J O I N T C E N T E R

AEI-BROOKINGS JOINT CENTER FOR REGULATORY STUDIES

Saving Lives: A Review of the Record

John F. Morrall III*

Office of Management and Budget
jmorrall@omb.eop.gov

Working Paper 03-6

July 2003

*The views expressed here are my own and do not necessarily reflect the views of OMB. I would like to thank Ivy Broder, Randall Lutter, John Graham, John Mendeloff, Bob Hahn, and Cass Sunstein as well as participants at the Syracuse University Conference on the Value of life for helpful comments.

J O I N T C E N T E R

AEI-BROOKINGS JOINT CENTER FOR REGULATORY STUDIES

In response to growing concerns about understanding the impact of regulation on consumers, business, and government, the American Enterprise Institute and the Brookings Institution have established the AEI-Brookings Joint Center for Regulatory Studies. The primary purpose of the center is to hold lawmakers and regulators more accountable by providing thoughtful, objective analysis of existing regulatory programs and new regulatory proposals. The Joint Center builds on AEI's and Brookings's impressive body of work over the past three decades that has evaluated the economic impact of regulation and offered constructive suggestions for implementing reforms to enhance productivity and consumer welfare. The views in Joint Center publications are those of the authors and do not necessarily reflect the views of the staff, council of academic advisers, or fellows.

All AEI-Brookings Joint Center publications can be found at www.aei.brookings.org

Executive Summary

I this paper, I present evidence on the cost-effectiveness of 76 regulatory actions promulgated by the Federal government from 1967 to 2001 by updating similar work published by the author in 1986. The paper first responds to several critiques of the original article recently published in prominent law journals by showing that most of the specific criticism is based on misrepresentations and mistakes. Wide differences in cost-effectiveness indicate the possibility of saving lives more effectively. Regulations aimed at reducing safety and cardiovascular risks have been more cost-effective than regulations aimed at reducing cancer risks. The author suggests several potential regulations that could save lives more cost-effectively than the vast majority of regulations issued to date.

Saving Lives: A Review of the Record

John F. Morrall III

1. Introduction

In 1986, I wrote a ten-page article called "A Review of the Record" that was published in *Regulation* (Morrall 1986). It contained a table that ranked 44 regulatory interventions by cost per life saved. Seventeen years later, the table has become both famous and infamous. One law professor labeled the table, "Table of Legends," and claims that "John Morrall's table may be the single most widely cited piece of evidence in current critiques of the regulatory system."[1] The table has played a prominent role in the academic and policy debates about regulatory reform, perhaps causing it to draw more scrutiny than it might otherwise have received. A lengthy law review article by Lisa Heinzerling, entitled "Regulatory Costs of Mythic Proportions," and published in 1998 *Yale Law Journal,* is devoted principally to questioning the credibility of the table and how it is used by advocates in the policy process.[2] Just as this table took on a life of its own, sometimes being cited in secondary sources without direct attribution to the original source, the Heinzerling article is becoming a "legend" in its own right, at least in the legal literature.[3]

After critiquing my work, Heinzerling and other critics proceeded to put forth similar critiques of the writings on regulatory reform by other scholars such as Tammy Tengs, John Graham, Bob Hahn, Kip Viscusi, Ralph Keeney, Cass Sunstein, Tom

---

[1] See Heinzerling (1998, p 2069). For example, she cites the following sample of "sources relying on one or another of Morrall's table": Breyer (1993), Viscusi (1992), Lutter and Morrall (1994), Sunstein (1996, 1990), Arrow et al (1996), Zeckhauser and Viscusi, (1990) and Mendelhoff (1988).

[2] She states: "Morrall's calculations, in short, have been used to support every one of the most prominent critiques of the regulatory system." She cites among other things: "the Republican proposed Contract with America." (Heinzerling 1998 p 1983). She states rather colorfully: "Like other modern legends, such as stories about rats served as hamburger and alligators living in the sewers, John Morrall's story is strange and believable. It reflects the "hopes, fears, and anxieties' of modern life. And it is false-true." Heinzerling (1998, p 1984). The article is 90 pages long and contains 531 footnotes.

[3] For example, see Parker (2003) and McGarity and Ruttenberg (2002).

Hopkins, Maureen Cropper, and Randall Lutter.[4] Because of the significant contribution that good empirical analysis can make to saving lives through smarter regulation, it is important to correct erroneous charges.

The paper responds to the critiques of "A Review of the Record" by reviewing the specific criticism and revising and updating the original table as appropriate. It finds that most of the charges leveled to discredit that article are based on misrepresentations, mistakes, and philosophical misconceptions. In particular, the paper adds 43 new regulations promulgated up to 2001 to the original 1986 table. The paper also answers the legitimate complaint that such tables are incomplete if they fail to show that more cost-effective alternatives exist in the real world by suggesting several new regulatory actions with the potential to save lives more cost effectively than the majority of promulgated regulatory actions listed in the new table.

2. Table of Legends

Table 1 reproduces the original 1986 table. The table is based primarily on estimates found in agency regulatory impact analyses (RIAs) reviewed by economists at OMB's Office of Information and Regulatory Affairs (OIRA), and before 1981, at the Council on Wage and Price Stability (COWPS). As objective analysts charged with gaining the most bang for the regulatory buck across all agencies, we did not accept agency representations without asking questions and probing beneath the surface. In an attempt to produce the "expected-value estimates" needed for cost effectiveness analysis, the table presented estimates that sometimes differed from agency estimates.[5] In the mid 80s and earlier, some agencies were not in the practice of quantifying or discounting

[4] See Heinzerling (1999), Heinzerling and Ackerman (2002), McGarity and Ruttenberg (2002), and Parker (2003).

[5] "A Review of the Record" was a companion piece to "The Perils of Prudence" (Nichols and Zeckhauser 1986) both under the title *Regulating Risk*. That article explained how FDA, OSHA, and EPA regularly used upper bound estimates and conservative default assumptions for cancer risk assessment even when more plausible estimates were available.

benefits.[6] Moreover, to the extent that they did, they often used methodologies and assumptions that were inconsistent across agencies and over time.

The critiques questioned the table's benefit estimates because it discounted benefits and used estimates that were often lower than agency estimates.[7] However, as Zeckhauser and Viscusi (1990) show, regulatory decisions based on cost-effectiveness rankings that use conservative or "worst case" assumptions are undesirable because they are likely to produce less overall risk reduction than using expected values. Even though the critics believe that the regulatory system is fine and needs no reform, they presumably would applaud improvements in consistency and cost-effectiveness.[8]

This paper does not respond to the charge that cost-effectiveness tables and discounting are inherently flawed since others have adequately defended these methodologies, including a response to Heinzerling (1998) by Donohue (1999) in the *Yale Law Journal*. However, the critics of the table also made more specific claims to which this paper does respond.

Claim #1. Morrall placed rules whose benefits did not exceed their costs at the bottom of his table.[9]

Table 1 does indeed place the worst rules ranked by their cost-effectiveness at the bottom of the table. Many of those rules were rejected and never issued. Table 1 clearly states that these rules were rejected. The article (Morrall (1986, p 31)) makes the point that "Comparing the cost-effectiveness of rules by year of issuance, agency, and legal status, the most important variable turns out to be legal status." The mean and median of

---

[6] OMB Circular A-94 requires agencies to discount both costs and benefits when evaluating program and regulatory proposals. Before 1992, a ten percent real rate was required. In 1992, the rate was lowered to seven percent. OMB is currently considering requiring both seven and three percent as well as allowing a broader range for special circumstances. See OMB (2003).

[7] See Heinzerling (1998), Heinzerling and Ackerman (2002), McGarity (1998), and Parker (2003). Note that McGarity states that OMB uses a 10% rate and then uses that rate to show that even modest present costs would outweigh benefits accruing in 50 years. OMB lowered its recommended rate to 7% in 1992 and suggested in its RIA guidance that lower rates such as 4% may be more appropriate for long time horizons.

[8] For example, "But the annual picture is a system striving to achieve a broad range of regulatory purposes and doing so at a reasonable costs" (Heinzerling (1998, p. 2069)).

[9] Heinzerling, (1998, p 2000).

the cost per life saved of the 26 final rules was $23 million and $2 million respectively, compared to $400 million and $289 million for the eight rejected rules.

Heinzerling (1998, p. 1999) does admit that Morrall did mark the rejected rules as "rejected," but states that "he only glancingly acknowledges that a substantial percentage of the rules at the bottom of his list were rejected for a reason he would presumably applaud." In a later article written with a co-author and published in the *Cornell Law Review* (Heinzerling and Ackerman, 2002 p.654), she states: "To be sure, in his original table, Morrall noted that the rules had been rejected. But this is a subtlety that subsequent users of the table have largely missed." However, the one source she cites, Table 5 of Justice Stephen Breyer's (1993) book, *Breaking the Vicious Circle: Toward Effective Risk Regulation,* does not list the rejected regulations included in my table.[10] The only table that I know that is based on my original table that lists the rejected rules without noting that they were rejected is a table by Heinzerling and Ackerman (2002, Table 1, p. 651).

Claim #2. Morrall included rules that do not exist.[11]

This is a two-part claim. First, proposed rules were included that had not gone final, and second, rules that did not exist (according to her research) were included. It is true that the 1983 OSHA EDB rule, listed as proposed, was never finalized because the firm that produced EDB eventually closed. But as of 1986, the proposed rule had not been withdrawn. The second rule on her list is EPA's 1986 arsenic/copper smelter rule that is listed as final. She assumes that it must refer to a 1983 proposal to regulate an ASARCO high-arsenic Tacoma smelter which also closed before the final rule was issued. However, it referred to a different smelter: ASARCO's low-arsenic El Paso smelter. Although she later discusses that rule (Heinzerling (1998, p. 2020-22)), she apparently mixed it up with the Arsenic/Low-Arsenic Copper rule listed as rejected in 1986. She may have been confused because she cites that rule as saving 0.9 annual lives,

[10] See Heinzerling (1998, p 1999 and fn 99) and Breyer (1993, pp 24-27). She states "these versions of the list imply, incorrectly, that all of the rules on the list are in force and generating current costs." Breyer does not list legal status because he includes only rules that were finalized.

[11] See Heinzerling (1998, p 2010).

a figure that is the same as EPA's estimate for the final Arsenic/Copper smelter rule. But she misplaced a decimal place since I list it as saving 0.09 lives, not 0.9.

Heinzerling (1998, p. 2013) also states that I listed two 1986 EPA rules that pertain to Arsenic and glass plants: one final rule listed as Arsenic/Glass Plant, and one listed as rejected for Arsenic/Glass Manufacturing. She states: "How Morrall determined that there were separate rules for 'glass plants' (sic) and 'glass manufacturing is unknown, let alone how he determined that one was rejected and one final. … The more expensive, rejected rule does not exist." Note that she drops the singular for "Glass Plant" and calls it a glass plants rule, which makes it appear as if it were glass manufacturing. Later in the article Heinzerling (1998, pp. 2021-22) discusses the arsenic glass plant (singular again) rule and how the proposed rule arguably would have regulated six plants but ended up regulating only one glass plant with the final regulation. It is unknown why she did not realize that the rule that regulated one glass plant was the final rule in the table while the proposal to regulate the rest of the glass manufacturing plants that was rejected was the more expensive rule listed as rejected in the table.

Finally, she states that EPA's 1984 Radionuclides/Uranium Mines rule, listed as final in Table 1, was withdrawn by the agency. The agency, at the same time that it withdrew several radionuclides rules after determining that the proposed control technology was illegal, announced its intention to go forward with the Uranium Mines rule with a modified control technology, which it did in 1985. My estimates are based on information in the 1985 *Federal Register* notice (40 FR 5190), which she fails to cite. The rule was finalized in 1989.

Claim #3. Morrall excluded rules that had high benefits relative to costs.[12]

Heinzerling (1998) cites EPA's phase down of lead in gasoline as one example. OIRA has often pointed to EPA's RIA, which it formally reviewed and approved, as an analysis of high quality that shows benefits significantly exceeding costs. However, the estimated benefits were primarily due to the reduced damage to catalytic converters and related car repair /maintenance matters, which were greater than the costs of the standard (Morgenstern (1997, p 56)). Criteria for inclusion in this table and the updated table are that life saving benefits must provide the majority of benefits and that non-health benefits

must not exceed compliance costs.[13] Heinzerling (1998) also cites the control of the common air pollutants by the Clean Air Act as examples of "provisions" that have produced benefits greater than costs. However, she does not cite agency regulations or RIAs available in 1986 that would allow cost per life saved estimates. OMB's annual *Report to Congress on the Costs and Benefits of Federal Regulations* routinely reports the very high benefits relative to cost produced by EPA's Clean Air program. For example, the most recent report singles out the exceptionally high benefits relative to costs over the last ten years produced by EPA's Office of Air, which issued regulations with estimated benefits ranging between $106 billion and $167 billion at a cost of only about $20 billion.[14]

Heinzerling (1998) charges that the table is also biased because it does not report cost per life saved for regulations that were never (but she believes should have been) proposed by the agencies. Although it seems a little disingenuous to criticize the table for containing regulations that "do not exist," and at the same time suggest that regulations that "do not exist" be included, the overall point is a good one. The final section suggests several candidate regulations that may save lives more cost-effectively than many of the regulations that have been issued up to now.

Heinzerling (1998, p. 2017) ends this section by stating that "In OMB's hands, cost-benefit analyses became a one-way ratchet; it was used to criticize proposals for regulation, never to criticize foreclosures to regulate. The bottom of Morrall's table, in short, reads like a COWPS/OMB regulatory hit list, and this is not a point in favor of its objectivity." It is not clear what the point of this statement is other than to lump "A Review of the Record" into a campaign against more sensible regulation generally, and

---

[12] See Heinzerling (1998, p 2014).

[13] Elsewhere Heinzerling (1998) is critical of the table because she claims it does not take into account non-health benefits. One way to reduce that problem is to include rules only if a significant majority of their benefits arise from health improvements. By the way, she is incorrect in her charge that non-health benefits were not included. Monetized non-health benefits were subtracted from costs while non-fatality health benefits were weighed using willingness-to-pay estimates and used to construct fatality equivalent indexes.

[14] See OMB (2003). According to the report, EPA's Office of Air provided over 75% of the benefits provided by the federal government's executive branch regulations that could be estimated.

OMB in particular. Since most of the regulations at the bottom of the cost-effectiveness rankings were rejected by the agencies, a fact she applauds and uses to argue that regulatory reform is unnecessary, it is contradictory to argue that the rejected regulations should not have been rejected.

Claim #4. The table presents problematic cost per life estimates because of discounting.[15]

Although analysts debate the actual discount rate to be used, they do not debate the necessity of discounting both future costs and benefits. However, Heinzerling also makes specific charges about the table that do need to be addressed. First, in her Table 2, she compares estimates of the cost per life saved for three regulations that appear in an article by Broder and Morrall (1983) published with the estimates for the same regulations that appear in the 1986 table. She points out that Broder and Morrall (1983) did not discount lives saved for latency. For example, she (1998, p 2019) claims that their estimate for OSHA's 1972 Asbestos rule "grew almost 40 times." However, instead of discounting lives saved, Broder and Morrall discounted the value of statistical lives (VSLs) estimated from labor market data and provided a table of discount factors for different rates and latency periods for use by the reader. Heinzerling (1998, p 2020) presents the differences as if there is some sort of inconsistency or flaw. She also states: "These large differences must be due to discounting, as this is the only methodological difference between the two sets of estimates." She apparently arrived at this conclusion without full investigation.[16]

She also draws comparison between the arsenic copper smelter and glass manufacturing plant rules, and reports huge differences between my estimates and her calculation based on agency estimates, which she attributes to discounting. As pointed

[15] See Heinzerling (1998, p. 2018).

[16] The differences are also due to inflation adjustments since the 1986 estimates were in 1984 dollars. For asbestos, the inflation adjustment of 2.23 accounted for more than half of the "almost 40 times" growth. This mistake also leads her to mistakenly calculate that I used a 37-year latency period for the OSHA arsenic rule while using 15 for the glass plant rule. I used 20 years not 37 years for the 1978 OSHA rule and 15 years for the later 1986 EPA rule, based on information in the EPA rulemaking record. (Heinzerling (1998) p 2056, fn 469)).

out above, she confuses the various arsenic regulatory proposals, which has the effect of overstating the effect of discounting.

Claim #5. Morrall adjusted the agencies' estimates of actual risk.[17]

This statement is true, but old news; I stated it in "A Review of the Record." As Garber (1999) and others have pointed out, consistency in assumptions and expected values are necessary for cost-effectiveness rankings to be useful in policy analysis. The article is upfront about the reasons for adjusting agency benefit estimates, and makes the point that "organizations public and private tend to overstate the effectiveness of their actions."[18] I also reported that agency cost estimates were not adjusted because, although agencies might have a tendency to underestimate costs for the same reason that they have to overestimate benefits, firms often find ways to reduce costs when actually facing the competitive need to do so. Agencies do not have explicit policies to underestimate costs, but many overestimate benefits in order to build in margins of safety. Although "A Review of the Record" does not detail the specific calculations for the 44 regulations in its ten pages, the data from 1986 to replicate the estimates are on file. Thus, the comment made by another critic, Richard Parker (2003, p. 19), that "Morrall is, of course, a government official and a busy man. Scholarship is not his first vocation. The fact remains: his findings cannot be replicated" is untrue, except for the fact of my being busy.

Perhaps the lesson here is that law professors should have their analytic calculations peer reviewed by qualified specialists in the field.[19] The Parker and Heinzerling articles contain numerous errors that could have been corrected by a

---

[17] See Heinzerling (1998, p 2025).

[18] See Morrall (1986, p. 28). Heinzerling and Parker selected only my estimates of regulations aimed at cancer for review and criticism. However, as stated in the paper, I also used most likely estimates for the effectiveness of safety regulations that were lower than the agencies estimates. My adjustment here also proved to be more accurate than agency optimistic assumptions. Seong and Mendeloff (2002) have recently found in a retrospective analysis of projections of safety benefits that OSHA tended to overestimate their impact (p 10). The critics who claimed that my sample of regulations was biased selected only a sample of regulations from my paper that they thought would show the paper was anti-toxin control.

[19] In general, articles published in law journals are not peered reviewed. They are selected by law students.

competent peer review process. For example, Parker (2003, p 18) reports that "Morrall also alters agency cost estimates without acknowledging that he is doing so." He arrives at this conclusion, which is contrary to what is stated in the article, after a phone conversation in which I said that I used a cost estimate of $1.3 billion annually for EPA's 1986 proposed Land Disposal regulation. Since he apparently assumed the agency estimate was $97 million based on the Heinzerling (1998) article, he states: "Only by independent investigation did the author learn that Morrall substituted his new number of $1.3 billion per year for the agency estimate of $97 million per year." A careful, independent investigation would have revealed that Heinzerling substituted a different regulatory proposal for the one in the table. The land disposal regulation in the table was published in the *Federal Register* on January 14, 1986. Its cost estimate was $1.3 billion annually (51 *FR* 1602). My independent investigation found that he substituted a different land disposal rule, one published in the *Federal Register* on December 11, 1986 that contained a $97 million cost estimate, for the one in the table.

A second example cited by both Heinzerling and Parker involves OSHA's 1985 proposed Formaldehyde regulation. Both Heinzerling and Parker asked me about the $72 billion per life saved estimate in separate phone conversations. I said the $72 billion estimate was from the filing that OMB submitted to OSHA's Formaldehyde docket, which describes the estimate in great detail (OMB 1986), and offered to supply them with copies.[20] There is no mystery about the calculation; it is easily replicated. Heinzerling points out that by her calculations, OSHA's estimate ranged from $21.8 million to $159.1 million per cancer case avoided.[21] If Heinzerling and Parker had reviewed the OMB filing, they would have learned that the differences are based on OMB's "weight of the evidence" approach rather than OSHA's use of the single animal study that found the greatest risk of cancer among rats exposed to formaldehyde. [22] The OMB estimate used

[20] Neither cites the filing in their article.
[21] See Heinzerling (1998, p 2026). These estimates are undiscounted for latency.
[22] Parker (2003, p 50) asks the question (even after I had offered to give him the answer): "Where does Morrall's $72 billion figure come from in any case?" After assuming that I used a 40 year latency period (I used 35 years as did the OMB filing) and making a series of other assumptions, he states "Morrall must have arbitrarily multiplied the agency's cost figures by a factor of 20." I said in the paper that I accepted agency cost estimates (Morrall (1986 p 29)).

the risk model that OSHA claimed fit the data the best (a five-stage model used by the Consumer Product Safety Commission). In addition, in an innovative meta-analysis, OMB included data from all six animal studies that had exposed rodents to formaldehyde up to that date, which included mice and hamsters as well as rats. Using a "weight of the evidence" approach significantly lowers the risk estimates for humans, and is entirely appropriate since there is no evidence that rats are better predictors of human risks than mice or hamsters.

To prove that the OMB estimates were too low, Heinzerling and Parker both quote an OSHA staff member who questioned the use of meta-analysis and disparaged OMB economists for not being toxicologists (Heinzerling (1998, pp. 2026-28)). They then produce their own estimates, which are also different from OSHA's. [23]

However, OMB's calculations do not depend upon toxicology; they depend upon statistical estimation procedures. OIRA had several Ph.D. statisticians on its staff who worked on the analyses while OSHA did not. Moreover, OMB's innovative use of meta-analysis to estimate risks has become standard practice and its estimate of the risk of formaldehyde has proved to be more accurate than OSHA's. For example, the latest risk assessments for formaldehyde used by Health Canada (2001) has been reduced by an order of magnitude compared to OSHA's 1985 estimate and is lower than OMB's 1986 estimate.

In arguing that my table underestimated the benefits of OSHA's 1976 coke oven rule, Heinzerling relies on a flawed OSHA estimate, even though its flaws were described in testimony that I presented at the OSHA coke oven hearing on behalf of COWPS that she cites.[24] Using data from a epidemiology study by Redmond *et al* (1972), OSHA

---

[23] Parker (2003, p 48) strangely claims that OSHA's formaldehyde "rule was never finalized. How could any rational agency even propose such a preposterously expensive rule? The answer is found in combination of Morrall's questionable accounting and the agency's concern with unquantifiable risks." The agency finalized the rule in 1987 at a permissible exposure level (PEL) of 1.0 parts per million and lowered the PEL to 0.75 in 1992.

[24] Heinzerling (1998, p 2032-34) also criticizes Morrall for producing different cost per life estimates for coke ovens over a ten year period. She neglects to point out that the differences were due to changes in OSHA's estimates from the proposed to the final rule, inflation adjustments, discounting VSL instead of costs per life saved and using a more sophisticated risk model based on EPA methodology.

(1976) assumed that working in coke plants for as little as three months would lead to an increased death rate of 9% compared to other steel workers to produce an estimate that 240 workers per year would die from coke oven exposure. This estimate assumes a 20% turnover rate per year for coke workers for 45 years, and then applies the 9% estimate to that total. However, the 9% excess death rate was not statistically significant at the 5% level. The excess death rate was due entirely to exposures of over 5 years duration; excess risk was not found for exposures of less than 5 years. Moreover, the 9% is not an annual rate. It is the excess rate for the whole study period, which varied per individual from 17 to 50 years or higher. I used the risk estimate produced by EPA's Carcinogen Assessment Group, which was also based on the Redmond data but weighted by years of exposure. OSHA's approach, its first attempt at risk assessment, is no longer used. Heinzerling should have spotted OSHA's flawed methodology, not just because of my testimony pointing out its problems, which she cited, but because she discusses EPA and later OSHA rules that use the accepted methodology.[25]

With respect to OSHA's ethylene oxide rule, as stated in the article, I used an EPA risk assessment model based on epidemiology that found a 1/5 to 1/13 lower risk than OSHA's risk assessment, which was based on animal data.[26] I reduced the OSHA estimate by 1/5. Heinzerling points out that a 1987 OMB report states that the ethylene oxide cost per life saved estimate was reported as $60 million, not $25.6 million as reported in the 1986 table. In the updated table in the next section, I use the 1987 estimate because it is based on a more accurate cost estimate.

With respect to OSHA's 1986 benzene proposal, I used an annual estimate of 3.8 lives saved per year compared to OSHA's estimate of 12.7 for 45 years of exposure for reduced leukemia. My calculation is based on an estimate by Crump and Allen, two well-respected risk assessors, which was 30% of OSHA's estimate. The agency never supplied a "significant risk determination" for aplastic anemia as required by the

[25] Heinzerling is a legal scholar not an epidemiologist or toxicologist. This may explain her approach of assuming that agencies were always correct and OMB analysts always wrong. OMB analysts review a broad array of evaluations and have the advantage of looking across agencies for the best science.

Supreme Court's 1980 Benzene decision (Industrial Union Department, AFL-CIO v API). When OSHA finalized the rule in 1987, it reduced its leukemia risk estimate to 40% of its estimate at the proposal stage, more in line with my estimate.

In summary, I have examined each of the cost-effectiveness estimates questioned by Heinzerling and Parker, and reviewed sources and reasons for the estimates that were published. I have shown that my estimates are defensible, replicable and, in all likelihood, more accurate than the corresponding agency estimates. Although there are significant technical uncertainties in all estimates of this sort, I am convinced that my estimates are plausible and without systematic bias against any particular agency or type of regulation.

3. The Updated Table

The next section updates the 1986 table and includes new regulations issued since then.[27] It continues the practice of using estimates provided by the agencies, usually in the RIAs prepared for the rulemakings. Because OMB reviews and approves agency RIAs at both the proposal and final stages of rulemaking, and both OMB and the agencies are producing higher quality RIAs with the passage of time, agency estimates are less likely to be explicitly conservative and methodologically inconsistent.[28] Because the new regulations added to Table 1 are in less need of refinement, I have not so done.

Table 2 presents 76 regulations, 33 from the Table 1[29]. I have accepted the critics' suggestion that, to reduce confusion, rejected and proposed rules should not be

---

[26] The study was from EPA's Carcinogen Assessment Group study, page V-10). Developments in the risk assessment field since 1984, increasingly suggest that human data, when available, should be given more weight than animal data.

[27] The table was also updated to 2002 dollars from the 1984 dollars used in the 1986 table by the CPI-U.

[28] Since 1990, OMB has issued guidance to agencies emphasizing the need to use expected-value estimates instead of worst case analysis and to improve consistencies of the assumptions used. (See OMB 1990). The guidance was revised and improved in 1996, 2000 and 2003. See http://www.whitehouse.gov/omb/inforeg/regpol.html.

[29] The calculations for the rest of the regulations are based on data from OMB (1992), Hahn, Lutter, and Viscusi (2000), OMB (2002A), Seong and Mendeloff (2002) and various agency RIA's. Since some of the estimates in OMB (1992) were incorrectly adjusted for inflation (but not by this author) by assuming the date of the regulations in the Morrall 1986 table indicated the date of the dollars. These have been corrected.

included in the table even if identified as such. Table 2 contains only rules issued in final form. I have also used a 7% percent compound interest rate to calculate the opportunity costs of the funds used to provide future benefits rather than discount the number of lives saved as done in the 1986 table. In 1992, OMB revised Circular A-94 to reduce the required interest rate for use in project and regulatory analysis from 10% to 7%. To answer critics who believe that lives should not be discounted, Table 2 uses the future expected value of the cost of saving lives at the times in the future when lives are saved. The fact that the two approaches are mathematically equivalent may not mollify the critics, but it does reduce their rhetorical appeal. For the same reason, Table 2 also uses the term "statistical lives" as small risks are being reduced and not identifiable lives.[30] Table 2 presents the "opportunity costs of statistical lives saved" (OCSLS). The table also uses only two significant figures to express uncertainty. Parker correctly points out that uncertainty is inherent in agency estimates. Ranges were not used because of unavailability and the complications that would be introduced in such a large table.[31] Finally, note that the table is also not subject to the Heinzerling critique that "lives are too priceless to price." The table simply presents the implicit cost of reducing risks based on agency actions.[32]

4. Results for 76 Final Regulations

Table 2 confirms the main conclusions of my 1986 article, as well as Tengs, *et al* (1995), that presented cost per life-year saved estimates for 587 interventions, many of

---

Since Breyer (1993) based his Table 5 on that data and many others used Breyer's table, e.g., Kniesner and Viscusi (2003) future citations should be to table 2. However, the mistake did not significantly change the rankings.

[30] As with the earlier paper, a fatality index, weighted by WTP estimates, was added to the denominator to take into account non-fatality health benefits and non-health benefits subtracted from the numerator to produce net costs.

[31] Note that the value of the table is as an indicator of overall regulatory performance. The point estimates in the table should not be used alone to judge the worth of specific regulations because of the limited information they convey and their inherent uncertainty.

[32] Partly because of the difficulty of explicitly valuing health benefits, OMB has proposed in its new draft guidelines that agency "prepare a CEA for all major rulemakings for which the primary benefits are improved public health and safety," (OMB 2003, p. 5516) in addition to a traditional Benefit-Cost Analysis when feasible.

which were medical interventions.[33] The range of cost-effectiveness among rules continues to be enormous. The range is six orders of magnitude from OSHA's 1998 respiratory protection rule to EPA's 1991 solid waste disposal facility criteria, compared to three orders of magnitude for the final rules in the 1986 table.

Second, toxin control, primarily cancer cases avoided, continues to be a significantly less cost-effective intervention than safety regulation. Using the $7 million Value of Statistical Life (VSL) estimate, which is the midrange of the Viscusi and Aldy (2003) meta-analysis of the better willingness to pay market studies, most clearly illustrates this conclusion. Thirty-one of the 35 regulations aimed at reducing safety risk pass this benefit-cost test compared to only six of the 34 regulations aimed primarily at cancer.

In addition to these 71 regulations, six regulations fall into different categories. All of these fall under the $7 million cutoff. Four are aimed primarily at cardiovascular disease; HHS's organ donor and food labeling, FAA's AEDs on large planes, and EPA's NOx SIP Call regulations. Two others are medical interventions: HHS's medical devices and mammography regulations. The sixth regulation, OSHA's 1998 respirator rule, which is aimed at both acute and chronic toxins, was the most cost-effective of the 76 rules. These findings are also consistent with the Tengs, *et al* (1995) findings that medical and safety interventions were significantly more cost-effective than toxin controls.

Another key cutoff point is where cost-ineffective regulations do more harm than good. Because resources are used to produce the benefits of risk reducing regulation, some of which would have been used to reduce risk in the absence of the regulation, there is an opportunity cost to spending that can be measured in risk reduction. The theoretical underpinnings and empirical estimates for this cutoff point have been developed in articles by Lutter and Morrall (1994), who called this approach the "Health-Health Analysis," and by Viscusi (1994). Lutter, Morrall, and Viscusi (1999) reconciled their

[33] The medical and public health literature tends to use life-years saved rather than lives saved. Using life-years saved as pointed out in Morrall (1986) increases the variances in the effectiveness estimates and strengthens the conclusions. For example see Viscusi, Hakes, and Carlin (1997) who find that using life years saved rather than lives saved based on a variant of my table increases the variance.

differences in empirical estimates by incorporating the effect of income on risky behavior in theoretical and empirical models. In 2002 dollars, their estimate is that a diversion of $21 million induces one fatality.

Using the $21 million cutoff indicates that 27 of the 76 regulations in Table 2 cause more harm than good. Only one of the 27 regulations that fail that test is a safety regulation and the other 26 are toxin control regulations. Seventy percent of the EPA regulations (16 of 23) appear to do more harm than good compared to 30% (16 of 53) for all other agencies. OSHA health regulations also aimed at toxin control have an equally poor record. Nine of 11 rules do more harm than good compared to one of 13 OSHA regulations aimed at safety. Overall, including respirator protection, 10 of 25 OSHA regulations fail the $21 million cutoff.

Over time, the cost-effectiveness of life saving regulations in this sample has not significantly changed. About 58% of the rules pass the benefit-cost test implied by using the $7 million VSL, and 65% of the rules pass the health-health test using the $21 million cutoff. These percentages are virtually unchanged when the sample is divided between the 42 rules issued before 1990, and the 34 rules issued in 1990 and after. One might conclude that OMB and the agencies are not improving their regulatory performance over time.[34] On the other hand, since one might expect that the most cost-effective opportunities to save lives might be chosen first, then there should be a tendency for the cost-per-life-saved estimates to increase over time. Moreover, since VSL is a normal good with an income elasticity of 0.5 to 0.6 according to Viscusi and Aldy (2002), implicit cost-per-life-saved estimates should also increase over time for that reason. The fact that this has not happened may indicate that the agencies and OMB have had some success.

The critics point out that tables such as Tables 1 and 2 are neither random samples nor a complete accounting of health, safety, and environmental regulations.[35] One should not generalize from the table that, in particular, environmental regulations as a

[34] This is consistent with the results of several studies that have examined the 1986 table and its offshoots, e.g., Farrow and Toman (1999), Hahn (1999) and Farrow (2000).

[35] However, as in Morrall 1986, I have attempted to include all the rules published in the *Federal Register* whose primary benefits were saving lives and for which reasonably complete information on risks, cost and benefits was available.

whole are cost-ineffective. OMB's annual *Report to Congress on the Cost and Benefits of Federal Regulation* has consistently found that EPA regulations produce the great majority of benefits. For example, the latest OMB report finds that four EPA rules (two aimed at reducing emissions from heavy duty highway engines, the Tier 2 rule limiting emissions from light duty trucks, and an acid rain rule) provide 70% of the benefits and 20% of the costs for 107 major rules reviewed over the last ten years whose benefits and costs could be monetized.[36] The overall benefits of the 107 rules ranged from $135 billion to $218 billion with costs of $38 billion to $44 billion. However, since the four EPA rules' benefits mainly flow from reducing fine particulate matter, a finding that regulations aimed narrowly at specific carcinogens does not appear to be cost-effective relative to other life saving opportunities appears sound. This was a key finding of "A Review of the Record," and remains a key finding of this review.

5. Recommendations for Further Regulation

One point that the critics of these tables make is that they do not indicate that cost-effective opportunities to regulate exist, since the regulations listed in the table have already been issued (Heinzerling, 1998, pp 2014-2117). OMB (2002b) has recently begun an effort to encourage the agencies to consider actions in a number of specific areas by sending them "prompt letters." Table 2, the cost-per-life-year tables of Tengs, *et al* (1995), and the OMB Benefit-Cost Report (2003) all suggest that further regulation to reduce cardiovascular diseases may provide cost-effective opportunities to save lives.[37] Table 3 lists several such potential opportunities. The FDA proposed two of these ideas. In 1999, the FDA proposed to reduce the intake of trans fatty acids by requiring labeling. In September of 2001, OMB sent a prompt letter to FDA to expedite this rulemaking. In 2003, FDA proposed requiring bar codes for drugs and biological products. OMB also sent a prompt letter to OSHA to promote AEDs in the workplace.[38] A fourth suggestion is to promote the increased intake of omega-3 fatty acids, which are found primarily in

[36] See OMB (2003, p 5493). The lower range of cost and benefit estimates was used for this calculation.
[37] Moreover, cardiovascular diseases cause 40% of the deaths in the US in 2000.
[38] The prompt letters may be viewed at <http://www.whitehouse.gov/omb/inforeg/prompt_letter.html>.

dark meat fish. The calculations are preliminary and meant to be suggestive of opportunities for action that require further analysis.[39] The four proposals save lives at a cost of $3,000 for reducing the intake of trans fat to $830,000 for requiring bar codes. Taken together, the four suggestions save 35,600 lives per year at a weighted average cost per life of $230,000, which ranks near the top in Table 2. These results suggest we could do a significantly better job saving lives.

6. Summary

The paper presents evidence on the cost-effectiveness of 76 regulatory actions promulgated by the Federal government from 1967 to 2001, which were directed primarily at saving lives. The paper revises and updates a similar table published by the author in 1986 by adding 43 additional regulations. The paper first responds to several critiques of the original table published in prominent law journals that question the legitimacy of cost-effectiveness tables that rank life-saving regulations in general and the author's estimates in particular. The paper examines each of the cost-effectiveness estimates questioned by the critics, and reviews sources and reasons for the estimates that were published. It finds that my estimates are defensible, replicable and, in all likelihood, more accurate than the corresponding agency estimates. Although there are significant technical uncertainties in all estimates of this sort, I am convinced that my estimates are plausible and without systematic bias against any particular agency or type of regulation. Second, the policy conclusions from the new table are similar to the original findings.

[39] The calculations for the two proposed rules are based on data from the RIAs. The calculations for the omega-3 suggestion is based on the cost of one extra helping of fish every three months and a dose response estimate from Lutter and Tucker (2003) based on risk data from the *Journal of the American Medical Association* (Hu et al 2002). The calculations for AEDs in the workplace are based on cost data from the FAA AED in large airplane rulemaking and risk and effectiveness estimates from Page *et al* (2000) published in the *New England Journal of Medicine.* It is based on placing one AED within five minutes of 100 workers.

Wide differences in cost-effectiveness indicate we could do a more effective and efficient job saving lives. In particular, it finds that regulations aimed at reducing safety and cardiovascular risks have been more cost-effective than regulations narrowly aimed at reducing cancer risks. Finally, the paper suggests several potential regulations aimed at cardiovascular risks that appear to save lives more cost-effectively than a majority of regulations issued in the past.

References

Arrow, Kenneth et al., (1996). "It there a Role for Benefit-Cost Analysis in Environmental, Health, and Safety Regulation?" *Science* 272, 221.

Breyer, Stephen. (1993). *Breaking the Vicious Circle: Toward Effective Risk Regulation*. Cambridge: Harvard University Press.

Broder, Ivy and John Morrall. (1983). "The Economic Basis for OSHA's and EPA's Generic Carcinogen Regulations" in Richard Zeckhauser and Derek Leebaert (eds). *What Role for Government*? Durham: Duke University Press.

Donohue, John. (1999). "Why We Should Discount the Views of Those Who Discount Discounting", *The Yale Law Journal* 108, 1901-1910.

Farrow, Scott and Michael Toman. (1999). "Using Environmental Benefit-Cost Analysis to Improve Government Performance." *Environment* 41, 12-37.

Farrow, Scott. (2000). "Improving Regulatory Performance: Does Executive Office Oversight Matter?" AEI-Brookings Joint Center for Regulatory Studies.

Garber, Alan. (1999). "Advances in Cost-Effectiveness Analysis of Health Interventions", National Bureau of Economic Research, Working Paper 7198.

Hahn, Robert. (1999). "Regulatory Reform: Assessing the Government's Numbers". AEI-Brookings Joint Center for Regulatory Studies.

Hahn, Robert, Randall Lutter, and W. Kip Viscusi. (2000). "Do Federal Regulations Reduce Mortality?" Washington: AEI-Brookings Joint Center for Regulatory Studies.

Health Canada. (2001). "Priority Substance List Assessment Report – Formaldehyde".

Heinzerling, Lisa. (1998). "Regulatory Costs of Mythic Proportions", *The Yale Law Journal* 107, 1981-2070.

Heinzerling, Lisa and Frank Ackerman. (2002). "The Humbugs of the Anti-Regulatory Movement", *Cornell Law Review* 87, 648-670.

Hu, F. et al. (2002). "Fish and Omega-3 Fatty Acid Intake and Risk of Coronary Heart Disease in Women" *Journal of the American Medical Association* 287, 1815-1821.

Kniesner, Thomas and W. Kip Viscusi. (2003). "Why Relative Economic Position Does Not Matter: A Cost-Benefit Analysis", *Yale Journal of Regulation* 20, 1-24.

Lutter, Randall and John Morrall. (1994). "Health-Health Analysis: A New Way to Evaluate Health and Safety Regulation", *Journal of Risk and Uncertainty* 8, 43-66.

Lutter, Randall, John Morrall, and W. Kip Viscusi. (1999). "The Cost-Per-Life-Saved Cutoff for Safety-Enhancing Regulations", *Economic Inquiry* 37, 599-608.

Lutter, Randall and Katherine Tucker. (2003). "Unacknowledged Health Benefits of Genetically Modified Food: Salmon and Heart Disease Deaths", *AgBioForum* 5, 59-64.

McGarity, Thomas. (1998). "A Cost-Benefit State" *Administrative Law Review* 50, 7-79.

McGarity, Thomas and Ruth Ruttenberg. (2002). "Counting the Cost of Health, Safety, and Environmental Regulation", *Texas Law Review*, 80, 1997-2057.

Mendelhoff, John. (1988). The *Dilemma of Toxic Substance Regulation*. Cambridge: MIT Press.

Morgenstern, Richard (ed). (1997). Economic *Analysis at EPA: Assessing Regulatory Impact*, Washington: Resources for the Future.

Morrall, John. (1986). "A Review of the Record", *Regulation* 10. 25-34.

Nichols, Albert and Richard Zeckhauser. (1986). "The Perils of Prudence: How Conservative Risk Assessments Distort Regulation, *Regulation* 10, 13-24.

Occupational Safety and Health Administration. (1976). Inflationary *Impact Statement: Coke Oven Emissions*.

Office of Management and Budget. (1986). "Comments on OSHA's Proposed Rulemaking: Occupational Exposure to Formaldehyde". (Available from the author).

____. (1990). 1990-*1991 Regulatory Program of the United States Government*, Washington: GPO.

____. (1992). 1991-*1992 Regulatory Program of the United States Government*. Washington: GPO.

____. (2002a). Analytical *Perspectives Budget of the United States Government FY 2003*. Washington: GPO.

____. (2002b). Stimulating *Smarter Regulation: 2002 Report to Congress on the Cost and Benefits of Regulations*.

____. (2003). "Draft 2003 Report to Congress and the Cost and Benefits of Federal Regulations" *Federal Register* 68, 5513-5526.

Page, R., et al. (2000). "Use of Automated External Defibrillators by a US Airline", *New England Journal of Medicine* 343, 1210-1216.

Parker, Richard. (2003). "Grading the Government", forthcoming *University of Chicago Law Review*.

Redmond, C.K. et al. (1972). "Long-term Mortality Study of Steelworkers-VI. Mortality from Malignant Neoplasms Among Coke Oven Workers", *Journal of Occupational Medicine* 14, 621-629.

Seong. S. Kyung and John Mendelhoff. (2002). "Assessing the Accuracy of OSHA's Estimation of the Benefit of Safety Standards", University of Pittsburgh.

Sunstein, Cass. (1996). "Health-Health Tradeoffs", University of Chicago Law Review 63, 1533-1548.

Tengs, Tammy et al. (1995). "Five-Hundred Life-Saving Interventions and Their Cost-Effectiveness", *Risk Analysis* 15, 369-390.

Viscusi, W. Kip. (1974). "Mortality Effects of Regulatory Costs and Policy Evaluation Criteria", *RAND Journal of Economics* 25, 94-109.

____. (1992). *Fatal Tradeoffs: Public and Private Responsibilities for Risk*. New York: Oxford University Press.

Viscusi, W. Kip, John Hakes, and Alan Carlin. (1997). "Measures of Mortality Risk", *Journal of Risk and Uncertainty* 14, 213-233.

Viscusi, W. Kip and Joseph Aldy. (2003). "The Value of Statistical Life: A Critical Review of Market Estimates Throughout the World", *Journal of Risk and Uncertainty*, forthcoming.

Zeckhauser, Richard and W. Kip Viscusi. (1990). "Risk Within Reason", *Science* 248, 559-563.

TABLE 1: THE COST OF VARIOUS RISK-REDUCING REGULATIONS PER LIFE SAVED

Regulation	Year	Agency	Status*	Initial Annual Risk**	Annual Lives Saved	Cost Per Life Saved (Thousands 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 10^6	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
Floor Emergency Lighting	1984	FAA	F	2.2 in 10^8	5.000	700
Crane Suspended Personnel 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	17,100
Arsenic/Glass Paint	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
Arsenic/Copper Smelter	1986	EPA	F	9.0 in 10^4	0.060	26,500
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
Beneze/Ethylbenzenol Styrene	1984	EPA	R	2.0 in 10^8	0.006	483,000
Arsenic/Low-Arsenic Copper	1986	EPA	R	2.6 in 10^4	0.090	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

*Proposed, rejected or final rule.

Table 2: OPPORTUNITY COSTS PER STATISICAL LIFE SAVED (OCSLS)

Regulation	Year Issued	Agency	OCSLS (millions of 2002 $)
Childproof Lighters	1993	CPSC	$ 0.1
Respiratory Protection	1998	OSHA-H	0.1
Logging Operations	1994	OSHA-S	0.1
Electrical Safety	1990	OSHA-S	0.1
Steering Column Protection	1967	NHTSA	0.2
Unvented Space Heaters	1980	CPSC	0.2
Safety Standards for Scaffolds	1996	OSHA-S	0.2
Cabin Fire Protection	1985	FAA	0.3
Trihalomethanes	1979	EPA	0.3
Organ Procurement Regulations	1998	HHS	0.3
AED on Large Planes	2001	FAA	0.3
Mammography Sts	1997	HHS	0.4
Food Labeling Regulations	1993	FDA	0.4
Stability & Control During Breaking/Trucks	1995	NHTSA	0.4
Electrical Power Generation	1994	OSHA-S	0.4
Passive Restraints/Belts	1984	NHTSA	0.5
Fuel System Integrity	1975	NHTSA	0.5
Underground Construction	1983	OSHA-S	0.5
Head Impact Protection	1995	NHTSA	0.7
Alcohol & Drug Control	1985	FRA	0.9
Servicing Wheel Rims	1984	OSHA-S	0.9
Reflective Devices for Heavy Trucks	1999	NHTSA	0.9
Seat Cushion Flammability	1984	FAA	1.0
Side Impact & Autos	1990	NHTSA	1.1
Medical Devices	1996	FDA	1.1
Floor Emergency Lighting	1984	FAA	1.2
Crane Suspended Personnel Platform	1984	OSHA-S	1.5
Low-Attitude Windshear	1988	FAA	1.8
Electrical Equipment Sts. /Metal Mines	1970	MSHA	1.9
Trenching and Excavation	1989	OSHA-S	2.1
Traffic Alert & Collision Avoidance	1988	FAA	2.1
Children's Sleepware Flammability	1973	CPSC	2.2
Side Doors	1970	NHTSA	2.2
Concrete & Masonry Construction	1985	OSHA-S	2.4
Confined Spaces	1993	OSHA-S	2.5
Hazard Communication	1983	OSHA-S	3.1
Child Restraints	1999	NHTSA	3.3
Benzene/Fugitive Emissions	1984	EPA	3.7
Rear/Up/Shoulder Belts/Autos	1989	NHTSA	4.4
Asbestos	1972	OSHA-H	5.5
EDB Drinking Water Sts.	1991	EPA	6.0
NO_x SIP Call	1998	EPA	6.0
Benzene/Revised: Coke By Products	1988	EPA	6.4
Radionuclides/Uranium Mines	1984	EPA	6.9
Roadway Worker Protection	1997	FRA	7.1
Grain Dust	1988	OSHA-S	11
Electrical Equipment Sts. /Coal Mines	1970	MSHA	13
Methylene Chloride	1997	OSHA-H	13
Arsenic/Glass Paint	1986	EPA	19
Benzene	1987	OSHA-H	22
Arsenic/Copper Smelter	1986	EPA	27

Table 2 (cont.)

Regulation	Year Issued	Agency	OCSLS (millions of 2002 $)
Uranium Mill Tailings/Inactive	1983	EPA	28
Hazardous Wastes Listing for Petroleum Sludge	1990	EPA	29
Acrylonitrile	1978	OSHA-H	31
Benzene/Revised: Transfer Operations	1990	EPA	35
4.4 methylenedianiline	1992	OSHA-H	36
Coke Ovens	1976	OSHA-H	51
Nat. Primary and Secondary Drinking Water Regulations Phase II	1991	EPA	50
Uranium Mill Tailings/Active	1983	EPA	53
Asbestos	1986	OSHA-H	66
Asbestos/Construction	1994	OSHA	71
Arsenic	1978	OSHA-H	77
Asbestos Ban*	1989	EPA	78
Ethylene Oxide	1984	OSHA-H	80
Lockout/Tagout	1989	OSHA-S	98
Hazardous Waste Management/Wood Products	1990	EPA	140
DES (Cattlefeed)	1979	FDA	170
Benzene/Revised: Waste Operations	1990	EPA	180
Sewage Sludge Disposal	1993	EPA	530
Land Disposal Restrictions	1990	EPA	530
Hazardous Waste: Solids Dioxin	1986	EPA	560
Prohibit Land Disposal	1988	EPA	1,100
Land Disposal Restrictions/Phase II	1994	EPA	2,600
Drinking Water: Phase II	1992	EPA	19,000
Formaldehyde	1987	OSHA-H	78,000
Solid Waste Disposal Facility Criteria	1991	EPA	100,000

Table 3: Opportunity for Cost-Effective Regulations

		Lives Saved Per Year	OCSLS $1,000s
1.	Reducing Intake of Trans Fat	10,000	3
2.	AED's in the Workplace	2,200	240
3.	Increasing Omega 3 Intake	21,000	270
4.	Bar Codes for Drug and Biologic Products	2,400	830