GLOBAL DEVELOPMENT AND ENVIRONMENT INSTITUTE

WORKING PAPER NO. 01-06

If It Exists, It's Getting Bigger: Revising the Value of a Statistical Life

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October 2001

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Abstract

What is the dollar value of saving a human life? Cost-benefit analysis of health and environmental regulation requires such a number, yet the concept raises numerous ethical and philosophical questions. There are good general reasons to reject the entire enterprise of monetizing life, and specific reasons to criticize the methods used to create such values. Valuations of life are usually based either on analysis of the wage premium for risky jobs, or on surveys of attitudes toward risk. Recent EPA analyses have relied heavily on an extensive but dated database of wage-risk estimates, leading to an inflation-adjusted estimate of $6.3 million per life in 2000 dollars. Re-analysis of that database, to reflect income elasticity effects, leads to an estimate of $13.8 million - and highlights the ethical limits on the use of any monetary value for life.

1. Introduction

How much is it worth to save a life? The question is crucial to cost-benefit analysis of health, safety, and environmental regulation, since avoided deaths figure so prominently among the benefits of these rules. An apparent consensus has emerged in recent regulatory practice around a figure of $5-6 million per "statistical life." In analyses performed for the Environmental Protection Agency (EPA), the value of a life, adjusted for inflation, reached $6.1 million in 1999 dollars, and would equal $6.3 million in 2000 dollars.[1]

On the one hand, there are troubling ethical and philosophical questions about the meaning of any such figure. These questions have not disappeared or lost their importance simply because cost-benefit analysis has become quite widely accepted. In fact, it is particularly important to recall these basic questions as the practitioners of cost-benefit analysis, more and

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[1] The original calculation can be found in EPA, *The Benefits and Costs of the Clean Air Act, 1970 to 1990*, 1997, Appendix I. For an example of a subsequent analysis citing the Clean Air Act analysis and adjusting only for inflation, see EPA, *Arsenic in Drinking Water Rule: Economic Analysis*, EPA Document 815-R-00-026, December 2000, p. 5-23.

more, debate only the technicalities and leave the fundamentals behind.

On the other hand, if the valuation of statistical lives is to play a role in public policy, there are good reasons to re-examine the empirical basis for the existing estimates. The available data and analyses are quite dated, and have generally been adjusted only for inflation. Several studies suggest that the value of a statistical life increases in proportion to average income. On this assumption, the same sources that have given rise to the $5-6 million estimates would actually imply a value that is closer to $14 million as of 2000 - and steadily rising. And this is only accounting for increases in income; if the value were adjusted for relative preferences and the special nature of environmental risks, as several scholars have recently proposed, the value would be even greater.

Section 2 summarizes ethical and philosophical questions about the valuation of life and suggests that they deserve to be taken seriously; these questions cast doubt on the idea that there is a meaningful numerical value for human life. Assuming for the sake of the argument that it is meaningful to ask what the value of a statistical life is, Section 3 reviews the estimates used in recent regulations and concludes that a consensus has emerged around a figure of approximately $6 million. Section 4 contrasts the two common methods used to calculate the value of a life, one based on observed market behavior (generally, labor market choices) with respect to risk, and the other based on hypothetical questions posed in stylized surveys. Section 5 argues that the accepted estimates should be revised upward, and offers a recalculation reflecting the connection between the value of life and average income levels. However, as pointed out in the conclusions, in Section 6, the link to income levels must not be taken to imply that lives of the rich are worth more than the poor; rather, this seeming paradox underscores the limits to the uses of any monetary valuation of life.

Despite our broader theoretical concerns, revision of the estimated value of a statistical life is of great practical significance at present. Influential voices in policymaking circles are calling for rollback of environmental protection, justifying this controversial position with the claim that cost-benefit analysis does not support many current regulations. If an updated version of the standard approach implies a higher valuation of life, then the benefits of many regulations are "worth" more in dollar terms. This is a point well worth making in the short run, although in the long run it will hopefully be made redundant by the more profound argument that there are essential human and ecological values transcending monetary valuation, values that will be both belittled and distorted if the trend toward translating all good things into dollars continues.

2. Risk, Life, and Ethics

A cascade of conceptual problems surrounds the subject of valuation of life. The decision to proceed with valuation, for cost-benefit analysis or other purposes, is in effect a decision to set aside these problems or to pretend they have been resolved. Yet the debates remain pressing and contentious. In this section we review some of the problems, beginning with the biggest ones.

What can it mean to say that saving one life is worth $6.3 million? Human life is the ultimate example of a value that is not a commodity, and does not have a price. You cannot buy the right to kill someone for $6.3 million, nor for any other price. Most systems of ethical and religious belief maintain that every life is sacred. So how could its "price" be anything less than infinite?

The standard response is that a value like $6.3 million is not a price on an individual's life or death. Rather, it is a way of expressing the value of small risks of death; for example, it is one million times the value of a one in a million risk. If people are willing to pay $6.30 to avoid a one in a million increase in the risk of death, then the "value of a statistical life" is $6.3 million.

It is not obvious that this trick resolves the dilemma. If human life is too sacred to buy and sell, why is it permissible to trade small risks of losing that ultimate value? One-millionth of an infinite value is still infinity, not $6.30. Many critics reject the entire enterprise of pricing risks to human life on grounds like these.[2]

In practice, moreover, analysts often ignore the distinction between valuing risk and valuing life, and act as if they have produced a valuation of life itself.[3] It is true that risk (or "statistical life") and life itself are distinct concepts. Many regulations reduce risk for a large number of people, and avoid actual death for a much smaller number. A complete cost-benefit analysis should, therefore, include valuation of both of these benefits. However, the standard practice is to calculate a value only for statistical life. If analysts did calculate the value of life itself according to the same compensation theory that underlies most environmental valuations, the benefit of remaining alive would be infinite, as "no finite amount of money could compensate

[2] E.g., Elizabeth Anderson, *Value in Ethics and Economics* (Harvard University Press, 1993).

[3] For further elaboration, see Lisa Heinzerling, "The Rights of Statistical People," 24 *Harv. Envtl. L. Rev.* 189, 203-06 (2000).

a person for the loss of his life, simply because money is no good to him when he is dead."[4]

The confusion between the valuation of risk and the valuation of life itself is unfortunately embedded in current regulatory practice. When risks of death are reduced by regulation, cost-benefit analysts commonly discount the monetary value of statistical life to reflect the temporal lag, if any, between the costs and benefits of regulation.[5] But rather than discounting from the moment when risk is reduced, they discount from the moment of avoided death - which is usually later, sometimes decades later in the case of reduced risks of cancer. In fact, discounting from the time of death is the practice recommended by the Office of Management and Budget.[6] If, however, monetary valuations of statistical life indeed represent only risk, and not life, then the value of statistical life should be discounted only from the date of a change in risk (typically, when a new regulation is enforced) rather than from the much later date of avoided actual death.[7]

In acknowledging the monetary value of reducing risk, economic analysts have contributed to our growing awareness that life-threatening risk itself – and not just the end result of such risk, death – is an injury. But they have erred in pretending that risk is all there is, and have blurred the line between risks and actual deaths. The paradox of monetizing the infinite or immeasurable value of human life has not been resolved, it has only been glossed over.

Another large problem with the standard approach to valuation of life is that it asks individuals (either directly through surveys, or indirectly through observing wage and job choices; see Section 4) only about their attitudes toward risks to themselves. A recurring theme in literature suggests that our deepest and noblest sentiments involve valuing someone else's life more highly than our own: think of parents' devotion to their children, soldiers' commitment to those whom they are protecting, lovers' concern for each other. Most spiritual beliefs call on us to value the lives of others - not only those closest to us, but also those whom we have never met.

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[4]John Broome, "Trying to Value a Life," 9 *J. Pub. Econ.* 91, 92 (1978).

[5]For discussion, see Lisa Heinzerling, "Discounting Our Future," 34 *Land & Water L. Rev.* 39 (1999).

[6]Economic Analysis of Federal Regulations Under Executive Order 12,866, at pt. III.B.5(a) (Report of Interagency Group Chaired by a Member of the Council of Economic Advisors) (Jan. 11, 1996).

[7]Heinzerling, "Discounting Our Future," 34 *Land & Water L. Rev.* at 71; Lisa Heinzerling, "Discounting Life," 108 *Yale L.J.* 1911, 1913 (1999).

This point echoes a procedure that has become familiar in other areas of environmental valuation. Economists often ask about existence values: how much is the existence of a wilderness area or endangered species worth to you, even if you will never personally experience it? If this question makes sense for bald eagles and national parks, it must be at least as important when applied to safe drinking water and working conditions for other people. How much is it worth to you to prevent a death far away? The answer cannot be deduced solely from your attitudes toward risks to yourself. We are not aware of any attempts to quantify the existence value of the life of a stranger, let alone a relative or a friend, but we are sure that most belief systems imply that it is a substantial, positive number (assuming, of course, that the value of life is a number in the first place).

A related issue is that the valuation of risk is based on individuals' private decisions as consumers or workers, not on their public values as citizens. Policies that reduce risk are often public goods, and are not available for purchase in individual portions. Therefore, it is often impossible to arrive at a meaningful social valuation by adding up the willingness to pay expressed by individuals. Instead, a collective decision about collective resources is required. As Amartya Sen has pointed out, if your willingness to pay for a large-scale environmental initiative is independent of what others are paying, then you probably have not understood the nature of the problem.[8]

Another problematical assumption is that there is a single value for all equal risks to life, such as $6.30 for a one in a million risk. That is, the process of valuation assumes that there is a single thing called "risk", with a price that applies to it regardless of context. Yet despite the finality of death, there is no reason to think that all deaths are equivalent and interchangeable. Nor, therefore, are all one in a million risks of death directly comparable to each other.

For example, the death rate is roughly the same – in fact, a bit over 0.5 per million – from a day of downhill skiing, from a day of working in the construction industry, or (extrapolating from the limited available data) from drinking about 20 liters of water containing 50 parts per billion of arsenic, the old regulatory limit that is up for revision.[9] This does not mean

[8] Amartya Sen, "The Discipline of Cost-Benefit Analysis," 29 *Journal of Legal Studies* 931 (2000).

[9] Skiing: in 1999 there were 30 fatalities and 52.2 million skier/snowboarder visits to ski slopes, for a death rate of 0.57 per million skier-days. (National Ski Areas Association, www.nsaa.org)

Construction: in 1997 there were 14.1 fatal injuries per 100,000 full-time construction workers; assuming 250 days per full-time year, the death rate was 0.56 per million days of work. (NIOSH, *Worker Health Chartbook, 2000*, p.36.)

Arsenic: male lifetime cancer rates per ppb of arsenic are 2.53×10^{-5} for bladder cancer and 2.75×10^{-5} for lung cancer; see EPA, *Arsenic in Drinking Water Rule: Economic Analysis*, December 2000 (EPA 815-R-00-026), Exhibit B-2, p. B-8. (Female cancer rates are higher.) Death rates are 26% for bladder cancer and 88% for lung cancer, for a combined male mortality rate of 3.08×10^{-5} per lifetime ppb of arsenic.

that society's responsibility to reduce risks is the same in each case.

Most people view risks imposed by others, without an individual's consent, as more worthy of government intervention than risks that an individual knowingly accepts. On that basis, the highest priority among our three examples is to reduce drinking water contamination, a hazard to which no one has consented. The acceptance of a risky occupation such as construction is at best quasi-voluntary – it involves somewhat more individual discretion than the "choice" of public drinking water supplies, but many people go to work under great economic pressure, and with little information about occupational hazards. In contrast, the choice of risky recreational pursuits such as skiing is entirely discretionary; obviously safer alternatives are readily available. Safety regulation in construction work is thus more urgent than regulation of skiing, despite the equality of risk.[10]

There are other factors that also matter in the evaluation of risks. The circumstances preceding death are important: sudden, painless death in pleasant circumstances is different from agonizing, slow deterioration surrounded by medical technology. Based on these and other arguments, E.J. Mishan argues that there is no meaning to the value of a statistical life, divorced from the particular policy that increases or decreases risk.[11] That is, even for an ultimate value such as life and death, the social context is decisive in our evaluation of risks.

It is useful, where possible, to collect quantitative information about the lives saved and health improved through public policy, but it may be pointless or confusing to translate that information into dollars. Thus, although what we have to say in the following sections will assume that lives are being translated into dollars, our preferred policy position could be summarized as follows: quantify, but don't monetize.

The EPA analysis is based on a person who drinks 2 liters of water per day. So lifetime consumption over 70 years is 2 x 70 x 365 = 5.11×10^4 liters. If risk is proportional to arsenic consumption, the risk per ppb per liter = (3.08×10^{-5}) / (5.11×10^4) = 6.03×10^{-10} per ppb per liter, or 3.01×10^{-8} per liter of 50 ppb water. At that rate, the risk from 19 liters of 50 ppb water equals the risk from a day of skiing.

[10]For an effort to quantify the additional value of avoiding involuntary risks, see Richard L. Revesz, "Environmental Regulation, Cost-Benefit Analysis, and the Discounting of Human Lives," 99 *Colum. L. Rev*. 941,968-71 (1999).

[11] Mishan, E. J., 1988. *Cost-Benefit Analysis: An Informal Introduction*, fourth edition (London: Routledge).

3. How Much Is a Statistical Life Worth?

Despite the philosophical problems with valuation of a life, a growing number of agencies do compile specific numerical values. Fifteen such valuations are tabulated in a recent article by Matthew Adler and Eric Posner, as shown in Table 1.

At first glance it appears that there is a wide range of values in Table 1, from $1.5 to $5.8 million. However, the estimates divide neatly into two narrower intervals. All the estimates from regulations before 1996, and some of the ones adopted in that busy year, lie between $1.5 and $3.0 million - as seen in the top half of the table. Some of the regulations adopted in 1996, and all of the ones adopted more recently, fall between $4.8 and $5.8 million - as seen in the bottom half of the table. On the strength of Table 1 it appears that a consensus was reached, during President Clinton's second term, that the value of a life was, in round numbers, between $5 and $6 million.

The source of the $5 - $6 million estimate is not hard to find. W. Kip Viscusi, a professor of law and economics at Harvard Law School, has authored or co-authored a number of studies of the value of a life, and has written several influential reviews of the subject.[12] In his view, the value of a statistical life is around $5 million in December 1990 dollars (the currency used throughout his calculations). An EPA re-analysis of Viscusi's data produced the more precise estimate of $4.8 million in 1990 dollars.[13] This value, adjusted for a decade of moderate inflation, crept up to $6.1 million in 1999 dollars in the arsenic cost-benefit analysis (which appeared after the Adler and Posner table), and is equivalent to $6.3 million in 2000 dollars. Several of the post-1996 figures in Table 1 may reflect adjustment for inflation to various years in the 1990s, or slightly different interpretations of the Viscusi data. In other words, regulatory practice in the late 1990s seemed to treat the EPA/Viscusi estimate as an established empirical constant, needing adjustment only for inflation.

The apparent consensus on a number is remarkable in view of the ongoing uncertainties and debates about methodology. Two rival methods are used to estimate the value of a life. As

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[12] His three major surveys are W. Kip Viscusi, *Fatal Tradeoffs: Public and Private Responsibilities for Risk* (New York: Oxford University Press, 1992); "The Value of Risks to Life and Health," *Journal of Economic Literature* 31 no. 4 (December 1993), 1912-1946; *Rational Risk Policy* (Oxford: Clarendon Press-Oxford University Press, 1998).

[13] See note 1.

discussed in the next section, both methods are problematic.

Table 1: Valuations of Life in Regulation

Agency	*Subject of regulation*	*Year*	*Value (million $)*
FAA	Establishment of airport radar	1990	1.5
Dept of Agriculture	Pathogen reduction in food inspection	1996	1.6
FDA	Restriction of tobacco sales to minors	1996	2.5
FAA	Flight simulator use in pilot training	1996	2.7
EPA	Protection of stratospheric ozone	1988	3.0
FDA	Food labeling regulations	1991	3.0
FAA	License requirements for aircraft launch	1996	3.0
Dept of Agriculture	National school lunch/school breakfast program	1994	1.5, 3.0
EPA	Ambient air quality standards: particulate matter	1997	4.8
EPA	Ambient air quality standards: ozone	1997	4.8
FDA	Manufacturing standards for medical devices	1996	5.0
FDA	Mammography standards	1997	5.0
EPA	Children's exposure to lead paint	1996	5.5
EPA	Disinfectants and byproducts in drinking water	1998	5.6
EPA	Radon in drinking water	1999	5.8

Source: Matthew D. Adler and Eric A. Posner, "Implementing Cost-Benefit Analysis When Preferences are Distorted," *Journal of Legal Studies* 29 no. 2, part 2 (June 2000), 1146.

4. Markets vs. Surveys

Most of the studies surveyed by Viscusi are wage-risk studies, inferring the value of a life from the wage premium paid for risky jobs. The alternative is contingent valuation, the survey method that is widely used to monetize other environmental values, but less common in valuation of life. However, a prominent recent study by Alan Krupnick and several co-authors at Resources for the Future (RFF) argues that carefully designed contingent valuation studies, asking people to value precisely defined, small changes in risk of mortality, yield estimates that are more appropriate for regulatory purposes.[14] That study obtains estimates of the value of a life that are strikingly lower than Viscusi's figure.

In fact, neither method is clearly superior on theoretical grounds. Both techniques fail to address the fundamental dilemmas discussed in Section 2. Instead, both search for the value of a nonexistent, homogeneous entity, which could be called generic acontextual risk (GAR); both assume that individual valuations of GAR, revealed through individual behavior or statements, should provide the basis for public valuation of specific risks in specific contexts. In practice, both techniques also rely on additional, and highly debatable, simplifying assumptions.

The more widely used technique, wage-risk analysis, assumes not only that there is a well-defined value of a statistical life, but also that workers' job choices accurately reveal that value. In the theoretical model underlying these studies, workers are assumed to be perfectly informed about risks, and free to choose among jobs at varying levels of risk. In reality, of course, workers are not always well informed about the relative risks of different jobs. And the

[14] Alan Krupnick, Anna Alberini, Maureen Cropper, Nathalie Simon, Bernie O'Brien, Ron Goeree, and Martin Heintzelman, "Age, Health, and the Willingness to Pay for Mortality Risk Reductions: A Contingent Valuation Survey of Ontario Residents," Resources for the Future Discussion Paper 00-37 (2000), http://www.rff.org.

workers who end up employed in risky occupations may lack the skills or mobility needed to find alternatives. Some of the most dangerous jobs are in mining, fishing, and agriculture, industries that are often located in remote areas with few other employers.

Assuming that workers are well-informed and able to switch occupations, the workers who accept risky jobs - those whose wages are reflected in wage-risk studies - are likely to have a higher tolerance for risk (and thus demand a smaller wage premium for risk) than other workers, let alone nonworkers. Many people are not in the workforce, including groups who are particularly vulnerable to environmental hazards such as children, pregnant and nursing women, the disabled, and the elderly. Health and environmental regulations are often of greatest benefit to these vulnerable, non-working parts of the population; should the value of a statistical life reflect their needs and preferences, as well as the behavior of workers who take dangerous jobs?

The alternative method of contingent valuation is in principle able to address this last point. Yet as practiced in the recent RFF study, contingent valuation of risks to life has at least as many problems as wage-risk analyses. Seeking to match the age profile of those who are harmed most by air pollution, the researchers interviewed only subjects between the ages of 40 and 75. The study's detailed analysis of differing valuations by age, as well as the initial choice of the age range, raises a troubling new issue: should the value of a life depend on the person's age? No ethical or legal system treats killing an older person as a lesser crime than killing a younger one. However, cost-benefit analysis employing age-differentiated valuations amounts to a stealth endorsement of this disturbing principle.[15] If the value of life is allowed to differ by age, why not investigate other differences, based on race, gender, or income, for example? It is not hard to see how this road leads to morally unacceptable outcomes, a point we discuss further in Section 6.

To address methodological problems that arise in contingent valuation, the RFF study developed an elaborate, multi-part questionnaire, asking subjects to assign prices to several hypothetical scenarios that differed only in a few elements relevant to risks. Yet this procedure created new methodological problems of its own. The questionnaire, including related demographic information and validation of responses, was so complex that it could only be administered on the computers at a central facility. Thus, despite great care in other aspects of statistical technique, the RFF study is limited to a highly nonrandom sample of the population: it includes only those subjects who were willing to go downtown and spend a considerable

[15] In addition to the RFF study (note 10), age-differentiated valuations are introduced via calculations of life-years rather than lives saved, in the work of John Graham, Tammy Tengs, and other researchers; see Ackerman and Heinzerling, *Priceless* (2002).

amount of time on the survey in exchange for a modest financial payment (35 Canadian dollars). It is therefore biased toward selecting those who respond well to small monetary incentives, who do not place a high value on their own time, and who are not very busy.

The RFF study comments that its results for the value of a life are half or less of the current U.S. EPA values.[16] This finding is devoid of policy implications for the U.S., not only because the study draws on a biased sample, but also because it was performed in Canada. Although there are numerous similarities between Canada and the U.S., there are also differences that are important for the valuation of life. Incomes are lower, on average, in Canada; the level of social insurance is greater, perhaps affecting the perceived need for private payment for risk reduction; patterns of health and safety regulation are different; and it is possible that cultural differences between the two nations lead to different preferences regarding risk.

Leaving aside the specifics of the RFF study, which method - wage-risk analysis or contingent valuation - would be expected to produce a higher value of life? A direct comparison of the two methods, as it happens also from Canada, performed a wage-risk analysis of a sample of workers, and then asked the same workers questions such as, “How much of a pay cut would you accept for a slightly safer job?”, or “How much of a pay increase would you demand for a slightly riskier job?”.[17] The result was that contingent valuation, based on asking workers about risk, implied a value of a statistical life 50 percent higher than the wage-risk study of the same workers’ job choices.

The authors attributed the difference, in part, to the existence of a group of very risk-averse workers. This group was concentrated in the safest job categories, so it had little impact on the analysis of wages for dangerous occupations. However, the contingent valuation questionnaire reflected the views of the risk-averse workers along with everyone else. Wage-risk analysis, by definition, focuses on the choices made by those who are willing to accept risks, which may already be a self-selected group that places a lower-than-average value on avoiding danger.

The final, and most important, question about the comparison cannot really be answered: which method is more appropriate? Both are searching for a nonexistent animal, generic acontextual risk. One method imagines that it can be found by observing workers in

[16] Krupnick et al. (note 10), p.40.

[17] Paul Lanoie, Carmen Pedro, and Robert Latour, “The Value of a Statistical Life: A Comparison of Two Approaches, *Journal of Risk and Uncertainty* 10 (1995), 235-257.

dangerous occupations, who are assumed, despite ample evidence to the contrary, to be well-informed and blessed with an abundance of job choices. The other method looks for it by offering small bribes for people to take part in lengthy interviews about contrived, hypothetical scenarios. Fishing for GAR, both methods end up catching mutant species that only vaguely resemble the prey they're after.

5. Viscusi's Values and Income Elasticity

If, despite these critiques, something has to be done and some number has to be used, what should it be? Suppose that we set aside all the varied questions about philosophy and methodology that have been raised so far, and turn to the actual data. There is no substantial alternative to the data assembled by Viscusi. For better or worse, they are likely to form the basis of numerical estimates of the value of a life for policy purposes in the near future. It is, however, possible to do a much better job of interpreting those data.

Numerous publications by Viscusi, as well as statements by others referring to his work, assert that the published estimates of the value of a statistical life tend to cluster between $3 million and $7 million, with an average of $5 million. As we have seen, versions of this estimate were adopted for regulatory purposes in the late 1990s. The empirical basis for these estimates is Viscusi's huge table summarizing the results of a range of studies; similar versions of it have appeared several times in his work. (All discussion here refers to his latest, 1998 version of the table.) The table presents results from 23 studies; some of the studies presented multiple estimates, yielding a total of 28 figures for the value of a statistical life.

Of the 28 estimates, four are for other countries, one per country, while 24 are for the U.S. There are many reasons why results are not directly comparable across national boundaries, as discussed in connection with Canadian estimates in Section 4: there are significant international differences in wages, safety regulations, cultural attitudes toward risk, and other factors that affect the wage-risk tradeoff. Therefore, in deriving an estimate for U.S. policymaking purposes, it is more appropriate to confine the analysis to the 24 U.S. estimates. Table 2 reproduces selected data for the U.S. estimates in Viscusi's table, with a few new calculations added. (We note in passing that the estimates do not display the much-discussed "cluster" between $3 and $7 million, and that the mean U.S. estimate is $6.2 million in December 1990 dollars.)

A striking fact about the database is its age: even in the 1998 version, the newest study included in the table was published in 1991, while the most recent data in any of the U.S. studies are from 1982. This may in part reflect the paucity of newer research. A meta-analysis of international studies of the value of a statistical life by Ted Miller, published in 2000, comments on the relative lack of recent U.S. research.[18] In contrast, Miller describes many newer studies from other countries.

A related problem, which points toward the need for adjustment, is the relationship of the estimates to income levels. On any of the theories supporting valuation of life, the tradeoff between money and risk should be influenced by income. Viscusi, in earlier work, has argued that the valuation of risk should be proportional to income, and Miller's meta-analysis found an income elasticity of the value of a statistical life, across countries, of close to 1.0.[19]

Indeed, it seems plausible that risk reduction is a luxury good, implying an income elasticity greater than unity. A study of data on risk and wages in Taiwan for 1982-97 found that the estimated value of a statistical life rose much faster than average incomes, implying an income elasticity between 2 and 3.[20] This does not directly apply to the U.S. for the reasons we have discussed. However, the finding of an income elasticity well above 1 - meaning that the value of a life rises faster than in proportion to income - is consistent with the common image of environmental protection as something that nations (or individuals) cannot afford when they are poor, but become interested in as they become affluent.

If the income elasticity is equal to 1.0, then the value of a statistical life is proportional to incomes. Under this assumption, as average incomes rise over time, the value of a life changes but the ratio of the value of a life to income remains constant. The last two columns of Table 2 present two variants of this ratio. For 15 of the 24 estimates, the mean income of the workers in the study sample is available; in these 15 studies, the value of a life averages 316 times the sample income. For 20 of the 24 estimates, the year of data collection is reported. In those 20 estimates, the value of a life averages 390 times GDP per capita in the data collection year.

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[18] Ted R. Miller, "Variations between Countries in Values of Statistical Life," *Journal of Transport Economics and Policy* 34 part 2, May 2000, 169-188. For a similar review of studies based on road safety, see Arianne de Blaeij, Raymond J.G.M Florax, Piet Rietveld, and Erik Verhoef, "The Value of Statistical Life in Road Safety: A Meta-Analysis," Tinbergen Institute Discussion Paper TI 2000-089/3, http://www.tinbergen.nl.

[19] W. Kip Viscusi and W. Evans, "Utility Functions that Depend on Health Status: Estimates and Economic Implications," *American Economic Review* 80 no.2 (1990), 353-374; Miller, *op.cit.* estimates an income elasticity between 0.85 and 1.0.

[20] James K. Hammitt, Jin-Tan Liu, and Jin-Long Liu, "Survival is a Luxury Good: The Increasing Value of a Statistical Life," NBER Summer Institute Workshop on Public Policy and the Environment, Cambridge, Massachusetts, August 2000. (Corresponding author: James Hamitt, Harvard School of Public Health, James_Hammitt@Harvard.edu.) Thanks to Matthew Kahn for this reference.

Table 2: Viscusi's U.S. estimates of the value of a statistical life

Author	Year of Publication	Data	Mean income of sample	GDP per capita (data year)	Value of life (million $)	Value of life/sample income	Value of life/GDP per capita
Smith	1974	NA	$22,640	NA	7.2	318	
Thaler & Rosen	1976	NA	$27,034	NA	0.8	30	
Smith	1976	1970	NA	$14,880	4.6		309
Viscusi	1978	1969	$24,834	$15,027	4.1	165	273
Brown	1980	1969	NA	$15,027	1.5		100
Viscusi	1981	1976	$17,640	$16,864	6.5	368	385
Olson	1981	NA	NA	NA	5.2		
Arnauld & Nichols	1983	NA	NA	NA	0.9		
Butler	1983	1954	NA	$10,255	0.9		88
Leigh & Folsom	1984	1974	$27,693	$16,345	9.7	350	593
Leigh & Folsom	1984	1977	$28,734	$17,470	10.3	358	590
Smith & Gilbert	1984	1978	NA	$18,239	0.7		38
Dillingham	1985	1977	$20,848	$17,470	0.9	43	52
Dillingham	1985	1977	$20,848	$17,470	3.9	187	223
Leigh	1987	1977	NA	$17,470	10.4		595
Herzog & Schlottmann	1990	1970	NA	$14,880	9.1		612
Moore & Viscusi	1988a	1982	$19,444	$18,108	2.5	129	138
Moore & Viscusi	1988a	1982	$19,444	$18,108	7.3	375	403
Moore & Viscusi	1988b	1977	$24,249	$17,470	7.3	301	418
Garen	1988	1981	NA	$18,660	13.5		723
Viscusi & Moore	1989	1982	$19,194	$18,108	7.8	406	431
Moore & Viscusi	1990a	1982	$19,194	$18,108	16.2	844	895
Moore & Viscusi	1990b	1982	$19,194	$18,108	16.2	844	895
Kniesner & Leeth	1991	1978	$26,226	$18,239	0.6	23	33
Mean		***1976***			***6.2***	***316***	***390***
Standard error					***1.0***	***65***	***62***

Source: W. Kip Viscusi, *Rational Risk Policy* (Clarendon, 1998), pp.54-57; except GDP per capita, ratios, means, and standard errors, which are our calculations. Data year is the midyear when a range of years was used.
All dollar amounts are in December 1990 dollars; GDP per capita was adjusted using the consumer price index.
Among the Moore & Viscusi estimates, 1988a and 1988b refer to separate publications using distinct methodologies, as do 1990a and 1990b; see Viscusi, *Rational Risk Policy*, for details.

Viscusi's table, dated as it is, apparently remains the strongest empirical basis for estimation of the value of a life in the U.S. It also appears reasonable to assume that the income elasticity of the value of a life is at least 1.0. On these assumptions, the appropriate estimate of the value of a life is found by using the ratios of the value of a life to income, not by sticking with the $5 million figure, with or without inflation adjustments. Of the two ratios, the GDP-based one, rather than the one based on workers' incomes, is more readily applied to public policy calculations: lots of people affected by regulations are not working, and GDP per capita provides an indicator of the income level of the population as a whole, working or not. For the year 2000, GDP per capita amounted to $35,400 in current dollars. The value of a statistical life should therefore be estimated at (390 x $35,400), or $13.8 million in 2000.

The revised estimate of $13.8 million is more than twice the $6.3 million figure which is obtained by inflation adjustment alone, the method used in recent EPA cost-benefit analyses.[21] As seen in Table 2, the average data year for the studies in the table is 1976. The U.S. economy has changed substantially since 1976, and so, undoubtedly, has the value of a life.

It is not only the level of income that has changed. The data collection years for many of the studies occurred in the late 1970s and early 1980s, a time when blue-collar male jobs (which include most high-risk occupations) were facing serious cutbacks.[22] The job choices available to workers in high-risk occupations in those years were quite limited. Even if workers were making fully informed, "rational" choices about employment, the alternatives open to them were bleak. In that depressed economic setting, the wage premium required to attract workers to risky jobs was presumably lower than normal. This argument suggests that, as in the Taiwan study, the value of a life may have grown faster than U.S. incomes over the past quarter-century.

A final statistical puzzle leads back toward the underlying problems with the

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[21] In its cost-benefit analysis of strengthening regulation of arsenic in drinking water, EPA included a sensitivity analysis that attempted to adjust the valuation of statistical life to take into account increases in income. This adjustment increased the value of a statistical life from $6.1 to 6.8 million. EPA 815-R-00-026, *Arsenic in Drinking Water Rule Economic Analysis* 5-28 (December 2000), available at <http://www.epa.gov/safewater/ars/econ_analysis.pdf>. EPA's effort falls short in three respects, however: first, it was not incorporated into EPA's primary analysis, but included only in its sensitivity analysis; second, like other EPA valuations, it is based on all of Viscusi's data, including foreign estimates that inappropriately lower the average; third, it reflects only the increases in income that occurred from 1990-1999, whereas our estimate incorporates all increases in income from 1976, the average vintage of the data, to 2000.

[22] For a review of the extensive literature on this subject see Frank Ackerman et al., editors, *The Changing Nature of Work* (Washington: Island Press, 1998).

methodology. The ratio of 390 times GDP per capita is far greater than estimates for many other countries. Miller, for example, finds typical values around 120 times GDP per capita, heavily influenced by European estimates.

There is no logical need for the ratio to be the same in all countries. Could the valuation of a life be a much higher multiple of income in the U.S. than in Europe? Anecdotal evidence suggests a greater concern with minor safety risks in the U.S., as reflected in ubiquitous warnings in parks and playgrounds, greater propensity to file lawsuits over modest damages, etc. Thus it is possible that Americans simply have a greater "taste" for safety.

It is also possible that basic differences between the American and European economies are involved, such that even with the same "taste" for safety Europeans would get lower market compensation for workplace risk. Income inequality is greater in the U.S. than in Europe, and most of the difference is found in the lower half of the income distribution, where hazardous blue-collar jobs are most likely located. The ratio of 90^{th} to 50^{th} percentile male wages is similar in the U.S. and Europe, while the ratio of 50^{th} to 10^{th} percentile wages is far greater in America than in other developed countries.[23]

In Europe, therefore, wage differentials between blue-collar jobs are smaller, reflecting the greater strength of the labor movement, higher minimum wages and labor standards, and more generous social welfare programs. As a result, the wage premium for risky jobs, compared to less risky jobs at the same skill level, may be smaller. Something similar may even affect the results of contingent valuation studies: a more expansive welfare state reduces the need for private financial provision for risk. Such factors can clearly lower the estimated value of a life, within the economic paradigm of valuation. Nonetheless, it seems bizarre to deduce that Europeans place a lower value on life *because* they have more equal wages and more extensive social welfare programs. The answer is perfectly logical; the problem lies in the question.

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[23] Francine D. Blau and Lawrence M. Kahn, "International Differences in Male Wage Inequality: Institutions versus Market Forces," *Journal of Political Economy* 104 no. 4 (August, 1996), 791-837.

6. Conclusion

The philosophical quandaries about the valuation of human life are inescapable. Where feasible, it is important to collect quantitative information about the expected impacts of policies, including lives that will be lost or saved as a result. But it is wrong to think that such information can be objectively transformed into a dollar amount of monetized benefits. The final stage of monetization turns useful information into contentious calculations, obscuring rather than clarifying the discussion of public policy. The alternative, in the long run, is the creation of a more informed process of democratic deliberation, one which uses but does not worship economic analysis.[24]

In the short run, meanwhile, cost-benefit analysis based on monetization of life and other values continues to gain ground. Viscusi's presentation of the data on the value of a life has enjoyed widespread acceptance as the definitive source on the subject. Although now quite dated, it is an impressive database; no obviously superior alternative has emerged. However, there are good reasons to think that the standard methodology, embodied in his data, understates the value of a statistical life.

The most important correction, recognizing that the value of life rises with income, has a dramatic effect on the estimates. Rather than deriving a fixed number such as $5 million or $6 million from Viscusi's data, it is more accurate to say that his work suggests that the value of a statistical life in the U.S. is 390 times GDP per capita. That number was up to about $14 million as of 2000, and continues to grow. Correction for other flaws in the standard methodology - reflecting relative income effects as proposed by Robert Frank and Cass Sunstein,[25] or adjustment for the special nature of a disease like cancer or for the involuntariness of risk, as suggested by Richard Revesz,[26] or inclusion of existence values for human life,

[24] This admittedly vague formulation is explored in more detail in Frank Ackerman and Lisa Heinzerling, *Priceless: Human Health, the Environment, and the Limits of the Market* (forthcoming, 2002).

[25] Robert Frank and Cass Sunstein, "Cost-Benefit Analysis and Relative Position," *University of Chicago Law Review* 68 (2001), 323. See also Gregory Besharov, "Three Questions about the Economics of Relative Position: A Response to Frank and Sunstein," AEI-Brookings Joint Center for Regulatory Studies Working Paper 01-08 (2001), http://www.aei.brookings.org.

comparable to those in other environmental valuations - would lead to even larger figures.

Calculation of the link between average income and the value of a statistical life could, if applied indiscriminately, lead to the unacceptable implication that rich people, or residents of rich nations, are worth more than the poor. For example, imagine a cost-benefit analysis of hazardous facilities serving the three countries of North America. If the value of a life were calculated separately for each country based on its average income, the study might well "prove" that everything toxic should be located in Mexico, where the lives that would be lost are so much cheaper than in the U.S. or Canada. his kind of logic was made (in)famous in a 1991 memo circulated by Lawrence Summers (former Secretary of the Treasury, now President of Harvard University) when he was the chief economist at the World Bank. Discussing the migration of "dirty industries" to developing countries, Summers' memo explained: The measurements of the costs of health impairing pollution depends 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 of dumping a load of toxic waste in the lowest wage country is impeccable and we should face up to that. [27]

The correct response to this outrageous view is to emphasize the philosophical commitment to equal treatment of all people, which in this case requires applying a single value of life to everyone involved in the study, regardless of its economic and geographic scope.[28] A subtle balance is needed, for those who would use the monetized value of life appropriately: the number should be the same for the entire affected population at any point in time, but should vary over time in proportion to average incomes. There is every reason to value U.S. and

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[26] Richard L. Revesz, "Environmental Regulation, Cost-Benefit Analysis, and the Discounting of Human Lives," 99 *Colum. L. Rev*. 941 (1999).

[27] Reprinted in *The Guardian*, p. 29 (Feb. 14, 1992). After the memo became public, Brazil's then-Secretary of the Environment Jose Lutzenburger wrote to Summers:

> Your reasoning is perfectly logical but totally insane... Your thoughts [provide] a concrete example of the unbelievable alienation, reductionist thinking, social ruthlessness and the arrogant ignorance of many conventional 'economists' concerning the nature of the world we live in...

(Available at http:www.whirledbank.org/ourwords/summers.html).

[28] That is, price discrimination within the affected population, based on income, age, or other characteristics, is not desirable, nor even ethically tolerable. The RFF study, discussed in Section 4, goes dangerously far down the slippery slope toward differentiated values for different lives.

Mexican lives equally at any moment in time, whenever both are involved; there is no reason to freeze the valuation of U.S. (or any other) lives at an arbitrary past value, such as the number that emerges from empirical data circa 1976.

In one sentence, our final conclusion is that we need both a much higher estimate of the value of a statistical life for contemporary U.S. policy analysis, and much greater humility about its universal applicability.

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