overregulation, respectively.[258]

7. Retrospective studies, though difficult, are indispensable tools for capturing the impact of waivers, variances, and other uses of official discretion; detecting errant predictions of costs and benefits; identifying important sources of estimation error; calibrating ex ante estimates; and, most of all, identifying needed changes to rules.[259]

8. If rational priority-setting in regulation is the goal, then it seems clear that cost-benefit analysis cannot be limited to screening final regulations. Agencies should also use the instrument for identifying risks that are not now regulated but ought to be—even (and especially) if they lack statutory authority to address the risk at the time of the assessment. Setting agendas for future legislative initiatives has long been recognized as a vital function of cost-benefit analysis.[260]

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[258] See Parts I.C and II.C.

[259] Indeed, the idea that a single ex ante estimate could provide an accurate picture of regulatory costs and benefits in perpetuity is absurd on its face. Yet that is the proposition implicit in the current practice of relying on ex ante estimates for conclusions about "the" costs and benefits of each rule. See Part I.C.

[260] The current OMB/OIRA director, John Graham, has made a start in the right direction with a new policy of encouraging agencies to identify new opportunities for cost-effective regulation. See Nakashima, *Equation Is Persuasion*, Wash Post at A35 (cited in note 3) (noting that Graham has created the "prompt letter" which urges agencies to issue rules in areas that appear to be cost-effective). It remains to be seen how far this initiative will extend in practice.

If OMB really intends to make the initiative meaningful, it should (1) instruct agencies to include a "regulatory opportunities" section as part of their strategic plans; (2) include an overview of regulatory gaps in OMB's annual report on costs and benefits of legislation; and (3) propose legislation that would require agencies and/or OMB to prepare periodic reports on *gaps* in regulatory programs that present real regulatory needs and cost-effective regulatory opportunities.

A new focus on regulatory opportunities may not be as controversial, or unlikely in the present climate, as one might tend to assume. Indeed, identifying favorable regulatory opportunities may present a win-win-win opportunity for agencies, public interest groups, and regulated interests. For agencies and public interest groups, closing regulatory gaps offers obvious public interest benefits. But currently regulated entities stand to gain as well: to the degree that agencies identify, and are given authority to regulate, the highest priority risks (including those now protected by gaps in agency jurisdiction), agencies may be less prone to try to extract the last ounce of protection from the sources currently within their control. See National Academy of Public Administration, *Setting Priorities, Getting Results: A New Direction for the Environmental Protection Agency* 61–66 (NAPA 1995) (describing how EPA's lack of jurisdiction to regulate radon in indoor air may have led the agency to focus excessively on regulation of radon in drinking water, which EPA had jurisdiction to regulate).

9. Requiring agencies to perform more—and more thorough—cost-benefit analyses will be expensive. That is not an objection to the requirement. It is simply an objection to imposing the requirement as an unfunded mandate. By any reasonable reckoning, the costs of responsible analysis are trivial compared to the economic, human, and ecological stakes involved in social regulation. If getting the analysis right requires doubling or tripling agencies' analytical and regulatory budgets, so be it. Congress must realize that in regulation, as elsewhere, "you get what you pay for."

B. Implications for Comprehensive Evaluations of Regulation

While strengthening the quality of single-rule analysis is an important first step, it is not the end of the road. There remains the issue of how best to evaluate regulatory performance overall. While full treatment of this issue lies beyond the scope of this brief concluding section, the broad contours of an appropriate approach may be inferred from the critique this Article has offered.

The central message of this Article is that while responsible cost-benefit analysis may reveal clear successes and failures in some cases, it is also certain to yield a significant category of ambiguous cases, in which existing data simply do not support an objective determination of whether the net benefits of the regulation are positive or not. Policymakers and the public generally should defer to agencies in ambiguous cases, just as courts are already instructed to do.[261]

Once the clear successes and clearly ambiguous cases are subtracted from the tally, what remains will be a smaller group of clear or likely regulatory failures—situations in which it appears that neither the health nor the ecological benefit of a regulation can plausibly justify the sums expended in pursuit of it; or in which more protection could have been achieved at less cost through greater flexibility or better regulatory design; or in which a cost-effective regulatory opportunity was overlooked. These are the cases that ought to attract the attention of scholars and policymakers, whatever their ideological bent. But these cases ought to attract attention in a different and more constructive way than they do now. Rather than merely serving as illustrations for sweeping pro- or anti-regulatory polemics aimed at whole-

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[261] See *Chevron USA Inc v Natural Resources Defense Council, Inc*, 467 US 837, 865–66 (1984) (calling for deference to agency interpretations when statutory text is ambiguous); *Ethyl Corp v EPA*, 541 F2d 1, 33–36 (DC Cir 1976) (calling for judicial deference to agencies when facts are ambiguous).

sale "reforms," these cases should first stimulate a three-part empirical investigation.

Initially, there should be a serious effort to obtain broad consensus on the facts of each case and on the characterization of the case as one of regulatory failure through overregulation, underregulation, or misregulation. Then, if a failure is established, there should be a concerted effort to determine whether the failure is typical or aberrant. Finally, if the failure is found to be of a programmatic nature, there should be a sustained inquiry into causes—whether statutory, political, or bureaucratic—so that reform efforts can be focused on the root causes of failure.

The difference between the approach to regulatory reform described above and the way now taken is, roughly speaking, the difference between pragmatic/inductive/empirical and polemical/deductive/anecdotal approaches. The polemical approach in current use certainly has its advantages: it offers ease of analysis, powerful rhetoric, and an easy path to broad and clear conclusions that rigorous empiricism might confound. The principal advantage of the empirical approach, on the other hand, is simply that it offers the only reliable means of finding the facts about regulation—and the only conceivable route of escape from the vicious cycle of ideological claim and counterclaim in which the regulatory debate is now mired. Everyone agrees that regulation should be based on "sound science." Yet, as this Article has shown, much of regulatory debate itself is being waged on profoundly unscientific—indeed, pseudo-scientific—terms, using unverified anecdotes or unsupportable and misleading numbers. The obvious solution is to hold critics and defenders of regulation to the same standard of rigorous empiricism that all demand of regulators themselves.

Who would do the investigating? It seems doubtful that either existing agencies or their entrenched critics in think tanks have the credibility, the independence, and the detachment needed to do the job effectively and credibly themselves. Indeed, think tanks produced two of the three studies this Article has critiqued, as well as the current (controversial) director of OMB.[262]

Although academia might fill this investigative role, it seems unlikely that academics will find it in their own professional interest to devote to the humble, unprestigious task of empirical research the time and effort needed to implement the methodical approach just described over a sustained period.[263]

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[262] See discussion in text accompanying note 29.

[263] See McGarity and Ruttenberg, 80 Tex L Rev at 2058 (cited in note 32) ("Perhaps because cost analysis lacks the intellectual sex appeal of benefits analysis, surprisingly few academic observers have decried the sorry state of retrospective empirical analysis of the hundreds of ex-ante cost assessments that have accumulated over the last three decades.").

The General Accounting Office (GAO) is currently empowered to undertake its own independent evaluation of agency cost-benefit analysis of economically significant rules. But it can do so only in response to a specific request of a chairman or ranking member of a congressional committee of jurisdiction.[264] This requirement seems likely to leave important parts of the regulatory picture unexamined.

If the GAO does not fill the gap, the only clear, remaining alternative is to establish a new body to act as a sort of external "ombudsman" in investigating allegations of regulatory failure, reporting causes, and recommending remedies.[265] While this may seem an expensive and elaborate response, it can hardly be considered disproportionately so. If it is true that billions of dollars are wasted each year due to over- and underregulation, then surely it would be cost-effective to authorize a few million dollars a year for a bipartisan team of researchers to investigate allegations of systemic failures, establish the facts, and recommend suitable remedies.

CONCLUSION

Regulatory scorecards have played a major role in shaping contemporary views of the administrative state. They come from prestigious sources, claim to be comprehensive and objective, and reach sensational conclusions. The result has been an extraordinary degree of influence for both the studies and their authors.

Yet this Article has shown that, in fact, these scorecards:

- alter agency numbers in undisclosed and arbitrary ways;
- draw on biased samples of regulation;
- undervalue the benefit of reducing risk to life and health;
- misrepresent ex ante guesses as actual cost-benefit measurements;
- falsely assume that regulations will never be eased or modified;

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[264] See Truth in Regulating Act of 2000 § 4, Pub L No 106-312, 114 Stat 1248, codified at 5 USC § 801 note (2000).

[265] For a discussion of responsibilities and issues raised by various types of ombuds, see American Bar Association, *Standards for the Establishment and Operation of Ombuds Offices: ABA Policy Adopted August 2001*, online at http://www.abanet.org/adminlaw/approvedreport.doc (visited July 2, 2003).

- disregard major categories of quantified and monetized benefits;
- disregard all unquantified costs and benefits;
- ignore important non-linearities of risk and risk preferences, as well as cumulative and distributive impacts;
- assume that savings from regulations foregone will be redirected to save lives, even though no mechanism for accomplishing such a redirection exists; and
- conceal important uncertainties, as well as virtually all the omissions and alterations discussed above.

In short, the three most widely cited and influential scorecards underlying the regulatory reform movement—studies issued by AEI-Brookings, the Harvard Center for Risk Analysis, and a senior OMB economist—are revealed to be, on close inspection, deeply flawed analyses which fail to prove their own conclusions.

In a brilliant monograph entitled *The Rhetoric of Reaction*, A.O. Hirschman describes the tried and effective rhetorical devices by which very appealing goals—such as equality, self-determination, or, by extension, protecting health, safety, or the environment—may be assailed or ridiculed indirectly when frontal assault is impossible in view of the popularity of the goals.[266] One such rhetorical device is the "perversity thesis" whereby the skeptic argues that pursuing the goal in question will produce unexpected or disproportionate costs and may, in fact, move society *away* from the goal. Scorecards—with their focus on the costs imposed by government intervention and lives supposedly sacrificed thereby—are perfect examples of the perversity thesis applied to regulation. That, in itself, does not make them wrong: truth can be trite. Nor do I mean to suggest that Hahn, Morrall, and Tengs/Graham prepared their scorecards with intent to mislead. I have found no evidence of any such motive. Nonetheless, when studies are shown to be blatantly untrue, Hirschman's analysis does help explain why deeply flawed studies are received so uncritically, and why they are circulated so enthusiastically, by those who disdain regulation.

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[266] Albert O. Hirschman, *The Rhetoric of Reaction: Perversity, Futility, Jeopardy* 3–8 (Harvard 1991) (comparing reactions against civil equality, universal suffrage, and the contemporary welfare state, and evincing three arguments common to them all: perversity of effect, futility of purpose, and jeopardy of the status quo).

Scorecards draw on a tradition of rhetoric—the rhetoric of reaction—that has been used, and proven effective, for centuries.

This is not to say that the American regulatory system is perfect, rational, or even good. This Article reaches no conclusion on that issue and certainly finds plenty of room for improvement in agency analyses. The point is not that all regulations are rational, but that critics have only pretended to prove that our regulatory system is pervasively irrational.

Arriving at valid conclusions about the cost-benefit rationality of our regulatory system is going to require much more than has been done so far. It will require closely investigating the facts of alleged regulatory failures (including failures to regulate) one intervention at a time, with careful regard to unquantified variables, uncertainties, cumulative impacts, and distributive concerns. And it will require, in cases where failure is found, patient empirical inquiry to determine whether the problem is typical or aberrational, and to identify its root causes.

Meanwhile, we should be wary of spectacular numerical claims that purport to show the systemic irrationality of government regulation from a cost-benefit perspective. For the tests that claim to show this are invalid.

Appendix A
Morrall Table

Regulation	Year	Agency	Status*	Initial Annual Risk**	Annual Lives Saved	Cost Per Life Saved (1,000s of 1984 $)
Steering Column Protection	1967	NHTSA	F	7.7 in 10^5	1,300.000	100
Unvented Space Heaters	1980	CPSC	F	2.7 in 10^5	63.000	100
Oil & Gas Well Service	1983	OSHA-S	P	1.1 in 10^3	50.000	100
Cabin Fire Protection	1985	FAA	F	6.5 in 10^8	15.000	200
Passive Restraints/Belts	1984	NHTSA	F	9.1 in 10^5	1,850.000	300
Fuel System Integrity	1975	NHTSA	F	4.9 in 10^6	400.000	300
Trihalomethanes	1979	EPA	F	6.0 in 10^5	322.000	300
Underground Construction	1983	OSHA-S	P	1.6 in 10^3	8.100	300
Alcohol & Drug Control	1985	FRA	F	1.8 in 10^6	4.200	500
Servicing Wheel Rims	1984	OSHA-S	F	1.4 in 10^5	2.300	500
Seat Cushion Flammability	1984	FAA	F	1.6 in 10^7	37.000	600

* Proposed, rejected, or final rule.
** Annual deaths per exposed population of 10^3 is 1000; 10^4 is 10,000; etc.

Regulation	Year	Agency	Status*	Initial Annual Risk**	Annual Lives Saved	Cost Per Life Saved (1,000s of 1984 $)
Floor Emergency Lighting	1984	FAA	F	2.2 in 10^8	5.000	700
Crane Suspended Personal Platform	1984	OSHA-S	P	1.8 in 10^3	5.000	900
Children's Sleepware Flammability	1973	CPSC	F	2.4 in 10^6	106.000	1,300
Side Doors	1970	NHTSA	F	3.6 in 10^5	480.000	1,300
Concrete & Masonry Construction	1985	OSHA-S	P	1.4 in 10^5	6.500	1,400
Hazard Communication	1983	OSHA-S	F	4.0 in 10^5	200.000	1,800
Grain Dust	1984	OSHA-S	P	2.1 in 10^4	4.000	2,800
Benzene/Fugitive Emissions	1984	EPA	F	2.1 in 10^5	0.310	2,800
Radionuclides/Uranium Mines	1984	EPA	F	1.4 in 10^4	1.100	6,900
Asbestos	1972	OSHA-H	F	3.9 in 10^4	396.000	7,400
Benzene	1985	OSHA-H	P	8.8 in 10^4	3.800	17,000
Arsenic/Glass Plant	1986	EPA	F	8.0 in 10^4	0.110	19,200
Ethylene Oxide	1984	OSHA-H	F	4.4 in 10^5	2.800	25,600

Regulation	Year	Agency	Status*	Initial Annual Risk**	Annual Lives Saved	Cost Per Life Saved (1,000s of 1984 $)
Uranium Mill Tailings/Inactive	1983	EPA	F	4.3 in 10^4	2.100	27,600
Acrylonitrile	1978	OSHA-H	F	9.4 in 10^4	6.900	37,600
Uranium Mill Tailings/Active	1983	EPA	F	4.3 in 10^4	2.100	53,000
Coke Ovens	1976	OSHA-H	F	1.6 in 10^4	31.000	61,800
Asbestos	1986	OSHA-H	F	6.7 in 10^5	74.700	89,300
Arsenic	1978	OSHA-H	F	1.8 in 10^3	11.700	92,500
Asbestos	1986	EPA	P	2.9 in 10^5	10.000	104,200
DES (Cattlefeed)	1979	FDA	F	3.1 in 10^7	68.000	132,000
Arsenic/Glass Manufacturing	1986	EPA	R	3.8 in 10^5	0.250	142,000
Benzene/Storage	1984	EPA	R	6.0 in 10^7	0.043	202,000
Radionuclides/DOE Facilities	1984	EPA	R	4.3 in 10^6	0.001	210,000
Radionuclides/Elemental Phosphorous	1984	EPA	R	1.4 in 10^5	0.046	270,000
Acrylonitrile	1978	OSHA-H	R	9.4 in 10^4	0.600	308,000

Regulation	Year	Agency	Status*	Initial Annual Risk**	Annual Lives Saved	Cost Per Life Saved (1,000s of 1984 $)
Benzene/Ethylbenzenol Styrene	1984	EPA	R	2.0 in 10^6	0.006	483,000
Arsenic/Low-Arsenic Copper	1986	EPA	R	2.6 in 10^4	0.90	764,000
Benzene/Maleic Anhydride	1984	EPA	R	1.1 in 10^6	0.029	820,000
Land Disposal	1986	EPA	P	2.3 in 10^8	2.520	3,500,000
EDB	1983	OSHA-H	P	2.5 in 10^4	0.002	15,600,000
Formaldehyde	1985	OSHA-H	P	6.8 in 10^7	0.010	72,000,000

Appendix B-1
Graham and Tengs "Opportunity Cost" Study Spreadsheet

	A	B	C	D	E	F	G	H	I	J	K	L
	Competing	Description	Marginal CL	Final Annual Costs at 100% Imp.	Final annual lives	Baseline % Imp.	Baseline Cost	Baseline Lives	Reallocation Spending	Reallocation Lives	Additional Lives Saved	$ Supplied for Reallocation
3	0	Ban residential growth in tsunami-prone areas	($8,655,184,021)	($8,655,184,021)	1	0	$0	0	($8,655,184,021)	1	1	$8,655,184,021
4	0	1988 (vs. 1971) safety standard for concrete construction	($3,224,537)	($390,169,014)	121	10	($39,016,901)	12	($390,169,014)	121	109	$351,152,113
5	0	Install windshields with adhesive bonding (vs. rubber gaskets) in cars	($1,669,164)	($175,262,176)	105	100	($175,262,176)	105	($175,262,176)	105	0	$0
6	0	Truss (vs. elective inguinal herniorrhaphy) for inguinal hernia in elderly patients	($1,387,013)	($320,400,000)	231	1	($3,204,000)	2	($320,400,000)	231	229	$317,196,000
7	0	Flammability standard for children's sleepwear size 0–6X	($414,105)	($28,009,518)	68	95	($26,609,042)	64	($28,009,518)	68	3	$1,400,476
8	0	Measles, mumps & rubella immunization for children	($291,406)	($284,412,061)	976	87	($246,016,433)	844	($284,412,061)	976	132	$38,395,628
9	0	Smoking cessation advice for pregnant women who smoke	($213,719)	($72,237,187)	338	80	($57,789,750)	270	($72,237,187)	338	68	$14,447,437
10	0	Terminate sale of 3-wheeled all-terrain vehicles	($93,190)	($13,792,176)	148	100	($13,792,176)	148	($13,792,176)	148	0	$0
11	16	Driver automatic (vs. manual) belts in cars	($82,581)	($204,388,066)	2,475	0	$0	0	($204,388,066)	2,475	2,475	$204,388,066
12	0	Reduce lead content of gasoline from 1.1 to 0.1 grams per leaded gallon	($1,881)	($9,595,396)	5,100	95	($9,115,626)	4,845	($9,595,396)	5,100	255	$479,770
13	0	Brady method screening for group B streptococci colonization during labor	($1,356)	($1,667,518)	1,230	10	($166,752)	123	($1,667,518)	1,230	1,107	$1,500,766
14	0	Mandatory seat belt use & child restraint law	$1,360	$13,939,330	10,248	85	$11,848,431	8,711	$13,939,330	10,248	1,537	$0
15	0	Sickle-cell screening for black newborns	$3,979	$226,786	57	80	$181,429	46	$226,786	57	11	$0
16	0	Media campaign to increase voluntary use of seat belts	$4,224	$13,939,330	3,300	15	$2,090,900	495	$13,939,330	3,300	2,805	$0
17	0	Public pedestrian safety information campaign	$6,925	$6,336,059	915	45	$2,851,227	412	$6,336,059	915	503	$0
18	0	Federal law requiring smoke detectors in homes	$7,637	$2,624,662	344	70	$1,837,264	241	$2,624,662	344	103	$0

Appendix B-1: Tengs/Graham

	A	B	C	D	E	F	G	H	I	J	K	L
	Competing	Description	Marginal CL	Final Annual Costs at 100% Imp.	Final annual lives	Baseline % Imp.	Baseline Cost	Baseline Lives	Reallocation Spending	Reallocation Lives	Additional Lives Saved	$ Supplied for Reallocation
19	0	Improve traffic safety information for children grades K–12	$9,841	$3,660,834	372	27	$970,121	99	$3,660,834	372	273	$0
20	0	Influenza vaccination for all citizens	$14,224	$312,181,614	21,948	13	$39,022,702	2,744	$312,181,614	21,948	19,205	$0
21	0	Require front & rear lights to be on when motorcycle is in motion	$15,360	$1,689,616	110	59	$996,873	65	$1,689,616	110	45	$0
22	0	Continuous (vs. nocturnal) oxygen for hypoxemic obstructive lung disease	$15,505	$697,722,772	45,000	49	$341,884,158	22,050	$697,722,772	45,000	22,950	$0
23	16	Driver & passenger automatic shoulder belt/knee pads (vs. manual belts) in cars	$23,080	$103,860,105	4,500	40	$41,544,042	1,800	$0	0	(1,800)	$41,544,042
24	0	Mammography every 3 years for women age 50–65	$28,979	$26,110,271	901	30	$7,833,081	270	$26,110,271	901	631	$0
25	0	Federal mandatory motorcycle helmet laws (vs. state-determined policies)	$34,657	$17,882,972	516	60	$10,729,783	310	$17,882,972	516	206	$0
26	0	Selective traffic enforcement programs at high-risk times & locations	$71,969	$300,470,009	4,175	78	$232,864,257	3,236	$300,470,009	4,175	939	$0
27	0	Motorcycle rider education program	$78,683	$2,675,225	34	5	$133,761	2	$2,675,225	34	32	$0
28	1	"American" oxygen depletion sensor system for gas space heaters	$81,098	$138,099	2	0	$0	0	$138,099	2	2	$0
29	0	1989 safety standard for underground gassy construction	$82,527	$165,055	2	0	$0	0	$165,055	2	2	$0
30	16	Driver & passenger automatic shoulder/manual lap (vs. manual lap) belts in cars	$94,077	$755,440,415	8,030	45	$339,948,187	3,614	$0	0	(3,614)	$339,948,187
31	0	Women's Health Trial to evaluate low-fat diet in reducing breast cancer	$103,678	$57,437,427	554	0	$0	0	$57,437,427	554	554	$0
32	0	Computed tomography in patients with severe headache	$105,801	$22,747,134	215	48	$10,804,889	102	$22,747,134	215	113	$0
33	0	Screen blood donors for HIV	$110,831	$32,362,556	292	100	$32,346,374	292	$32,362,556	292	0	$0

Appendix B-1: Tengs/Graham

	A	B	C	D	E	F	G	H	I	J	K	L
	Competing	Description	Marginal CL	Final Annual Costs at 100% Imp.	Final annual lives	Baseline % Imp.	Baseline Cost	Baseline Lives	Reallocation Spending	Reallocation Lives	Additional Lives Saved	$ Supplied for Reallocation
34	0	Improve motorcycle testing & licensing system	$121,155	$10,419,297	86	98	$10,210,911	84	$10,419,297	86	2	$0
35	0	Insulate omnidirectional CB antennae to avert electrocution	$139,625	$1,116,998	8	100	$1,116,998	8	$1,116,998	8	0	$0
36	0	Ban asbestos in drum brake linings (A/M)	$146,166	$1,533,475	10	100	$1,533,475	10	$1,533,475	10	0	$0
37	15	Driver & passenger non-motorized automatic (vs. manual) belts in light trucks	$152,446	$209,307,875	1,373	5	$10,465,394	69	$209,307,875	1,373	1,304	$0
38	0	Benzene exposure standard of 1 (vs. 10) ppm in rubber & tire industry	$179,529	$982,791	5	95	$933,652	5	$982,791	5	0	$0
39	0	Push-button release & emergency locking retractors on truck & bus seat belts	$196,415	$9,820,725	50	100	$9,820,725	50	$9,820,725	50	0	$0
40	1	"French" oxygen depletion sensor system for gas space heaters	$202,746	$345,247	2	100	$345,247	2	$0	0	(2)	$345,247
41	0	Full (vs. 50%) enforcement of national 55 mph speed limit	$220,492	$792,007,404	3,592	3	$19,800,185	90	$792,007,404	3,592	3,502	$0
42	0	Dual master cylinder braking system in cars	$220,821	$57,413,472	260	100	$57,413,472	260	$57,413,472	260	0	$0
43	0	Automatic fire extinguishers in airplane lavatory trash receptacles	$279,832	$881,472	3	98	$859,435	3	$881,472	3	0	$0
44	0	Alcohol safety programs for drunk drivers	$290,708	$746,246,976	2,567	8	$55,968,523	193	$746,246,976	2,567	2,374	$0
45	0	Ban asbestos in brake blocks	$312,300	$311,781	1	100	$311,781	1	$311,781	1	0	$0
46	0	Multimedia retraining courses for injury-prone drivers	$317,809	$11,123,304	35	28	$3,058,909	10	$11,123,304	35	25	$0
47	0	Ban asbestos in disk brake pads LMV (aftermarket)	$351,967	$629,089	2	100	$629,089	2	$629,089	2	0	$0
48	2	Strengthen unreinforced masonry San Francisco buildings to LA standards	$361,787	$3,762,581	10	5	$188,129	1	$3,762,581	10	10	$0
49	0	Heart transplantation for patients age 50 with terminal heart disease	$365,118	$460,048,544	1,260	55	$250,726,456	687	$460,048,544	1,260	573	$0

Appendix B-1: Tengs/Graham

	A	B	C	D	E	F	G	H	I	J	K	L
	Compet-ing	Description	Marginal CL	Final Annual Costs at 100% Imp.	Final annual lives	Baseline % Imp.	Baseline Cost	Baseline Lives	Reallocation Spending	Reallocation Lives	Additional Lives Saved	$ Supplied for Reallocation
50	10	Radon remediation in homes with levels >8.11 pCi/L	$381,390	$1,432,118,343	3,755	12	$164,693,609	432	$1,432,118,343	3,755	3,323	$0
51	0	Require employers to ensure employees' motor vehicle safety	$439,827	$252,900,761	575	20	$50,580,152	115	$252,900,761	575	460	$0
52	0	Flammability standard for upholstered furniture	$512,837	$220,519,807	430	0	$0	0	$220,519,807	430	430	$0
53	0	Smoke detectors in airplane lavatories	$520,589	$1,405,591	3	98	$1,370,451	3	$1,405,591	3	0	$0
54	15	Driver & passenger motorized automatic (vs. manual) belts in light trucks	$557,607	$765,594,290	1,373	8	$57,419,572	103	$0	0	(103)	$57,419,572
55	10	Radon remediation in homes with levels >4 pCi/L	$595,643	$1,906,057,034	3,200	12	$219,196,559	368	$0	0	(368)	$219,196,559
56	0	Revised safety standard for underground non-gassy construction	$617,667	$2,161,836	4	0	$0	0	$2,161,836	4	4	$0
57	15	Driver airbag (vs. manual lap/shoulder belt) in light trucks	$632,762	$1,084,554,047	1,714	5	$54,227,702	86	$0	0	(86)	$54,227,702
58	0	Ban asbestos in pipeline wrap	$706,063	$60,808	0	100	$60,808	0	$60,808	0	0	$0
59	0	Emergency signs, floor lighting, etc. (vs. upper lighting only) in airplanes	$731,080	$5,491,334	8	100	$5,491,334	8	$5,491,334	8	0	$0
60	0	Redesign chain saws to reduce rotational kickback injuries	$741,853	$7,121,791	10	99	$7,050,574	10	$7,121,791	10	0	$0
61	15	Driver & passenger airbags (vs. manual lap/shoulder belts) in light trucks	$754,852	$1,658,408,996	2,197	0	$0	0	$0	0	0	$0
62	0	Fiberglass fire-blocking airplane seat cushions	$795,433	$10,817,892	14	98	$10,547,444	13	$10,817,892	14	0	$0
63	C15	Radionuclide emission control at underground uranium mines	$855,132	$470,323	1	100	$470,323	1	$470,323	1	0	$0
64	0	Flammability standard for children's sleepwear size 7–14	$860,478	$23,280,638	27	75	$17,460,478	20	$23,280,638	27	7	$0
65	0	Ban asbestos in specialty paper	$871,083	$2,211	0	100	$2,211	0	$2,211	0	0	$0

Appendix B-1: Tengs/Graham

	A	B	C	D	E	F	G	H	I	J	K	L
	Competing	Description	Marginal CE	Final Annual Costs at 100% Imp.	Final annual lives	Baseline % Imp.	Baseline Cost	Baseline Lives	Reallocation Spending	Reallocation Lives	Additional Lives Saved	$ Supplied for Reallocation
66	0	Workplace practice standard for electric power generation operation	$983,444	$25,569,542	26	0	$0	0	$25,569,542	26	26	$0
67	0	Pedestrian & bicycle visibility enhancement programs	$1,015,252	$115,738,682	114	1	$1,157,387	1	$115,738,682	114	113	$0
68	0	Ceilings of 0–8500 lb light trucks withstand forces of 1.5 x vehicle's weight	$1,084,552	$8,893,329	8	92	$8,181,863	8	$8,893,329	8	1	$0
69	0	Automobile dummy acceleration (vs. side door strength) tests	$1,092,466	$72,441,435	66	20	$14,488,287	13	$72,441,435	66	53	$0
70	0	Improve educational curriculum for beginning drivers	$1,166,755	$407,197,407	349	43	$173,058,898	148	$407,197,407	349	201	$0
71	0	Process safety standard for management of hazardous chemicals	$1,294,496	$274,433,226	212	10	$27,443,323	21	$274,433,226	212	191	$0
72	0	Ban asbestos in drum brake linings (OEM)	$1,349,407	$793,825	1	100	$793,825	1	$793,825	1	0	$0
73	0	Coke oven emission standard for iron- or steel-producing plants	$1,357,884	$12,220,956	9	10	$1,160,991	1	$12,220,956	9	8	$0
74	0	Lock out or tag out of machinery in repair	$1,641,141	$200,219,227	122	33	$65,071,249	40	$200,219,227	122	82	$0
75	0	Side structure improvements in cars to reduce door intrusion upon crash	$1,920,078	$921,637,306	480	100	$921,637,306	480	$921,637,306	480	0	$0
76	13	Widen shoulders on rural two-lane roads to 5 (vs. 2) feet	$2,169,766	$394,070,859	182	23	$88,665,943	41	$394,070,859	182	141	$0
77	0	Ban asbestos in corrugated A/C sheet	$2,335,786	$16,584	0	100	$16,584	0	$16,584	0	0	$0
78	0	Ban asbestos in disk brake pads HV	$2,361,047	$35,379	0	100	$35,379	0	$35,379	0	0	$0
79	C11	Control of new benzene fugative emissions	$2,437,648	$199,887	0	100	$199,887	0	$199,887	0	0	$0
80	0	First aid training for drivers	$2,489,885	$244,008,681	98	10	$24,400,868	10	$244,008,681	98	88	$0
81	0	Annual mammography & breast exam for women age 40–49	$2,576,559	$403,972,351	157	2	$8,079,447	3	$403,972,351	157	154	$0

Appendix B-1: Tengs/Graham

	A	B	C	D	E	F	G	H	I	J	K	L
	Competing	Description	Marginal CL	Final Annual Costs at 100% Imp.	Final annual lives	Baseline % Imp.	Baseline Cost	Baseline Lives	Reallocation Spending	Reallocation Lives	Additional Lives Saved	$ Supplied for Reallocation
82	C10	Control of existing benzene fugative emissions	$2,579,188	$799,548	0	100	$799,548	0	$799,548	0	0	$0
83	0	Side door strength standard in light trucks to minimize front seat intrusion	$2,608,931	$268,719,848	103	54	$145,108,718	56	$268,719,848	103	47	$0
84	13	Widen lanes on rural roads to 11 (vs. 9) feet	$2,612,964	$1,454,309,122	557	35	$509,008,193	195	$0	0	(195)	$509,008,193
85	0	Seat back height of 24" (vs. 20") in school buses	$3,081,150	$7,394,759	2	10	$739,476	0	$7,394,759	2	2	$0
86	C15	Radionuclide emission control at underground uranium mines	$3,135,484	$940,645	1	0	$0	0	$940,645	0	0	$0
87	0	1,3 Butadiene exposure standard of 2 (vs. 1000) ppm PEL in polymer plants	$3,330,240	$4,107,042	1	40	$1,642,817	0	$4,107,042	1	1	$0
88	0	Coronary care unit for emergency patients with acute chest pain	$3,624,255	$525,516,990	145	23	$118,241,323	33	$525,516,990	145	112	$0
89	0	Ban asbestos in flat A/C sheet	$3,661,336	$190,164	0	100	$190,164	0	$190,164	0	0	$0
90	0	Front disk (vs. drum) brakes in cars	$4,202,137	$268,936,788	64	100	$268,936,788	64	$268,936,788	64	0	$0
91	0	Flammability standard for children's clothing size 0–6X	$4,306,973	$730,008,820	169	53	$383,254,631	89	$730,008,820	169	81	$0
92	16	Driver airbag/manual lap belt (vs. manual lap/shoulder belt) in cars	$4,911,917	$2,387,191,710	486	0	$0	0	$0	0	0	$0
93	0	Benzene emission control at pharmaceutical manufacturing plants	$4,930,801	$152,855	0	100	$152,855	0	$152,855	0	0	$0
94	0	Equipment, work practices & training standard for hazardous waste cleanup	$5,386,489	$210,073,057	39	25	$52,518,264	10	$210,073,057	39	29	$0
95	0	Improve pedestrian education programs for school bus passengers grades K–6	$5,392,012	$17,254,438	3	95	$16,391,716	3	$17,254,438	3	0	$0
96	0	Ban asbestos in disk brake pads LMV (OEM)	$5,534,737	$385,856	0	100	$385,856	0	$385,856	0	0	$0

Appendix B-1: Tengs/Graham

	A	B	C	D	E	F	G	H	I	J	K	L
	Competing	Description	Marginal CL	Final Annual Costs at 100% Imp.	Final annual lives	Baseline % Imp.	Baseline Cost	Baseline Lives	Reallocation Spending	Reallocation Lives	Additional Lives Saved	$ Supplied for Reallocation
97	19	Full compliance with 1989 (vs. partial with 1971) safety standard for trenches	$5,802,721	$429,401,347	74	10	$42,940,135	7	$429,401,347	74	67	$0
98	0	Ban asbestos in roofing felt	$5,975,754	$446,665	0	100	$446,665	0	$446,665	0	0	$0
99	0	Ban asbestos in friction materials	$6,274,235	$227,755	0	100	$227,755	0	$227,755	0	0	$0
100	C2	Arsenic emission control at primary copper smelters	$6,401,613	$576,145	0	100	$576,145	0	$576,145	0	0	$0
101	0	South Coast of California ozone control program	$7,567,779	$15,135,557,621	2,000	95	$14,303,101,952	1,890	$10,070,027,717	1,331	(559)	$4,233,074,235
102	0	Crossing control arms for school buses	$7,702,874	$18,486,898	2	63	$11,554,311	2	$0	0	(2)	$11,554,311
103	0	Radionuclide emission control at Department of Energy facilities	$7,838,710	$235,161	0	0	$0	0	$0	0	0	$0
104	0	Signal arms on school buses	$8,216,399	$6,162,299	1	75	$4,621,724	1	$0	0	(1)	$4,621,724
105	0	Ban asbestos in non-roofing coatings	$8,511,979	$250,972	0	100	$250,972	0	$0	0	(0)	$250,972
106	0	Government buy-out of Times Beach residents due to dioxin contamination	$9,565,788	$6,256,007	1	100	$6,256,007	1	$0	0	(1)	$6,256,007
107	0	Warning letters sent to problem drivers	$9,954,653	$9,954,653	1	78	$7,714,856	1	$0	0	(1)	$7,714,856
108	0	Ban asbestos in millboard	$10,023,518	$570,492	0	100	$570,492	0	$0	0	(0)	$570,492
109	0	External loud speakers on school buses	$11,297,549	$13,557,058	1	3	$406,712	0	$0	0	(0)	$406,712
110	C6	Benzene emission control at coke by-product recovery plants	$11,480,695	$22,387,355	2	100	$22,387,355	2	$0	0	(2)	$22,387,355
111	C1	Arsenic emission control at glass manufacturing plants	$14,501,613	$4,785,532	0	100	$4,785,532	0	$0	0	(0)	$4,785,532
112	0	Side door strength standard in light trucks to minimize back seat intrusion	$14,514,795	$72,573,973	5	9	$6,858,240	0	$0	0	(0)	$6,858,240
113	14	Electronic sensors for school buses	$15,576,923	$112,153,846	7	2	$1,682,308	0	$0	0	(0)	$1,682,308
114	0	Vinyl chloride emission control at EDC/VC and PVC plants	$16,776,339	$175,312,742	10	100	$175,312,742	10	$0	0	(10)	$175,312,742

Appendix B-1: Tengs/Graham

	A	B	C	D	E	F	G	H	I	J	K	L
	Compet-ing	**Description**	**Marginal CL**	**Final Annual Costs at 100% Imp.**	**Final annual lives**	**Baseline % Imp.**	**Baseline Cost**	**Baseline Lives**	**Reallocation Spending**	**Reallocation Lives**	**Additional Lives Saved**	**$ Supplied for Reallocation**
115	0	Ground fault circuit interrupters	$17,684,580	$21,557,503	1	55	$11,856,627	1	$0	0	(1)	$11,856,627
116	2	Strengthen unreinforced masonry San Francisco buildings to beyond LA standards	$18,225,000	$10,935,000	1	90	$9,841,500	1	$0	0	(1)	$9,841,500
117	0	Universal (vs. category-specific) precautions to prevent HIV transmission	$21,251,985	$403,788	0	60	$242,273	0	$0	0	(0)	$242,273
118	14	Mechanical sensors for school buses	$22,423,922	$161,452,240	7	2	$2,421,784	0	$0	0	(0)	$2,421,784
119	0	Ban asbestos in beater-add gaskets	$23,720,662	$10,828,300	0	100	$10,828,300	0	$0	0	(0)	$10,828,300
120	0	Formaldehyde exposure standard of 1 (vs. 3) ppm in wood industry	$28,784,262	$40,567,285	1	50	$20,283,643	1	$0	0	(1)	$20,283,643
121	0	Ban asbestos in clutch facings	$28,856,627	$1,208,427	0	100	$1,208,427	0	$0	0	(0)	$1,208,427
122	0	Flammability standard for children's clothing size 7–14	$28,981,394	$1,960,264,178	68	53	$1,029,138,693	36	$0	0	(36)	$1,029,138,693
123	0	Rear outboard & center (vs. outboard only) lap/shoulder belts in all cars	$33,867,478	$101,602,435	3	5	$5,080,122	0	$0	0	(0)	$5,080,122
124	C8	Benzene emission control during transfer operations	$39,233,542	$38,448,871	1	100	$38,448,871	1	$0	0	(1)	$38,448,871
125	0	Radionuclide emission control at surface uranium mines	$42,371,404	$940,645	0	0	$0	0	$0	0	0	$0
126	0	Triple the wind resistance capabilities of new buildings	$44,735,170	$12,033,760,825	269	1	$120,337,608	3	$0	0	(3)	$120,337,608
127	0	Dioxin emission standard of 5 lbs/air dried ton at pulp mills	$51,028,086	$84,196,343	2	25	$21,049,086	0	$0	0	(0)	$21,049,086
128	0	Seat belts for passengers in school buses	$52,995,773	$52,995,773	1	3	$1,589,873	0	$0	0	(0)	$1,589,873
129	C16	Radon emission control at Department of Energy facilities	$54,870,968	$3,292,258	0	0	$0	0	$0	0	0	$0
130	0	Ban asbestos in roof coatings	$56,810,924	$8,361,694	0	100	$8,361,694	0	$0	0	(0)	$8,361,694
131	C14	Radionuclide emission control at elemental phosphorous plants	$58,790,323	$2,821,935	0	100	$2,821,935	0	$0	0	(0)	$2,821,935

Appendix B-1: Tengs/Graham

	A	B	C	D	E	F	G	H	I	J	K	L
	Competing	Description	Marginal CL	Final Annual Costs at 100% Imp.	Final annual lives	Baseline % Imp.	Baseline Cost	Baseline Lives	Reallocation Spending	Reallocation Lives	Additional Lives Saved	$ Supplied for Reallocation
132	0	Ban asbestos in sheet gaskets	$61,663,811	$9,473,933	0	100	$9,473,933	0	$0	0	(0)	$9,473,933
133	0	Ban asbestos in packing	$61,778,129	$54,175	0	0	$0	0	$0	0	0	$0
134	0	Ban asbestos in A/C pipe	$64,151,319	$19,738,374	0	100	$19,738,374	0	$0	0	(0)	$19,738,374
135	0	Ban asbestos in beater-add gaskets/2	$69,242,870	$5,577,779	0	0	$0	0	$0	0	0	$0
136	0	Arsenic emission control at secondary lead plants	$82,396,898	$21,423,194	0	0	$0	0	$0	0	0	$0
137	0	Ban asbestos in reinforced plastics	$88,774,900	$4,486,547	0	0	$0	0	$0	0	0	$0
138	0	Staff school buses with adult monitors	$93,666,948	$2,341,673,711	25	15	$351,251,057	4	$0	0	(4)	$351,251,057
139	0	Construct sea walls to protect against 100-year storm surge heights	$94,429,956	$5,760,227,320	61	10	$576,022,732	6	$0	0	(6)	$576,022,732
140	C14	Radionuclide emission control at elemental phosphorous plants	$98,095,853	$3,433,355	0	0	$0	0	$0	0	0	$0
141	0	Chloroform reduction hypochlorite with chlorine dioxide at 70 mills	$98,674,550	$62,164,966	1	80	$49,731,973	1	$0	0	(1)	$49,731,973
142	C14	Radionuclide emission control at elemental phosphorous plants	$103,862,903	$4,056,532	0	0	$0	0	$0	0	0	$0
143	0	Acrylonitrile emission control via best available technology	$105,843,749	$12,701,250	0	0	$0	0	$0	0	0	$0
144	0	Ban asbestos in A/C shingles	$110,689,635	$3,500,347	0	100	$3,500,347	0	$0	0	(0)	$3,500,347
145	0	Radionuclide emission control at operating uranium mill tailings	$117,580,645	$587,903	0	100	$587,903	0	$0	0	(0)	$587,903
146	0	Benzene emission control at ethylbenzene/styrene process vents	$152,854,839	$305,710	0	0	$0	0	$0	0	0	$0
147	C9	Control of benzene storage vessels	$152,854,839	$152,855	0	0	$0	0	$0	0	0	$0
148	0	Ban asbestos in high-grade electrical paper	$165,455,468	$6,499,854	0	0	$0	0	$0	0	0	$0
149	C9	Control of benzene storage vessels	$181,074,194	$1,963,597	0	0	$0	0	$0	0	0	$0

Appendix B-1: Tengs/Graham

	A	B	C	D	E	F	G	H	I	J	K	L
	Compet-ing	Description	Marginal CL	Final Annual Costs at 100% Imp.	Final annual lives	Baseline % Imp.	Baseline Cost	Baseline Lives	Reallocation Spending	Reallocation Lives	Additional Lives Saved	$ Supplied for Reallocation
150	0	Ban asbestos in sheet gaskets/PTFE	$205,261,954	$3,503,664	0	0	$0	0	$0	0	0	$0
151	0	Benzene emission control during waste operations	$210,170,059	$115,593,532	1	100	$115,593,532	1	$0	0	(1)	$115,593,532
152	0	Benzene emission control at maleic anhydride plants	$220,463,710	$881,855	0	0	$0	0	$0	0	0	$0
153	0	Radionuclide control via best available technology in phosphorous mines	$283,051,835	$4,811,881	0	0	$0	0	$0	0	0	$0
154	0	Radionuclide emission control at phosphogypsum stacks	$315,997,984	$50,559,677	0	0	$0	0	$0	0	0	$0
155	0	Ban asbestos in thread, yarn, etc.	$367,637,799	$17,595,711	0	0	$0	0	$0	0	0	$0
156	C6	Benzene emission control at coke by-product recovery plants	$419,762,903	$30,782,613	2	0	$0	0	$0	0	0	$0
157	0	Radionuclide emission control during disposal of uranium mill tailings piles	$427,565,982	$18,812,903	0	0	$0	0	$0	0	0	$0
158	C8	Benzene emission control during transfer operations	$466,046,921	$43,575,387	1	0	$0	0	$0	0	0	$0
159	C10	Control of existing benzene fugative emissions	$473,682,028	$7,431,097	0	0	$0	0	$0	0	0	$0
160	0	Ban asbestos in sealant tape	$530,958,338	$4,553,989	0	0	$0	0	$0	0	0	$0
161	C11	Control of new benzene fugative emissions	$536,951,613	$1,810,742	0	0	$0	0	$0	0	0	$0
162	0	Ban asbestos in automatic transmission components	$718,643,539	$22,112	0	100	$22,112	0	$0	0	(0)	$22,112
163	C2	Arsenic emission control at primary copper smelters	$916,283,844	$43,916,371	0	0	$0	0	$0	0	0	$0
164	C7	Benzene emission control at service stations storage vessels	$979,446,774	$68,561,274	0	0	$0	0	$0	0	0	$0
165	0	Control of benzene equipment leaks	$1,053,522,581	$105,352,258	0	0	$0	0	$0	0	0	$0
166	C14	Radionuclide emission control at elemental phosphorous plants	$1,068,914,956	$26,338,065	0	0	$0	0	$0	0	0	$0
167	C4	Benzene emission control at bulk gasoline terminals	$1,679,051,613	$67,162,065	0	0	$0	0	$0	0	0	$0

Appendix B-1: Tengs/Graham

	A	B	C	D	E	F	G	H	I	J	K	L
	Compet-ing	Description	Marginal CL	Final Annual Costs at 100% Imp.	Final annual lives	Baseline % Imp.	Baseline Cost	Baseline Lives	Reallocation Spending	Reallocation Lives	Additional Lives Saved	$ Supplied for Reallocation
168	C5	Benzene emission control at chemical manufacturing process vents	$1,957,717,742	$3,915,435	0	0	$0	0	$0	0	0	$0
169	C2	Arsenic emission control at primary copper smelters	$2,301,221,198	$50,359,790	0	0	$0	0	$0	0	0	$0
170	C3	Benzene emission control at bulk gasoline plants	$2,448,616,935	$48,972,339	0	0	$0	0	$0	0	0	$0
171	C12	Radionuclide emission control at coal-fired industrial boilers	$2,746,683,871	$1,098,673,548	0	0	$0	0	$0	0	0	$0
172	0	Ban asbestos in acetylene cylinders	$3,832,765,540	$8,845	0	0	$0	0	$0	0	0	$0
173	0	Ban asbestos in missile liner	$4,554,531,310	$110,745,181	0	0	$0	0	$0	0	0	$0
174	C13	Radionuclide emission control at coal-fired utility boilers	$5,117,109,677	$5,117,109,677	1	0	$0	0	$0	0	0	$0
175	C5	Benzene emission control at chemical manufacturing process vents	$6,664,966,044	$54,569,177	0	0	$0	0	$0	0	0	$0
176	0	Ban asbestos in diaphragms	$15,546,543,284	$255,920,020	0	0	$0	0	$0	0	0	$0
177	C7	Benzene emission control at service stations storage vessels	$21,128,066,129	$279,841,935	0	0	$0	0	$0	0	0	$0
178	0	Radionuclide emission control at NRC-licensed & non-DOE facilities	$28,129,354,839	$2,821,935	0	0	$0	0	$0	0	0	$0
179	0	Radionuclide emission control at uranium fuel cycle facilities	$364,500,000,000	$36,450,000	0	0	$0	0	$0	0	0	$0
180	C1	Arsenic emission control at glass manufacturing plants	Dominated	$92,524,210	0	0	$0	0	$0	0	0	$0
181	C12	Radionuclide emission control at coal-fired industrial boilers	Dominated	$1,998,870,968	0	0	$0	0	$0	0	0	$0
182	C13	Radionuclide emission control at coal-fired utility boilers	Dominated	$5,173,548,387	0	0	$0	0	$0	0	0	$0
183	C4	Benzene emission control at bulk gasoline terminals	Dominated	$167,905,161	0	0	$0	0	$0	0	0	$0
184	C12	Radionuclide emission control at coal-fired industrial boilers	Extended dominance	$827,767,742	0	0	$0	0	$0	0	0	$0
185	C14	Radionuclide emission control at elemental phosphorous plants	Extended dominance	$975,919	0	0	$0	0	$0	0	0	$0

Appendix B-1: Tengs/Graham

	A	B	C	D	E	F	G	H	I	J	K	L
	Compet-ing	Description	Marginal CL	Final Annual Costs at 100% Imp.	Final annual lives	Baseline % Imp.	Baseline Cost	Baseline Lives	Reallocation Spending	Reallocation Lives	Additional Lives Saved	$ Supplied for Reallocation
186	C3	Benzene emission control at bulk gasoline plants	Extended dominance	$44,774,710	0	0	$0	0	$0	0	0	$0
187	C16	Radon emission control at Department of Energy facilities	Extended dominance	$1,763,710	0	100	$1,763,710	0	$0	0	0	$1,763,710
188		TOTAL					$21,351,519,816	56,715		117,622	60,906	$17,692,505,374

SUMMARY

Funds spent on "inefficient" interventions	Dollar Amount	% of total base $
—Threshold of efficiency at $8m/life	$2,642,043,049	12%
—Threshold of efficiency at $7m/life	$16,956,699,312	79%
—Threshold of efficiency at $5m/life	$17,070,185,847	80%
		% of total reallocation $
Funds made available for reallocation by fully funding negative cost interventions	$9,584,144,277	54%
Funds supplied by reducing or eliminating costly interventions	$8,108,361,097	46%
Additional lives saved by reallocation as per 1981 NHTSA study	12,487	

Appendix B-2
Table 1*
Key Additional Life Savers in Reallocation

Row # App. B-1	Description (#, Date of Estimate)	Percent Imp. in Baseline	Additional Lives Saved in Realloca-tion
22	Continuous (vs. nocturnal) oxygen for hypoxemic obstructive lung disease (#709, 1980)	49%	22,950
20	Influenza vaccine for all citizens (#455, 1981)	13%	19,205
41	Full (vs 50%) enforcement of nat'l 55 mph speed limit (#175, 1981)	3%	3,502
50	Radon remediation in homes with levels >8.11 pCi/L (#1267, 1991)	12%	2,955**
16	Media campaign to increase voluntary use of seatbelts (#175, 1981)	15%	2,805
44	Alcohol safety program for drunk drivers (#175, 1981)	8%	2,375
14	Mandatory seat belt use and child restraint law (#175, 1981)	85%	1,537
37	Driver & passenger non-motorized automatic (vs. manual) belts in light trucks (#1089, 1990)	5%	1,185***
13	Brady method screening for group B streptococci colonization during labor (#1220, 1990)	10%	1,107
	TOTAL		57,621

* All data derived from Graham/Tengs unpublished spreadsheet reproduced in Appendix B-1.

** Derived by subtracting 368 (number of lives saved in competing radon intervention—row 55) from 3,323 (lives saved in dominant radon intervention—row 50).

*** Derived by subtracting 103 and 16 (number of lives saved in competing seat belt interventions—rows 54 and 57, respectively) from 1,304 (lives saved in dominant intervention in cluster—row 37).

Appendix B-2
Table 2*
Key Fund Sources in Reallocation

Row # App. B-1	Description (#, Date of Estimate)	Funds Supplied for Reallocation	Percent of Funds Re-allocated
	Total funds reallocated	$17,692,505,374**	100.0%
	Funds supplied by fully implementing negative-cost	$9,584,144,277	54.0%
3	Ban residential growth in tsunami-prone areas (#1221, 1982)	$8,655,184,021	49.0%
4	1988 Safety Standard for concrete construction	$351,152,113	2.0%
6	Truss (vs. elective inguinal herniorrhaphy) for inguinal hernia in elderly patients (#148, 1977)	$317,196,000	1.8%
	Funds supplied by eliminating or reducing costly interventions	$8,108,361,097	46.0%
101	Ozone control for Southern California (partial elimination)	$4,233,074,235	23.9%
122	Flammability standard for children's clothing	$1,029,138,693	5.8%
139	Construct sea walls to protect against 100-year storm surges (#1221, 1982)	$576,022,732	3.3%
84	Widen lanes on rural roads	$509,008,193	2.9%
138	Staff school buses with adult monitors (#1124, 1989)	$351,251,057	2.0%

* From Appendix B-1, column L.
** From Appendix B-1, cell L188.

Appendix B-3a
Graham and Tengs Non-Toxic-Related Interventions

Compet-ing	Description	Marginal CL	Final Annual Costs	Final Annual Lives	Percent Imp.	Baseline Cost	Baseline Lives
0	Ban residential growth in tsunami-prone areas	($8,655,184,021)	($8,655,184,021)	1.0	0	$0	0.0
0	1988 (vs. 1971) safety standard for concrete construction	($3,224,537)	($390,169,014)	121.0	10	($39,016,901)	12.1
0	Install windshields with adhesive bonding (vs. rubber gaskets) in cars	($1,669,164)	($175,262,176)	105.0	100	($175,262,176)	105.0
0	Truss (vs. elective inguinal herniorrhaphy) for inguinal hernia in elderly patients	($1,387,013)	($320,400,000)	231.0	1	($3,204,000)	2.3
0	Flammability standard for children's sleepwear size 0–6X	($414,105)	($28,009,518)	67.6	95	($26,609,042)	64.3
0	Measles, mumps & rubella immunization for children	($291,406)	($284,412,061)	976.0	87	($246,016,433)	844.2
0	Smoking cessation advice for pregnant women who smoke	($213,719)	($72,237,187)	338.0	80	($57,789,750)	270.4

Appendix B-3a: Tengs/Graham

Competing	Description	Marginal CL	Final Annual Costs	Final Annual Lives	Percent Imp.	Baseline Cost	Baseline Lives
0	Terminate sale of 3-wheeled all-terrain vehicles	($93,190)	($13,792,176)	148.0	100	($13,792,176)	148.0
16	Driver automatic (vs. manual) belts in cars	($82,581)	($204,388,066)	2,475.0	0	$0	0.0
0	Brady method screening for group B streptococci colonization during labor	($1,356)	($1,667,518)	1,230.0	10	($166,752)	123.0
0	Mandatory seat belt use & child restraint law	$1,360	$13,939,330	10,248.0	85	$11,848,431	8,710.8
0	Sickle-cell screening for black newborns	$3,979	$226,786	57.0	80	$181,429	45.6
0	Media campaign to increase voluntary use of seat belts	$4,224	$13,939,330	3,300.0	15	$2,090,900	495.0
0	Public pedestrian safety information campaign	$6,925	$6,336,059	915.0	45	$2,851,227	411.8
0	Federal law requiring smoke detectors in homes	$7,637	$2,624,662	343.7	70	$1,837,264	240.6
0	Improve traffic safety information for children grades K–12	$9,841	$3,660,834	372.0	27	$970,121	98.6

Appendix B-3a: Tengs/Graham

Competing	Description	Marginal CL	Final Annual Costs	Final Annual Lives	Percent Imp.	Baseline Cost	Baseline Lives
0	Influenza vaccination for all citizens	$14,224	$312,181,614	21,948.1	13	$39,022,702	2,743.5
0	Require front & rear lights to be on when motorcycle is in motion	$15,360	$1,689,616	110.0	59	$996,873	64.9
0	Continuous (vs. nocturnal) oxygen for hypoxemic obstructive lung disease	$15,505	$697,722,772	45,000.0	49	$341,884,158	22,050.0
16	Driver & passenger automatic shoulder belt/knee pads (vs. manual belts) in cars	$23,080	$103,860,105	4,500.0	40	$41,544,042	1,800.0
0	Mammography every 3 years for women age 50–65	$28,979	$26,110,271	901.0	30	$7,833,081	270.3
0	Federal mandatory motorcycle helmet laws (vs. state-determined policies)	$34,657	$17,882,972	516.0	60	$10,729,783	309.6
0	Selective traffic enforcement programs at high-risk times & locations	$71,969	$300,470,009	4,175.0	78	$232,864,257	3,235.6
0	Motorcycle rider education program	$78,683	$2,675,225	34.0	5	$133,761	1.7

Appendix B-3a: Tengs/Graham

Competing	Description	Marginal CL	Final Annual Costs	Final Annual Lives	Percent Imp.	Baseline Cost	Baseline Lives
1	"American" oxygen depletion sensor system for gas space heaters	$81,098	$138,099	1.7	0	$0	0.0
0	1989 safety standard for underground gassy construction	$82,527	$165,055	2.0	0	$0	0.0
16	Driver & passenger automatic shoulder/ manual lap (vs. manual lap) belts in cars	$94,077	$755,440,415	8,030.0	45	$339,948,187	3,613.5
0	Women's Health Trial to evaluate low-fat diet in reducing breast cancer	$103,678	$57,437,427	554.0	0	$0	0.0
0	Computed tomography in patients with severe headache	$105,801	$22,747,134	215.0	48	$10,804,889	102.1
0	Screen blood donors for HIV	$110,831	$32,362,556	292.0	100	$32,346,374	291.9
0	Improve motorcycle testing & licensing system	$121,155	$10,419,297	86.0	98	$10,210,911	84.3
0	Insulate omnidirectional CB antennae to avert electrocution	$139,625	$1,116,998	8.0	100	$1,116,998	8.0

Appendix B-3a: Tengs/Graham

Competing	Description	Marginal CL	Final Annual Costs	Final Annual Lives	Percent Imp.	Baseline Cost	Baseline Lives
15	Driver & passenger non-motorized automatic (vs. manual) belts in light trucks	$152,446	$209,307,875	1,373.0	5	$10,465,394	68.7
0	Push-button release & emergency locking retractors on truck & bus seat belts	$196,415	$9,820,725	50.0	100	$9,820,725	50.0
1	"French" oxygen depletion sensor system for gas space heaters	$202,746	$345,247	1.7	100	$345,247	1.7
0	Full (vs. 50%) enforcement of national 55 mph speed limit	$220,492	$792,007,404	3,592.0	3	$19,800,185	89.8
0	Dual master cylinder braking system in cars	$220,821	$57,413,472	260.0	100	$57,413,472	260.0
0	Automatic fire extinguishers in airplane lavatory trash receptacles	$279,832	$881,472	3.2	98	$859,435	3.1
0	Alcohol safety programs for drunk drivers	$290,708	$746,246,976	2,567.0	8	$55,968,523	192.5

Appendix B-3a: Tengs/Graham

Compet-ing	Description	Marginal CL	Final Annual Costs	Final Annual Lives	Percent Imp.	Baseline Cost	Baseline Lives
0	Multimedia retraining courses for injury-prone drivers	$317,809	$11,123,304	35.0	28	$3,058,909	9.6
2	Strengthen unreinforced masonry San Francisco buildings to LA standards	$361,787	$3,762,581	10.4	5	$188,129	0.5
0	Require employers to ensure employees' motor vehicle safety	$439,827	$252,900,761	575.0	20	$50,580,152	115.0
0	Flammability standard for upholstered furniture	$512,837	$220,519,807	430.0	0	$0	0.0
0	Smoke detectors in airplane lavatories	$520,589	$1,405,591	2.7	98	$1,370,451	2.6
15	Driver & passenger motorized automatic (vs. manual) belts in light trucks	$557,607	$765,594,290	1,373.0	8	$57,419,572	103.0
0	Revised safety standard for underground non-gassy construction	$617,667	$2,161,836	3.5	0	$0	0.0
15	Driver airbag (vs. manual lap/shoulder belt) in light trucks	$632,762	$1,084,554,047	1,714.0	5	$54,227,702	85.7

Appendix B-3a: Tengs/Graham

Competing	Description	Marginal CL	Final Annual Costs	Final Annual Lives	Percent Imp.	Baseline Cost	Baseline Lives
0	Emergency signs, floor lighting, etc. (vs. upper lighting only) in airplanes	$731,080	$5,491,334	7.5	100	$5,491,334	7.5
0	Redesign chain saws to reduce rotational kickback injuries	$741,853	$7,121,791	9.6	99	$7,050,574	9.5
15	Driver & passenger airbags (vs. manual lap/shoulder belts) in light trucks	$754,852	$1,658,408,996	2,197.0	0	$0	0.0
0	Fiberglass fire-blocking airplane seat cushions	$795,433	$10,817,892	13.6	98	$10,547,444	13.3
0	Flammability standard for children's sleepwear size 7–14	$860,478	$23,280,638	27.1	75	$17,460,478	20.3
0	Workplace practice standard for electric power generation operation	$983,444	$25,569,542	26.0	0	$0	0.0
0	Pedestrian & bicycle visibility enhancement programs	$1,015,252	$115,738,682	114.0	1	$1,157,387	1.1

Appendix B-3a: Tengs/Graham

Compet-ing	Description	Marginal CL	Final Annual Costs	Final Annual Lives	Percent Imp.	Baseline Cost	Baseline Lives
0	Ceilings of 0–8500 lb light trucks withstand forces of 1.5 x vehicle's weight	$1,084,552	$8,893,329	8.2	92	$8,181,863	7.5
0	Automobile dummy acceleration (vs. side-door strength) tests	$1,092,466	$72,441,435	66.3	20	$14,488,287	13.3
0	Improve educational curriculum for beginning drivers	$1,166,755	$407,197,407	349.0	43	$173,058,898	148.3
0	Process safety standard for management of hazardous chemicals	$1,294,496	$274,433,226	212.0	10	$27,443,323	21.2
0	Lock out or tag out of machinery in repair	$1,641,141	$200,219,227	122.0	33	$65,071,249	39.7
0	Side structure improvements in cars to reduce door intrusion upon crash	$1,920,078	$921,637,306	480.0	100	$921,637,306	480.0
0	First aid training for drivers	$2,489,885	$244,008,681	98.0	10	$24,400,868	9.8
0	Annual mammography & breast exam for women age 40–49	$2,576,559	$403,972,351	156.8	2	$8,079,447	3.1

Appendix B-3a: Tengs/Graham

Competing	Description	Marginal CL	Final Annual Costs	Final Annual Lives	Percent Imp.	Baseline Cost	Baseline Lives
0	Side-door strength standard in light trucks to minimize front seat intrusion	$2,608,931	$268,719,848	103.0	54	$145,108,718	55.6
13	Widen lanes on rural roads to 11 (vs. 9) feet	$2,612,964	$1,454,309,122	556.6	35	$509,008,193	194.8
0	Seat back height of 24" (vs. 20") in school buses	$3,081,150	$7,394,759	2.4	10	$739,476	0.2
0	1,3 Butadiene exposure standard of 2 (vs. 1000) ppm PEL in polymer plants	$3,330,240	$4,107,042	1.2	40	$1,642,817	0.5
0	Front disk (vs. drum) brakes in cars	$4,202,137	$268,936,788	64.0	100	$268,936,788	64.0
0	Flammability standard for children's clothing size 0–6X	$4,306,973	$730,008,820	169.5	53	$383,254,631	89.0
16	Driver airbag/manual lap belt (vs. manual lap/ shoulder belt) in cars	$4,911,917	$2,387,191,710	486.0	0	$0	0.0
0	Equipment, work practices & training standard for hazardous waste cleanup	$5,386,489	$210,073,057	39.0	25	$52,518,264	9.8

Appendix B-3a: Tengs/Graham

Competing	Description	Marginal CL	Final Annual Costs	Final Annual Lives	Percent Imp.	Baseline Cost	Baseline Lives
0	Improve pedestrian education programs for school bus passengers grades K–6	$5,392,012	$17,254,438	3.2	95	$16,391,716	3.0
19	Full compliance with 1989 (vs. partial with 1971) safety standard for trenches	$5,802,721	$429,401,347	74.0	10	$42,940,135	7.4
0	Crossing control arms for school buses	$7,702,874	$18,486,898	2.4	63	$11,554,311	1.5
0	Signal arms on school buses	$8,216,399	$6,162,299	0.8	75	$4,621,724	0.6
0	Warning letters sent to problem drivers	$9,954,653	$9,954,653	1.0	78	$7,714,856	0.8
0	External loud speakers on school buses	$11,297,549	$13,557,058	1.2	3	$406,712	0.0
0	Side door strength standard in light trucks to minimize back seat intrusion	$14,514,795	$72,573,973	5.0	9	$6,858,240	0.5
14	Electronic sensors for school buses	$15,576,923	$112,153,846	7.2	2	$1,682,308	0.1

Appendix B-3a: Tengs/Graham

Competing	Description	Marginal CL	Final Annual Costs	Final Annual Lives	Percent Imp.	Baseline Cost	Baseline Lives
0	Ground fault circuit interrupters	$17,684,580	$21,557,503	1.2	55	$11,856,627	0.7
2	Strengthen unreinforced masonry San Francisco buildings to beyond LA standards	$18,225,000	$10,935,000	0.6	90	$9,841,500	0.5
0	Universal (vs. category-specific) precautions to prevent HIV transmission	$21,251,985	$403,788	0.0	60	$242,273	0.0
14	Mechanical sensors for school buses	$22,423,922	$161,452,240	7.2	2	$2,421,784	0.1
0	Flammability standard for children's clothing size 7–14	$28,981,394	$1,960,264,178	67.6	53	$1,029,138,693	35.5
0	Rear outboard & center (vs. outboard only) lap/shoulder belts in all cars	$33,867,478	$101,602,435	3.0	5	$5,080,122	0.2
0	Triple the wind resistance capabilities of new buildings	$44,735,170	$12,033,760,825	269.0	1	$120,337,608	2.7
0	Seat belts for passengers in school buses	$52,995,773	$52,995,773	1.0	3	$1,589,873	0.0

Appendix B-3a: Tengs/Graham

Compet-ing	Description	Marginal CL	Final Annual Costs	Final Annual Lives	Percent Imp.	Baseline Cost	Baseline Lives
0	Staff school buses with adult monitors	$93,666,948	$2,341,673,711	25.0	15	$351,251,057	3.8
0	Construct sea walls to protect against 100-year storm surge heights	$94,429,956	$5,760,227,320	61.0	10	$576,022,732	6.1
TOTAL						$5,694,105,666	48,381.2

Average cost per life saved	$117,693
Non-toxic-related spending: ratio of spending on high-cost (i.e. >$8 million per life) to total spending on non-toxic-related interventions	62.61%

Appendix B-3b
Graham and Tengs Toxic-Related Interventions—Baseline Scenario

Competing	Description	Marginal Cost per Life Saved	Final Annual Costs at 100% Imp.	Final Annual Lives at 100% Imp.	% Imp.	Baseline Cost	Baseline Lives
0	Reduce lead content of gasoline from 1.1 to 0.1 grams per leaded gallon	($1,881)	($9,595,396)	5,100.00	95	($9,115,626)	4,845.0
0	Ban asbestos in drum brake linings (A/M)	$146,166	$1,533,475	10.49	100	$1,533,475	10.5
0	Benzene exposure standard of 1 (vs. 10) ppm in rubber & tire industry	$179,529	$982,791	5.47	95	$933,652	5.2
0	Ban asbestos in brake blocks	$312,300	$311,781	1.00	100	$311,781	1.0
0	Ban asbestos in disk brake pads LMV (aftermarket)	$351,967	$629,089	1.79	100	$629,089	1.8
10	Radon remediation in homes with levels >8.11 pCi/L	$381,390	$1,432,118,343	3,755.00	12	$164,693,609	431.8
10	Radon remediation in homes with levels >4 pCi/L	$595,643	$1,906,057,034	3,200.00	12	$219,196,559	368.0
0	Ban asbestos in pipeline wrap	$706,063	$60,808	0.09	100	$60,808	0.1
C15	Radionuclide emission control at underground uranium mines	$855,132	$470,323	0.55	100	$470,323	0.6
0	Ban asbestos in specialty paper	$871,083	$2,211	0.00	100	$2,211	0.0

Appendix B-3b: Tengs/Graham

Competing	Description	Marginal Cost per Life Saved	Final Annual Costs at 100% Imp.	Final Annual Lives at 100% Imp.	% Imp.	Baseline Cost	Baseline Lives
0	Process safety standard for management of hazardous chemicals	$1,294,496	$274,433,226	212.00	10	$27,443,323	21.2
0	Ban asbestos in drum brake linings (OEM)	$1,349,407	$793,825	0.59	100	$793,825	0.6
0	Coke oven emission standard for iron- or steel-producing plants	$1,357,884	$12,220,956	9.00	10	$1,160,991	0.9
0	Ban asbestos in corrugated A/C sheet	$2,335,786	$16,584	0.01	100	$16,584	0.0
0	Ban asbestos in disk brake pads HV	$2,361,047	$35,379	0.01	100	$35,379	0.0
C11	Control of new benzene fugative emissions	$2,437,648	$199,887	0.08	100	$199,887	0.1
C10	Control of existing benzene fugative emissions	$2,579,188	$799,548	0.31	100	$799,548	0.3
C15	Radionuclide emission control at underground uranium mines	$3,135,484	$940,645	0.70	0	$0	0.0
0	1,3 Butadiene exposure standard of 2 (vs. 1,000) ppm PEL in polymer plants	$3,330,240	$4,107,042	1.23	40	$1,642,817	0.5
0	Ban asbestos in flat A/C sheet	$3,661,336	$190,164	0.05	100	$190,164	0.1

Appendix B-3b: Tengs/Graham

Competing	Description	Marginal Cost per Life Saved	Final Annual Costs at 100% Imp.	Final Annual Lives at 100% Imp.	% Imp.	Baseline Cost	Baseline Lives
0	Benzene emission control at pharmaceutical manufacturing plants	$4,930,801	$152,855	0.03	100	$152,855	0.0
0	Equipment, work practices & training standard for hazardous waste cleanup	$5,386,489	$210,073,057	39.00	25	$52,518,264	9.8
0	Ban asbestos in disk brake pads LMV (OEM)	$5,534,737	$385,856	0.07	100	$385,856	0.1
0	Ban asbestos in roofing felt	$5,975,754	$446,665	0.07	100	$446,665	0.1
0	Ban asbestos in friction materials	$6,274,235	$227,755	0.04	100	$227,755	0.0
C2	Arsenic emission control at primary copper smelters	$6,401,613	$576,145	0.09	100	$576,145	0.1
0	South Coast of California ozone control program	$7,567,779	$15,135,557,621	2,000.00	95	$14,303,101,952	1,890.0
0	Radionuclide emission control at Department of Energy facilities	$7,838,710	$235,161	0.03	0	$0	0.0
0	Ban asbestos in non-roofing coatings	$8,511,979	$250,972	0.03	100	$250,972	0.0
0	Government buy-out of Times Beach residents due to dioxin contamination	$9,565,788	$6,256,007	0.65	100	$6,256,007	0.7
0	Ban asbestos in millboard	$10,023,518	$570,492	0.06	100	$570,492	0.1

Appendix B-3b: Tengs/Graham

Competing	Description	Marginal Cost per Life Saved	Final Annual Costs at 100% Imp.	Final Annual Lives at 100% Imp.	% Imp.	Baseline Cost	Baseline Lives
C6	Benzene emission control at coke by-product recovery plants	$11,480,695	$22,387,355	1.95	100	$22,387,355	2.0
C1	Arsenic emission control at glass manufacturing plants	$14,501,613	$4,785,532	0.33	100	$4,785,532	0.3
0	Vinyl chloride emission control at EDC/VC and PVC plants	$16,776,339	$175,312,742	10.45	100	$175,312,742	10.5
0	Ban asbestos in beater-add gaskets	$23,720,662	$10,828,300	0.46	100	$10,828,300	0.5
0	Formaldehyde exposure standard of 1 (vs. 3) ppm in wood industry	$28,784,262	$40,567,285	1.41	50	$20,283,643	0.7
0	Ban asbestos in clutch facings	$28,856,627	$1,208,427	0.04	100	$1,208,427	0.0
C8	Benzene emission control during transfer operations	$39,233,542	$38,448,871	0.98	100	$38,448,871	1.0
0	Radionuclide emission control at surface uranium mines	$42,371,404	$940,645	0.02	0	$0	0.0
0	Dioxin emission standard of 5 lbs/air dried ton at pulp mills	$51,028,086	$84,196,343	1.65	25	$21,049,086	0.4
C16	Radon emission control at Department of Energy facilities	$54,870,968	$3,292,258	0.06	0	$0	0.0
0	Ban asbestos in roof coatings	$56,810,924	$8,361,694	0.15	100	$8,361,694	0.1
C14	Radionuclide emission control at elemental phosphorous plants	$58,790,323	$2,821,935	0.05	100	$2,821,935	0.0
0	Ban asbestos in sheet gaskets	$61,663,811	$9,473,933	0.15	100	$9,473,933	0.2

Appendix B-3b: Tengs/Graham

Competing	Description	Marginal Cost per Life Saved	Final Annual Costs at 100% Imp.	Final Annual Lives at 100% Imp.	% Imp.	Baseline Cost	Baseline Lives
0	Ban asbestos in packing	$61,778,129	$54,175	0.00	0	$0	0.0
0	Ban asbestos in A/C pipe	$64,151,319	$19,738,374	0.31	100	$19,738,374	0.3
0	Ban asbestos in beater-add gaskets/2	$69,242,870	$5,577,779	0.08	0	$0	0.0
0	Arsenic emission control at secondary lead plants	$82,396,898	$21,423,194	0.26	0	$0	0.0
0	Ban asbestos in reinforced plastics	$88,774,900	$4,486,547	0.05	0	$0	0.0
C14	Radionuclide emission control at elemental phosphorous plants	$98,095,853	$3,433,355	0.04	0	$0	0.0
0	Chloroform reduction hypochlorite with chlorine dioxide at 70 mills	$98,674,550	$62,164,966	0.63	80	$49,731,973	0.5
C14	Radionuclide emission control at elemental phosphorous plants	$103,862,903	$4,056,532	0.04	0	$0	0.0
0	Acrylonitrile emission control via best available technology	$105,843,749	$12,701,250	0.12	0	$0	0.0
0	Ban asbestos in A/C shingles	$110,689,635	$3,500,347	0.03	100	$3,500,347	0.0
0	Radionuclide emission control at operating uranium mill tailings	$117,580,645	$587,903	0.01	100	$587,903	0.0
0	Benzene emission control at ethylbenzene/styrene process vents	$152,854,839	$305,710	0.00	0	$0	0.0
C9	Control of benzene storage vessels	$152,854,839	$152,855	0.00	0	$0	0.0

Appendix B-3b: Tengs/Graham

Competing	Description	Marginal Cost per Life Saved	Final Annual Costs at 100% Imp.	Final Annual Lives at 100% Imp.	% Imp.	Baseline Cost	Baseline Lives
0	Ban asbestos in high grade electrical paper	$165,455,468	$6,499,854	0.04	0	$0	0.0
C9	Control of benzene storage vessels	$181,074,194	$1,963,597	0.04	0	$0	0.0
0	Ban asbestos in sheet gaskets/PTFE	$205,261,954	$3,503,664	0.02	0	$0	0.0
0	Benzene emission control during waste operations	$210,170,059	$115,593,532	0.55	100	$115,593,532	0.6
0	Benzene emission control at maleic anhydride plants	$220,463,710	$881,855	0.00	0	$0	0.0
0	Radionuclide control via best available technology in phosphorous mines	$283,051,835	$4,811,881	0.02	0	$0	0.0
0	Radionuclide emission control at phosphogypsum stacks	$315,997,984	$50,559,677	0.16	0	$0	0.0
0	Ban asbestos in thread, yarn, etc.	$367,637,799	$17,595,711	0.05	0	$0	0.0
C6	Benzene emission control at coke by-product recovery plants	$419,762,903	$30,782,613	1.97	0	$0	0.0
0	Radionuclide emission control during disposal of uranium mill tailings piles	$427,565,982	$18,812,903	0.04	0	$0	0.0
C8	Benzene emission control during transfer operations	$466,046,921	$43,575,387	0.99	0	$0	0.0

Appendix B-3b: Tengs/Graham

Competing	Description	Marginal Cost per Life Saved	Final Annual Costs at 100% Imp.	Final Annual Lives at 100% Imp.	% Imp.	Baseline Cost	Baseline Lives
C10	Control of existing benzene fugative emissions	$473,682,028	$7,431,097	0.32	0	$0	0.0
0	Ban asbestos in sealant tape	$530,958,338	$4,553,989	0.01	0	$0	0.0
C11	Control of new benzene fugative emissions	$536,951,613	$1,810,742	0.09	0	$0	0.0
0	Ban asbestos in automatic transmission components	$718,643,539	$22,112	0.00	100	$22,112	0.0
C2	Arsenic emission control at primary copper smelters	$916,283,844	$43,916,371	0.14	0	$0	0.0
C7	Benzene emission control at service stations storage vessels	$979,446,774	$68,561,274	0.07	0	$0	0.0
0	Control of benzene equipment leaks	$1,053,522,581	$105,352,258	0.10	0	$0	0.0
C14	Radionuclide emission control at elemental phosphorous plants	$1,068,914,956	$26,338,065	0.07	0	$0	0.0
C4	Benzene emission control at bulk gasoline terminals	$1,679,051,613	$67,162,065	0.04	0	$0	0.0
C5	Benzene emission control at chemical manufacturing process vents	$1,957,717,742	$3,915,435	0.00	0	$0	0.0
C2	Arsenic emission control at primary copper smelters	$2,301,221,198	$50,359,790	0.14	0	$0	0.0

Appendix B-3b: Tengs/Graham

Competing	Description	Marginal Cost per Life Saved	Final Annual Costs at 100% Imp.	Final Annual Lives at 100% Imp.	% Imp.	Baseline Cost	Baseline Lives
C3	Benzene emission control at bulk gasoline plants	$2,448,616,935	$48,972,339	0.02	0	$0	0.0
C12	Radionuclide emission control at coal-fired industrial boilers	$2,746,683,871	$1,098,673,548	0.40	0	$0	0.0
0	Ban asbestos in acetylene cylinders	$3,832,765,540	$8,845	0.00	0	$0	0.0
0	Ban asbestos in missile liner	$4,554,531,310	$110,745,181	0.02	0	$0	0.0
C13	Radionuclide emission control at coal-fired utility boilers	$5,117,109,677	$5,117,109,677	1.00	0	$0	0.0
C5	Benzene emission control at chemical manufacturing process vents	$6,664,966,044	$54,569,177	0.01	0	$0	0.0
0	Ban asbestos in diaphragms	$15,546,543,284	$255,920,020	0.02	0	$0	0.0
C7	Benzene emission control at service stations storage vessels	$21,128,066,129	$279,841,935	0.08	0	$0	0.0
0	Radionuclide emission control at NRC-licensed & non-DOE facilities	$28,219,354,839	$2,821,935	0.00	0	$0	0.0
0	Radionuclide emission control at uranium fuel cycle facilities	$364,500,000,000	$36,450,000	0.00	0	$0	0.0
C1	Arsenic emission control at glass manufacturing plants	Dominated	$92,524,210	0.17	0	$0	0.0

Appendix B-3b: Tengs/Graham

Competing	Description	Marginal Cost per Life Saved	Final Annual Costs at 100% Imp.	Final Annual Lives at 100% Imp.	% Imp.	Baseline Cost	Baseline Lives
C12	Radionuclide emission control at coal-fired industrial boilers	Dominated	$1,998,870,968	0.20	0	$0	0.0
C13	Radionuclide emission control at coal-fired utility boilers	Dominated	$5,173,548,387	0.20	0	$0	0.0
C4	Benzene emission control at bulk gasoline terminals	Dominated	$167,905,161	0.04	0	$0	0.0
C16	Radon emission control at Department of Energy facilities	Extended dominance	$1,763,710	0.03	100	$1,763,710	0.0
C12	Radionuclide emission control at coal-fired industrial boilers	Extended dominance	$827,767,742	0.30	0	$0	0.0
C14	Radionuclide emission control at elemental phosphorous plants	Extended dominance	$975,919	0.01	0	$0	0.0
C3	Benzene emission control at bulk gasoline plants	Extended dominance	$44,774,710	0.01	0	$0	0.0
	TOTAL					$15,281,384,831	7,605.4

Appendix B-3b: Tengs/Graham

Average cost per life saved	$2,009,270
Spending on high-cost (cost per life >$8 million) as % of total spending on toxics	3.36%
Combined compliance costs from interventions to control 7 substances (arsenic, asbestos, benzene, ozone, radionuclides, radon, and vinyl chloride)	$15,107,554,735
% of total toxic spending in sample accounted for by 7 substances	98.86%

Appendix C
Hahn Table of Net Benefits

Cites are to Federal Register: "58FR131" means Volume 58 of Federal Register, page 131. The letter "F" in the "Status" column indicates a final rule; "P" indicates a proposed rule. The date in the sixth column refers to the effective date of the final rule (in the case of final rules) and the date proposed (in the case of proposed rules).

The entries (apart from amendments in brackets) are those supplied by Robert Hahn, the original author of this table. A brief spot check of Hahn's entries has revealed many errors: incorrect cites, missing cites, erroneous dates, confusion of final with proposed rules, etc. The cites listed below are those supplied by Hahn, with corrections supplied in brackets where spot checks revealed clear errors.

	Agency	Dept.	Regulation	Status	Cite/Date	Costs—Final ($ million)	Benefits—Final ($ million)	Net Benefits ($ million)
1	CPSC		Childproof Lighters	F	[58FR37554] 1993	$688	$5,942	$5,254
2	DOL	MSHA	Safety standards for explosives at metal and non-metal mines	F	58FR69596 1993	$21	$80	$59
3	DOL	MSHA	Safety standards for ventilation in underground coal mines	F	57FR20868 1992	$295	$386	$91
4	DOL	OSHA	Occupational exposure to asbestos	F	59FR40964 1994	$4,454	$542	($3,912)

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	Agency	Dept.	Regulation	Status	Cite/Date	Costs—Final ($ million)	Benefits—Final ($ million)	Net Benefits ($ million)
5	DOL	OSHA	Lead exposure in construction (interim final rule)	F	58FR26590 1993	$6,636	$6,803	$167
6	DOL	OSHA	Occupational exposure to cadmium (two standards)	F	57FR42102 1992	$2,599	$524	($2,075)
7	DOL	OSHA	Occupational exposure to 4,4' methylenedianiline	F	57FR35630 1992	$177	$30	($147)
8	DOL	OSHA	Bloodborne pathogens	F	56FR235 1991	$13,650	$42,217	$28,567
9	DOL	OSHA	Hazardous waste operations and emergency response	F	54FR9294 1989	$2,868	$3,145	$277
10	DOL	OSHA	Occupational exposure to formaldehyde	F	52FR42168 1987	$1,516	$12	($1,504)
11	DOL	OSHA	Standard for occupational exposure to benzene	F	52FR34460 1987	$584	$243	($341)
12	DOL	OSHA	Occupational exposure to asbestos	F	51FR22612 1986	$11,298	$1,435	($9,863)

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	Agency	Dept.	Regulation	Status	Cite/Date	Costs—Final ($ million)	Benefits—Final ($ million)	Net Benefits ($ million)
13	DOL	OSHA	Permit required confined spaces	F	58FR4462 1993	$2,948	$8,561	$5,612
14	DOL	OSHA	Process safety management of highly hazardous chemicals	F	57FR36 1992	($10,891)	$15,236	$26,127
15	DOL	OSHA	Electrical safety-related work practices	F	55FR31984 1990	$564	$7,258	$6,694
16	DOL	OSHA	Control of hazardous energy (lockout/tagout)	F	54FR36634 1989	$829	$41,952	$41,123
17	DOL	OSHA	Underground construction	F	54FR23824 1989	$35	$508	$473
18	DOL	OSHA	Concrete and masonry construction safety standards	F	53FR22612 1988	($7,124)	$7,555	$14,679
19	DOL	OSHA	Mechanical power press standard (part 1910.217)	F	53FR8322 1988	($2,452)	-	$2,452
20	DOL	OSHA	Grain handling facilities	F	52FR49592 1987	$428	$1,689	$1,260

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	Agency	Dept.	Regulation	Status	Cite/Date	Costs—Final ($ million)	Benefits—Final ($ million)	Net Benefits ($ million)
21	DOT	FAA	Computer operations and general certification and operations requirements	F	[60FR65832] 1995	($401)	-	$401
22	DOT	NHTSA	FMVSS: Stability and Control of Medium and Heavy Vehicles During Braking	F	58FR50738 1993	$2,335	$32,010	$29,676
23	DOT	NHTSA	Head impact protection (FMVSS 201)	F	?	$7,352	$40,842	$33,490
24	DOT	NHTSA	Center high mount stop lamp on vehicles other than passenger cars	F	56FR16015 1991	($521)	$7,555	$8,076
25	DOT	NHTSA	Extension of automatic crash requirements to light trucks	F	56FR12472 1991	$15,574	$94,133	$78,559
26	DOT	NHTSA	Side impact protection (FMVSS 214)	F	55FR45722 1990	$871	$43,098	$42,227
27	DOT	NHTSA	Federal motor vehicle standard, occupant crash protection	F	49FR28962 1984	$12,710	$779,739	$767,029

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	Agency	Dept.	Regulation	Status	Cite/Date	Costs—Final ($ million)	Benefits—Final ($ million)	Net Benefits ($ million)
28	DOT	USCG	Vessel response plans	F	[61FR1052] 1996	$4,773	-	($4,773)
29	DOT	USCG	Double hull standards for vessels carrying oil in bulk	F	60FR13318 1995	$10,364	-	($10,364)
30	EPA	CAA	Municipal solid waste landfills: EG and NSPS	F	61FR9905 1996	$2,198	$1,768	($430)
31	EPA	CAA	Federal Standards for marine vessel loading and unloading operations	F	60FR48388 1995	$959	$548	($411)
32	EPA	CAA	Municipal waste combustors: EG + NSPS	F	60FR65381 1995	$9,029	$2,182	($6,847)
33	EPA	CAA	Ozone transport commission: low emission vehicle program for the Northeast Ozone Transport Region	F	[60FR4712] 1995	$4,950	$1,598	($3,352)
34	EPA	CAA	NESHAP: petroleum refining operations	F	[60FR43244] 1995	$1,052	$3,027	$1,975

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	Agency	Dept.	Regulation	Status	Cite/Date	Costs—Final ($ million)	Benefits—Final ($ million)	Net Benefits ($ million)
35	EPA	CAA	Control of air pollution from new motor vehicles and new motor vehicle engines	F	59FR16262 1994	$248	$4,812	$4,564
36	EPA	CAA	Fuel and fuel additives: standards for reformulated gasoline	F	[59FR7716] 1994	$10,930	$2,635	($8,294)
37	EPA	CAA	Hazardous waste, treatment, and disposal facilities: Organic Air Emission Standards	F	59FR62896 1994	$1,733	$15,430	$13,697
38	EPA	CAA	Acid rain NOx regulations under title IV of the CAAA of 1990	F	59FR13538 1994	$3,008	$17,874	$14,866
39	EPA	CAA	Clean fuel fleet program requirements for vehicle conversions	F	59FR50042 1994	$1,054	$70	($984)
40	EPA	CAA	Determination of significance for nonroad sources and emission standards for new nonroad compression-ignition engines	F	59FR31306 1994	$1,233	$10,584	$9,351

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	Agency	Dept.	Regulation	Status	Cite/Date	Costs—Final ($ million)	Benefits—Final ($ million)	Net Benefits ($ million)
41	EPA	CAA	Equivalent emissions limitations under CAA section 112(J)	F	59FR26429 1994	$325	$55	($270)
42	EPA	CAA	Fuels and fuel additives registration regulations	F	59FR33042 1994	$300	-	($300)
43	EPA	CAA	Hazardous organic NESHAP (HON) for the synthetic organic chemical manufacturing industry	F	59FR19402 1994	$3,858	$14,869	$11,011
44	EPA	CAA	Interim requirements for deposit control gasoline additives: regulation of fuels and additives	F	59FR54678 1994	$897	$1,598	$701
45	EPA	CAA	Regulation of fuels and fuel additives: renewable oxygenate requirements for reformulated gasoline	F	59FR39258 1994	$505	-	($505)

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	Agency	Dept.	Regulation	Status	Cite/Date	Costs—Final ($ million)	Benefits—Final ($ million)	Net Benefits ($ million)
46	EPA	CAA	Control of air pollution from new motor vehicles and new motor vehicle engines: regulations requiring onboard diagnostic systems	F	58FR9468 1993	$19,117	$8,343	($10,774)
47	EPA	CAA	Criteria and procedures for determining conformity to state or federal	F	58FR62188 1993	$251	-	($251)
48	EPA	CAA	Determining conformity of general federal actions to state or federal implementation plans	F	58FR63214 1993	$1,286	-	($1,286)
49	EPA	CAA	Evaporative emission regulations for gasoline-fueled and methanol-fueled light-duty vehicles, light-duty trucks, and heavy-duty vehicles	F	58FR16002 1993	$1,619	$8,404	$6,785
50	EPA	CAA	Acid rain permits, allowance system, emissions monitoring	F	58FR3590 1993	$22,045	$70,695	$48,650

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	Agency	Dept.	Regulation	Status	Cite/Date	Costs—Final ($ million)	Benefits—Final ($ million)	Net Benefits ($ million)
51	EPA	CAA	Operating permits regulations title V of the CAA	F	57FR32250 1992	$7,777	-	($7,777)
52	EPA	CAA	Vehicle inspection and maintenance requirements for state implementation plans	F	57FR52950 1992	$4,442	$4,707	$265
53	EPA	CAA	[Gaseous and particulate emission regulations for 1994 and later model year light-duty vehicles and light-duty trucks]	F	56FR25724 1991	$28,613	$7,555	($21,058)
54	EPA	CAA	NESHAP: Benzene emissions from benzene transfer operations	F	55FR8292 1990	$512	$110	($402)
55	EPA	CAA	NESHAP: Benzene emissions from benzene waste operations	F	55FR8292 1990	$1,735	$121	($1,614)
56	EPA	CAA	Fuel quality for diesel fuel sold in 1993 and later	F	54FR35276 1989	$2,047	$46,681	$44,633
57	EPA	CAA	Volatility regulations for gasoline and alcohol blends sold in calendar year 1992 and beyond	F	55FR23658 1990	$3,447	$18,865	$15,418

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	Agency	Dept.	Regulation	Status	Cite/Date	Costs—Final ($ million)	Benefits—Final ($ million)	Net Benefits ($ million)
58	EPA	CAA	Volatility regulations for gasoline and alcohol blends: 1989	F	54FR11868 1989	$1,217	$13,121	$11,904
59	EPA	CAA	NESHA: proposed response to remand for benzene storage vessles	F	54FR38044 1989	$2	$9	$8
60	EPA	CAA	NESHA: proposed response to remand for coke by-product recovery plants	F	54FR38044 1989	$311	$2,245	$1,934
61	EPA	CAA	NSPS for new residential wood heaters	F	53FR5860 1988	($478)	$63,804	$64,282
62	EPA	CAA	NSPS: Industrial-commercial-institutional steam-generating units	F	52FR47826 1987	$581	$5,877	$5,297
63	EPA	CAA	Regulation of fuels and fuel additives, gasoline lead content	F	50FR9386 1985	($16,618)	$359,196	$375,814

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	Agency	Dept.	Regulation	Status	Cite/Date	Costs—Final ($ million)	Benefits—Final ($ million)	Net Benefits ($ million)
64	EPA	CAA	NOx emissions standards for light duty trucks and heavy duty engines	F	50FR10606 1985	$7,504	$27,549	$20,045
65	EPA	CERCLA	EPCRA section 313: proposed addition of chemicals	F	59FR61432 1994	$688	-	($688)
66	EPA	CERCLA	National oil and hazardous substances pollution contingency plans	F	55FR8666 1990	$21,241	-	($21,241)
67	EPA	CERCLA	EPCRA section 313: toxic chemical release inventory reporting	F	53FR4500 1988	$7,797	-	($7,797)
68	EPA	CERCLA	EPCRA section 311 and 312: emergency and hazardous chemical release planning	F	52FR38344 1987	$1,803	-	($1,803)
69	EPA	CERCLA	National oil and hazardous substances contingency plan	F	[47FR31180] 1982	$2,513	-	($2,513)

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	Agency	Dept.	Regulation	Status	Cite/Date	Costs—Final ($ million)	Benefits—Final ($ million)	Net Benefits ($ million)
70	EPA	CWA	Water quality guidance for the Great Lakes system	F	[60FR15366] 1995	$2,764	$12	($2,752)
71	EPA	CWA	Oil pollution prevention: non-transportation-related onshore facilities	F	[59FR34070] 1994	$251	-	($251)
72	EPA	CWA	Oil and point source category, offshore subcategory	F	[58FR12454] 1993	$1,154	$524	($630)
73	EPA	CWA	Coastal nonpoint pollution control program development	F	58FR5182 1993	$5,590	-	($5,590)
74	EPA	CWA	Sewage sludge use and disposal regulations—40 CFR § 503	F	[58FR9248] 1993	$646	$10	($636)
75	EPA	CWA	Organic chemicals, plastics and synthetic fibers point source category effluent limitation guidelines, pretreatment standards and NSPS	F	52FR42522 1987	$11,231	$637	($10,594)

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	Agency	Dept.	Regulation	Status	Cite/Date	Costs—Final ($ million)	Benefits—Final ($ million)	Net Benefits ($ million)
76	EPA	CWA	Electroplating and metal finishing point source categories: effluent limitation guidelines, etc.	F	48FR32462 1983	$4,046	-	($4,046)
77	EPA	CWA	Iron and steel manufacturing point source category-effluent limitation guidelines, etc.	F	[49FR21024] 1984	$4,541	-	($4,541)
78	EPA	FIFRA	Worker protection standard for agricultural pesticides	F	57FR38102 1992	$875	-	($875)
79	EPA	FIFRA	Data requirements for registration (alternative 2—chosen option)	F	[49FR42856] 1984	$6,689	-	($6,689)
80	EPA	RCRA	Land disposal restrictions phase II, universal treatment standards	F	59FR47982 1994	$1,884	$6	($1,877)
81	EPA	RCRA	Solid waste disposal facility, 40 CFR §§ 257–58	F	56FR50978 1991	$2,423	$0	$2,422
82	EPA	RCRA	Hazardous waste management system—wood preservatives	F	55FR50450 1990	$229	$14	($216)

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	Agency	Dept.	Regulation	Status	Cite/Date	Costs—Final ($ million)	Benefits—Final ($ million)	Net Benefits ($ million)
83	EPA	RCRA	Land disposal restrictions for third third scheduled waste	F	55FR22520 1990	$8,580	$137	($8,443)
84	EPA	RCRA	[Toxicity Characteristics Revisions]	F	55FR11798 1990	($6,310)	$2	$6,312
85	EPA	RCRA	Hazardous waste management system-reportable quantities petroleum refinery primary and secondary sludge listings	F	55 FR46354 1990	$1,830	-	($1,830)
86	EPA	RCRA	Prohibit the land disposal of the first third of scheduled wastes	F	53FR11742 1988	$20,089	$149	($19,939)
87	EPA	RCRA	USTs: technical requirements	F	53FR37082 1988	($8,393)	$57	$8,450
88	EPA	RCRA	RCRA financial responsibility requirements for USTs	F	53FR43322 1988	$443	-	($443)
89	EPA	RCRA	Hazardous waste management system: land disposal restrictions	F	52FR25760 1987	$2,186	-	($2,186)

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	Agency	Dept.	Regulation	Status	Cite/Date	Costs—Final ($ million)	Benefits—Final ($ million)	Net Benefits ($ million)
90	EPA	RCRA	Hazardous waste management system: final solvents and dioxin	F	51FR40572 1986	$3,877	$58	($3,819)
91	EPA	SDWA	Drinking water regulations, synthetic organic chemicals—phase V	F	57FR31776 1992	$846	-	($846)
92	EPA	SDWA	Drinking water: lead and copper	F	56FR26460 1991	$10,261	$46,086	$35,826
93	EPA	SDWA	National primary and secondary water regulations—Phase II: MCL	F	56FR3526 1991	$16,609	$1,987	($14,622)
94	EPA	SDWA	National primary drinking water regulations: MCLGs for 30 synthetic organic and 8 inorganic chemicals [notice of proposed rulemaking]	[F]	54FR22062 1989	$13,050	-	($13,050)
95	EPA	SDWA	National primary drinking water regulations: total coliform	F	54 FR27544 1989	$2,822	-	($2,822)

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	Agency	Dept.	Regulation	Status	Cite/Date	Costs—Final ($ million)	Benefits—Final ($ million)	Net Benefits ($ million)
96	EPA	TSCA	Asbestos, manufacture, importation, processing, and distribution in commerce prohibitions	F	54FR29460 1989	$1,435	$223	($1,212)
97	EPA	TSCA	Asbestos-containing materials in school rule	F	[52FR41826] 1987	$10,114	-	($10,114)
98	EPA	TSCA	PCB manufacture, processing, distribution in commerce and use	F	[4 different rules may correspond to this truncated title]	$1,492	-	($1,492)
99	EPA	TSCA	Premanufacture notification and review procedures	F	48FR21722 1983	$585	-	($585)
100	HHS	FDA	Seafood HACCP	F	60FR6509 1995	$279	-	($279)
101	HHS	FDA	Food labeling regulations	F	58FR2927 1993	$2,583	$23,850	$21,267

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	Agency	Dept.	Regulation	Status	Cite/Date	Costs—Final ($ million)	Benefits—Final ($ million)	Net Benefits ($ million)
102	HHS	HCFA	Clinical Laboratory Improvement Amendments of 1988 (CLIA)	F	57FR7002 1992	$25,633	-	($25,633)
103	HUD	OH	Manufactured home construction and safety standards	F	59FR2456 1994	($920)	$114	$1,034
104	USDA	APHIS	Animal welfare regulations (part 3)—specifications for the human	F	[54FR20669] 1989	$1,208	-	($1,208)
105	USDA	APHIS	Animal welfare regulations (parts 1 & 2)	F	[52FR29865] 1987	$928	-	($928)
106	USDA	FSI	Nutrition labeling of meat and poultry products	F	[no final rule on point issued in 1992 as per Hahn table]	$333	$18,925	$18,592
107	DOL	OSHA	Respiratory protection standard	P	5/13/78	$1,225	$4,295	$3,071
108	DOL	OSHA	Occupational exposure to 2-methoxyethanol, etc.	P	3/22/89	$144	-	($144)

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	Agency	Dept.	Regulation	Status	Cite/Date	Costs—Final ($ million)	Benefits—Final ($ million)	Net Benefits ($ million)
109	DOL	OSHA	Occupational exposure to methylene chloride (25 ppm standard)	P	11/6/87	$1,375	$294	($1,081)
110	DOL	OSHA	Walking and working surfaces [clarification of regulation]	P	4/9/86	$1,752	$38,784	$37,032
111	DOT	FRA	Roadway worker protection	P	3/13/92	$84	$200	$116
112	DOT	NHTSA	Side impact protection, light trucks, buses, and multipurpose passenger vehicles	P	6/14/90	$2,983	$2,654	($329)
113	DOT	USCG	Structural and operational measures to reduce oil spills from existing tank vessels without double hulls	P	11/2/91	$668	-	($668)
114	EPA	CAA	Acid rain phase II: NOx emission reduction program	P	1/18/92	$1,537	$8,624	$7,087
115	EPA	CAA	Revised standards for hazardous waste combustors	P	4/18/92	$1,356	$471	($885)

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	Agency	Dept.	Regulation	Status	Cite/Date	Costs—Final ($ million)	Benefits—Final ($ million)	Net Benefits ($ million)
116	EPA	CAA	Control of air pollution from new motor vehicles	P	10/9/91	$8,069	$4,193	($3,876)
117	EPA	CAA	Revisions to the federal test procedure (FTP) for emissions	P	2/6/91	$2,429	$6,204	$3,776
118	EPA	CAA	Medical waste incinerators—NSPS and EG	P	2/26/91	$4,802	$2,344	($2,457)
119	EPA	CAA	List of regulated substances and thresholds for accidental release	P	1/30/90	($11,359)	$7,100	$18,459
120	EPA	CAA	Emission standards for new nonroad spark-ignition engines	P	5/15/90	$623	$3,356	$2,733
121	EPA	CAA	Emissions standards for new gasoline spark-ignition and diesel engines	P	1/18/90	$4,118	$5,914	$1,796
122	EPA	CAA	Requirements for constructed, reconstructed, or modified major sources	P	3/31/90	$301	$43	($258)

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	Agency	Dept.	Regulation	Status	Cite/Date	Costs—Final ($ million)	Benefits—Final ($ million)	Net Benefits ($ million)
123	EPA	CAA	Effluent limitations guidelines, pretreatment standards, and new source performance standards for pulp and paper industry	P	12/16/89	$6,636	$8,422	$1,786
124	EPA	CWA	Metal product and machinery effluent guidelines, pretreatment standards, etc.	P	5/29/91	$1,570	$59	($1,511)
125	EPA	CWA	Pharmaceutical manufacturing industry effluent guidelines and standards	P	5/1/91	$1,446	$19	($1,427)
126	EPA	CWA	Pesticide chemicals point source category, reformulating, packaging, and repackaging effluent limitations guidelines, pretreatment standards, and new source performance standards	P	4/13/90	$374	-	($374)

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	Agency	Dept.	Regulation	Status	Cite/Date	Costs—Final ($ million)	Benefits—Final ($ million)	Net Benefits ($ million)
127	EPA	CWA	Oil pollution prevention: non-transportation-related onshore and offshore facilities	P	10/21/87	($1,305)	-	$1,305
128	EPA	RCRA	Land disposal restrictions, phase IV: issues associated with Clean Water Act treatment equivalency, and treatment standards for wood-preserving wastes and toxicity characteristic metal wastes, part II	P	8/21/91	$945	$11	($934)
129	EPA	RCRA	Corrective action for Solid Waste Management Units (SWMUs) at hazardous waste management facilities	P	7/26/86	$14,626	$713	($13,914)
130	EPA	SDWA	Enhanced surface water treatment requirements (interim stage 2)	P	7/28/90	$7,163	-	($7,163)

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	Agency	Dept.	Regulation	Status	Cite/Date	Costs—Final ($ million)	Benefits—Final ($ million)	Net Benefits ($ million)
131	EPA	SDWA	Primary drinking water regulations, disinfectants, and disinfection	P	7/28/90	$19,492	$37,302	$17,810
132	EPA	SDWA	National primary drinking water regulations: radionuclides	P	7/17/87	$2,275	$227	($2,048)
133	HHS	FDA	General preamble and proposed alternative approaches to mammography standards	P	4/2/92	($131)	$1,081	$1,212
134	HHS	FDA	Regulations restricting the sale and distribution of cigarettes	P	8/10/91	($39,563)	$229,720	$269,283
135	HUD	LBP	Requirements for notification, evaluation, and reduction of lead-based paint hazards in federally owned residential property and housing receiving federal assistance	P	6/6/92	$913	-	($913)
136	USDA	FSIS	Pathogen reduction: HACCP for meat and poultry	P	2/2/91	$2,725	-	($2,725)

Appendix D
Empirical Measurements of Life Values (Income- and Inflation-Adjusted)†

	A	B	C	D	E	F	G	H	I	J	K
	Study (date of study)	**Listed life value**	**Listed life value**	**Date of data**	**Real Income Index (per cap. income in data year/per cap. income in 2000)**	**Measured life value, income-growth adjusted to 2000**	**Measured life value, adjusted for distribution & income-growth to 2000**	**Measured life value, income-growth adjusted to 2020**	**Measured life value, income-growth and income distribution adjusted to 2020**	**Same as G but assume income elasticity is 0.5**	**Same as I but assume income elasticity is 0.5**
3	Kneiser and Leeth (1991)	$0.6	$0.8	1978	0.67	$1.2	$1.6	$2.3	$2.3	$1.1	$1.4
4	Smith and Gilbert (1984)	$0.7	$0.9	1978	0.67	$1.4	$1.8	$2.7	$2.7	$1.3	$1.7
5	Dillingham (1985)	$0.9	$1.2	1977	0.65	$1.8	$2.4	$3.6	$3.6	$1.8	$2.2
6	Miller & Guria (1991)*	$1.2	$1.6	1991	0.84	$1.9	$2.5	$3.7	$3.7	$2.0	$2.5
7	Butler (1983)	$1.1	$1.5	1955	0.36	$4.0	$5.4	$8.0	$8.0	$3.2	$4.0
8	Viscusi, Magat, and Huber (1991b)**	$2.7	$3.6	1991	0.84	$4.2	$5.6	$8.3	$8.3	$4.5	$5.6
9	Moore and Viscusi (1988a)	$2.5	$3.3	1982	0.69	$4.8	$6.3	$9.4	$9.4	$4.7	$5.8
10	Gerking, de Haan, and Schulze (1988)***	$3.4	$4.5	1988	0.83	$5.4	$7.2	$10.7	$10.7	$5.7	$7.1
11	Gegax, et al (1985)****	$3.3	$4.4	1985	0.77	$5.6	$7.5	$11.2	$11.2	$5.8	$7.2
12	Marin and Psacharopoulos (1982)	$2.8	$3.7	1977	0.65	$5.7	$7.6	$11.3	$11.3	$5.5	$6.8
13	Cousineau, Lacroix, and Girard (1988)	$3.6	$4.7	1988	0.83	$5.7	$7.6	$11.4	$11.4	$6.1	$7.6
14	Jones-Lee (1989)*	$3.8	$5.0	1989	0.84	$6.0	$7.9	$11.8	$11.8	$6.4	$7.9

† Dollar figures in Column B are measured in millions of 1990 dollars. All other dollar figures are measured in millions of 2000 dollars.

* Indicates source is a contingent-valuation survey.

** Source: U.S. Census Bureau, Statistical Abstract of the United States 422, table 647 (2001). Values for years prior to 1960 and for 1969 are interpolated.

*** Assumes income elasticity of 1.0.

**** Assumes high-risk worker earns 33% less than benchmark U.S. person.

Appendix D: Life Values

	A	B	C	D	E	F	G	H	I	J	K
	Study (date of study)	**Listed life value**	**Listed life value**	**Date of data**	**Real Income Index (per cap. income in data year/per cap. income in 2000)**	**Measured life value, income-growth adjusted to 2000**	**Measured life value, adjusted for distribution & income-growth to 2000**	**Measured life value, income-growth adjusted to 2020**	**Measured life value, income-growth and income distribution adjusted to 2020**	**Same as G but assume income elasticity is 0.5**	**Same as I but assume income elasticity is 0.5**
15	Dillingham (1985)	$3.9	$5.1	1985	0.77	$6.7	$8.9	$13.2	$13.2	$6.8	$8.5
16	V.K. Smith (1976)	$4.7	$6.2	1976	0.63	$9.8	$13.1	$19.5	$19.5	$9.3	$11.6
17	Viscusi (1978)	$4.1	$5.4	1969	0.54	$10.0	$13.2	$19.7	$19.7	$8.9	$11.1
18	Olson (1981)	$5.2	$6.9	1981	0.69	$10.0	$13.3	$19.7	$19.7	$9.8	$12.1
19	R.S. Smith (1976)	$4.6	$6.1	1967	0.46	$13.1	$17.4	$25.8	$25.8	$11.1	$13.8
20	Viscusi (1981)	$6.5	$8.6	1976	0.63	$13.6	$18.1	$26.9	$26.9	$12.9	$16.0
21	Moore and Viscusi (1988a)	$7.3	$9.6	1982	0.69	$13.9	$18.5	$27.5	$27.5	$13.7	$17.0
22	Viscusi and Moore (1989)	$7.8	$10.3	1982	0.69	$14.9	$19.8	$29.4	$29.4	$14.6	$18.1
23	R.S. Smith (1974)	$7.2	$9.5	1969	0.54	$17.5	$23.3	$34.6	$34.6	$15.6	$19.4
24	Leigh and Folsom (1984)	$9.7	$12.8	1977	0.65	$19.8	$26.4	$39.2	$39.2	$18.9	$23.5
25	Leigh (1987)	$10.4	$13.7	1977	0.65	$21.2	$28.3	$42.0	$42.0	$20.3	$25.2
26	Herzog and Schlottman (1987)	$9.1	$12.0	1970	0.54	$22.1	$29.4	$43.7	$43.7	$19.8	$24.6
27	Garen (1988)	$13.5	$17.8	1981	0.69	$25.9	$34.4	$51.1	$51.1	$25.3	$31.5