

The Valuation of Risks to Life and Health: Guidelines for Policy Analysis

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The task of valuing the impacts of government policies on life and health remains a particularly controversial undertaking. In part, this controversy has been stimulated by the special status accorded to health-related concerns, as reflected in the wide range of health-enhancing government programs. Unfortunately, there has also been much needless controversy stimulated by misconceptions regarding what the appropriate economic measure of the value of health status should be.

Initial efforts to value health focused on the direct monetary costs involved – the lost income, medical expenses, and other out-of-pocket outlays. Until recently, this approach was the dominant benefit assessment technique used by Federal agencies. The source of the popularity of the direct cost approach is that the task of benefit assessment becomes a well-defined problem. Data on worker wages are widely available, and a few minor assumptions enable one to obtain estimates of the economic costs of the health impacts. This precision is largely illusory to the extent that the analyst is not measuring the benefits of health risk reduction but rather a highly imperfect proxy for these broader concerns. In this review, I will outline a more appropriate procedure for such benefit assessments and the range of values associated with this approach.

Willingness-to-Pay Principles

The conceptual basis for valuing reductions in risks to life and health is the same as for other benefit categories. It is society's willingness to pay for this risk reduction that is the appropriate measure. Much of the benefit will be derived by those directly affected by the policy and by their families, but the altruistic concerns of society at large also enter. Whether or not those bearing the risk are cognizant of the risk or are compensated for incurring it (e.g., through wage premiums for risky jobs) does not affect the rationale for using the willingness-to-pay approach, although it may affect the desirability of the policy and how much society is willing to pay to reduce the risk. In particular, the perceived equity of the risk may be greatly affected by the presence of compensation.

Ever since the classic essay by Schelling (1968) economists have focused, not on how much society should pay to prevent certain death, but on how much we are willing to pay to save statistical lives. In particular, the pertinent benefit of a government program is a reduction of the probability of death or some other health aspect for a large number of individuals rather than the prevention of a certain number of deaths that might be identified after the fact.

One reason for this distinction is that society's valuation of an identified certain life is likely to be greater than that of a statistical life. A trapped coal miner whose plight is featured on the evening news may evoke more public concern than the unidentifiable beneficiary of automobile passive-restraint systems. This difference in attitudes is usually taken as an index of society's excessive concern for identified lives. However, one might see the pattern somewhat differently if one viewed the high valuation of identified lives as being the result of a more thoughtful expression of individual values than in the airbag case, where the implications for risk reduction may be less clear-cut to the casual observer. One also might view it as reflecting a greater sense of responsibility for identifiable fatalities. The consensus in the literature is that society places an irrationally large weight on identified lives, but the interpretation of this phenomenon is by no means straightforward.

A second reason for drawing a distinction between statistical lives and certain lives can be traced to the role of wealth effects. An individual's willingness to pay to reduce a risk should be greater per unit risk for small risks than for large risks. A similar principle determines one's attitude toward valuing large risks as opposed to small risks. If one were to purchase such a risk reduction sequentially by, for example, buying back bullets from a gun with which one is being forced to play Russian roulette, one would be willing to pay less for each successive bullet as each bullet was purchased because one becomes poorer with each bullet purchased.¹ For much the same reason, if a worker were willing to pay \$2 to reduce the risk of his job by one chance in a million per lifetime, this result does not mean he would be willing to pay \$2 million to prevent certain death. Such an allocation might greatly exceed his lifetime wealth.

To clarify the underpinnings of the value of risk reduction methodology, it may be instructive to summarize a model based on the job risk case considered in Viscusi (1979). In this instance, the value of life will be implied by the risk-dollars tradeoff selected by the worker.

Let p be the probability of an event that leads to one's death and $w(p)$ represent the schedule of annual earnings for jobs posing a risk p . The principal matter of interest is the slope of this relationship – the risk-dollars tradeoff. The increase in earnings in response to an increase in risk will be denoted by dw/dp (i.e., the derivative of earnings with respect to the risk

probability). For the case of certain death, this rate of tradeoff represents the implicit value of one's life; this magnitude in turn hinges on worker attitudes toward risk. More specifically, let Y^0 represent initial assets, x represent consumption (equal to $Y^0 + w(p)$), U^1 represent utility when healthy, and U^2 represent utility when injured or dead, where $U^1(x) > U^2(x)$; $U^1 > U^2$ and $U_{xx}^1, U_{xx}^2 \leq 0$. Then one can show that

$$\frac{dw}{dp} = \frac{U^1 - U^2}{(1-p)U_x^1 + pU_x^2} = \frac{\text{difference in welfare when healthy or injured}}{\text{expected marginal utility of compensation}}$$

If p represents the risk of death, dw/dp represents the implicit value per unit risk to one's life; for situations in which p represents the nonfatal risk, dw/dp represents the implicit value per unit risk of injury.

This equation makes clear the fact that the implicit value terminology is somewhat misleading, since dw/dp does not represent the amount the worker would require to accept certain death or injury. Rather, it reflects the worker's rate of tradeoff between risk and dollars for very small risks. According to this model, for sufficiently small risk changes, the risk-dollars tradeoff should be the same whether the individual is being paid to incur a greater risk or is spending money to purchase a reduction in risk. A worker who values his life at \$1 million will require \$100 to accept a 1 in 10,000 chance of death. Alternatively, if there were a group of 10,000 individuals, one of whom would be killed, then overall these individuals would accept one certain but randomly inflicted death if they were compensated \$100 each.

This development has been based on the assumption that individuals are rational and, more specifically, on the assumption that they maximize subjective expected utility (SEU). Although convenient analytically, the basic result regarding willingness to pay for marginal reductions in risk does not require that the expected utility hypothesis hold. As shown by Arrow (1983), one obtains similar results if individuals have utility functions that depend on consumption (or money) and the risk level, where this utility function need only be defined up to a monotone transformation.

The resolution of lotteries over time may create anxiety for the individual incurring the risk. This factor can be included as an additional component in the formulation of the willingness-to-pay analysis,² but its practical import is unclear. The possibility of cognitive dissonance with respect to risk-induced anxiety also arises if people find it beneficial to ignore the risks they face (see Akerlof and Dickens 1981). If this selective attention to one's environment occurs after one has made a risk-related choice, then the earlier analysis is

unchanged. If individuals do not make sensible choices with respect to risks because of cognitive dissonance, misperception of the risk, or some other type of irrationality, then the appropriate policy issue is how individuals would value the risk reduction *if* they were rational (see Chapter 5).

Adjustment in the Value of Life: Quantity, Quality, and Heterogeneity

The value attached to reducing risks to life and health will not be a single number. In the case of policies affecting individual's lives, these efforts do not confer immortality but simply extend an individual's life by preventing an immediate death. Saving the life of a 20-year-old will save a greater number of discounted expected life years than saving the life of an 80-year-old. At high discount rates such as the 10 percent rates now employed, these quantity adjustments will make little difference unless the age differences are stark. The discounted number of life years saved is about the same in each case.

The timing of the life extension is of consequence, however, in that one should discount deferred health benefits (in monetary terms) just as one would discount other deferred policy impacts. A frequently voiced counter-argument is that a year of hearing loss at age 25, for example, is no less important than a year of hearing loss at age 20. Therefore, these health impacts should receive equal weight, even though one of these incidents occurs five years later. At the time of their occurrence, these health effects may be associated with equal willingness to pay (WTP). The willingness-to-pay amount for the more immediate loss should receive a greater weight, since this money could be invested, giving it a terminal value five years hence that is greater than the original willingness-to-pay figure. The practice of discounting the monetary value of deferred health benefits accomplishes a similar result.

The choice of the appropriate level of the discount rate is by no means clear-cut. Consumers' inability to borrow and lend at the same rate is both a cause and a reflection of the existence of capital market imperfections and implies that the discount rate may be different for different consumers. Insurance market imperfections also influence observed interest rates since individuals will save more to provide for future contingencies in the absence of perfect insurance markets. These issues have been the focus of debates in the benefit-cost analysis literature for decades, and the administrative solution has been for the Office of Management and Budget to prescribe a 10 percent discount rate.

The quality of the life extension also matters, and ideally one should focus on quality-adjusted life years (see Zeckhauser and Shepard 1976). If the lives saved involve reduced capacity (e.g., a stroke victim), one should take this lower life quality into account, since the individual's own valuation of such a potential life extension would be less under these circumstances.

These quality concerns are particularly pertinent with respect to life-extending efforts for individuals with catastrophic illnesses. In the case of shifts in mortality distributions for individuals in good health, the quantity adjustments and particularly the discounting of deferred benefits are most essential.

These concerns are within individual variations in how health impacts should be valued. Additional concerns arise across individuals because of heterogeneity in the value of life. There is no theoretical restriction that individuals should have the same value of life. In general, individuals would be expected to have quite different values of life that hinge on their attitudes toward risk, just as their other tastes vary.

One determinant of the monetary value of safety that people will have is their individual wealth. There is a strong negative relationship between individual wealth and the risks one will choose to accept. The richer one is, the safer the job one will select from any given wage-risk schedule that is offered in the market, other things being equal. Society may wish to redistribute income or undertake educational programs to boost earnings opportunities so that people will not find it necessary to increase their income through hazardous work, but in terms of the market choices these different tradeoffs reflect the preferences individuals exhibit.

There is no natural force that would drive individuals to have the same risk-money tradeoff. Whereas most consumer items command a single price, jobs are likely to command quite different risk premiums per unit of risk for different people. This is because the risk of a job is indivisible and cannot be spread across the entire population.

Workers who are informed of these risks before they choose their jobs should select the occupations that are most appropriate for their own preferences. Individuals with low values of safety consequently should accept high-risk jobs and receive lower premiums per unit of risk, whereas individuals putting high values on safety should accept low-risk jobs and receive higher risk premiums per unit of risk. In many studies it has not been possible to estimate this heterogeneity in the value of safety (i.e., in the value of statistical lives) because of the lack of sufficient empirical information. Nonetheless, this inability does not imply that this heterogeneity is unimportant.

In circumstances in which the heterogeneity in valuations of health can be identified, incorporating these differences in a policy analysis may be controversial. Some might question that reducing the fatality risks for cigarette smoking should be accorded a low value, but a low-income worker who attempts to boost his income through a job as risky as smoking cigarettes might be viewed somewhat differently. The reason for incurring the voluntary risk may be of consequence insofar as it may affect society's altruistic concerns.

If one were to use uniform values of health for all individuals in these

situations rather than a lower value for those who are involved in largely voluntary, high-risk situations, in effect one would be valuing the high-risk individuals' lives by more than they would themselves. In the case of a regulation that alters the available job opportunities, the net effect may be to eliminate risk-dollar tradeoffs which the individuals themselves found attractive. To the extent that workers' decisions are rational, such regulations will lower their welfare. In the case of a program that provides medical services, a uniform value of life serves as an implicit means of redistribution. In doing so, it will be less efficient than a direct-transfer program in accomplishing this objective.³

The Human Capital Approach

Although the willingness-to-pay methodology is the generally accepted approach among economists, it is by no means the most prevalently used method for valuing health risks. For the past two decades the most popular approach has been to examine the financial costs associated with the health impact, principally medical costs and the present value of lost earnings. This technique, which is illustrated in the analysis by Rice and Cooper (1967), has been termed the human capital approach because it parallels that taken in the human capital literature developed by Theodore Schultz, Gary Becker, and others.

That branch of academic literature which deals with human resources does not attempt to value health but rather the economic implications of training and education. The assumption that monetary implications dominate the individual's choice of a job-training program is reasonable, but it is far less realistic to assume that foregone earnings are a good proxy for the value of a lost limb or one's life. Indeed, it is noteworthy that no leading economist associated with the academic research on human capital has ever espoused this approach to valuing health risks.

To the extent that the human capital approach has any merit, it is that it provides a technique for estimating willingness to pay. It is not a competing conceptual approach but rather an empirical approach to the value-of-life problem. The reason for its popularity among analysts is clear: it makes the analyst's task of valuing life a well-defined problem. Once equipped with a set of mortality tables and individual earnings, it is a straightforward task to calculate the human capital benefits measure. Unfortunately, the analyst is assessing an incorrect measure of benefits precisely, so that the results are not particularly meaningful. In terms of the nature of the results, the human capital approach leads to value-of-life estimates about an order of magnitude smaller than those that address the risk-dollars tradeoff directly.⁴ Clearly, individual well-being goes far beyond its financial implications.

Valuations Using Market Data

Conceptual Background

In most areas of economic inquiry, the usual approach to obtaining empirical estimates is to gather market data to estimate the relationship of interest. In this case, there is no explicit price for health outcomes, since individuals do not explicitly purchase risk reductions in the marketplace. Health effects are, however, among the attributes of products and jobs that individuals select. Ideally one would like to isolate the risk-dollar tradeoffs that are implicit in these choices. Indeed, since the time of Adam Smith (1776), economists have observed that hazardous jobs will command compensating differentials.

The techniques for assessing the risk-dollar tradeoffs were originally devised to analyze *hedonic*, or quality-adjusted, prices for automobiles (Griliches 1971). The quality component that will be the focus here is the risk associated with the job or product. Most of the emphasis to date has been on the labor market, since the extensive data available on characteristics of jobs and workers make it feasible to disentangle premiums for job risks from premiums for other attributes of the job.

The standard approach is to specify an earnings equation and to identify the risk premiums, controlling for other factors that influence one's income. More specifically, let w be the workers' annual earnings, x_i ($i = 1, 2, \dots, n$) be a series of explanatory variables (e.g., education and union status), p be the annual death risk, and q be the annual nonfatal injury risk. The general linear form of the earnings equations is:

$$w = \alpha + \sum_{i=1}^m \beta_i x_i + \gamma_0 p + \gamma_1 q + u$$

where u is a random error term. In some analyses, the dependent variable is the natural logarithm of w . The coefficient γ_0 of p represents what has been termed the implicit value of life (i.e., $\partial w / \partial p$), and γ_1 represents the implicit value of a nonfatal injury. In fact, these values represent the risk-dollar tradeoff, not the value the person would place on certain death or injury. To the extent that the job risk variables measure the worker's true risk with some random measurement error, the resulting value of life estimates will be biased downward.

A model of this type would include the following explanatory variables. The x_i capture income-related personal characteristics (i.e., age, race, sex, marital status, education, job experience) and job-related characteristics (i.e., unionization, industry, occupation, supervisory status, physical conditions, work speed). The inclusion of extensive nonpecuniary job characteristics variables is essential to ensure that the estimated values of γ_0 and γ_1 reflect premiums for risk rather than rewards for other, possibly correlated,

unpleasant job attributes. Studies that have included such lists are those of Viscusi (1979), which is based on the workers' particular job, and Brown (1980), who linked the worker's occupation to a set of average characteristics. Indeed, most studies do not even include the nonfatal injury rate because of an inability to successfully disentangle the premiums for fatal and nonfatal risks.

Empirical Estimates

The principal studies of market premiums for risk are summarized in Table 7-1. With the exception of Blomquist's (1979) analysis of seatbelt usage and Portney's (1981) study of the effect of air pollution on property values, the analyses all use labor market data. Those nonlabor market studies are more indirect. Blomquist, for example, had to construct an elaborate model to link the seatbelt buckling decision and its discomfort to the value of life. Portney's study utilized air pollution data, dose-response information, and property value data to infer a price-risk tradeoff. This analysis assumed that individuals are aware of these linkages and that it is the mortality risk that is instrumental. The labor market studies utilize an industry-specific risk level which should be a more direct index of the risks.

The usual procedure is to match workers' jobs or occupational classification to some measure of the risk using occupational fatality data based on life insurance or Bureau of Labor Statistics industry rate measures. Occupational risk measures have the advantage that the risks of occupations may be more similar across industries than are risks of a job within an industry. However, there has been no empirical verification that this is the case. In addition, life insurance data reflect non-job-related risks of death as well as those associated with the job, which is a disadvantage.

Ideally, one would like to use workers' subjective assessments of the risk rather than an objective proxy for the risk level, since it is the individual's own risk beliefs that will drive market outcomes. The University of Michigan Survey of Working Conditions data (see Viscusi 1979) utilize a danger-perception dummy variable that takes on a value of one if the worker believes that his job exposes him to dangerous or unhealthy conditions, and zero if it does not. Although this variable provides only a rough approximation to the actual risk level, the derived annual risk premium was almost identical whether one used the subjective risk perception data or the Bureau of Labor Statistics industry injury risk.

Of the labor market studies, the principal outlier is by Thaler and Rosen (1976), whose value of life estimate of \$580,000 is the lowest from the labor market. This result is not spurious but is attributable primarily to the nature of their sample. The Thaler-Rosen results pertain to workers in very high risk jobs with an average annual risk of fatality of 1/1,000. In contrast, the average job poses an annual fatality risk of 1/10,000. Because of the

Table 7-1. Summary of market studies of risk tradeoffs*

Investigator	Sample	Implicit value of life	Implicit value of nonfatal injuries
Blomquist (1979)	Seatbelt usage, Panel Study of Income Dynamics, 1972	\$560,000	-
Brown (1980)	National Longitudinal Survey, 1967-1973	\$1-\$1.5 million	-
Leigh (forthcoming)	Panel Study of Income Dynamics, 1974	\$3.8-\$8.9 million*	\$45,000-\$56,000
	Quality of Employment Survey, 1977	\$4.8-\$8.4 million*	\$38,000-\$64,000
Olson (1981)	Current Population Survey, 1973	\$7.4 million	-
Portney (1981)	Air Pollution and Property Values	\$593,000-\$890,000	-
Smith (1965)	Current Population Survey, 1967	\$7.5 million	-
	Current Population Survey, 1973	\$3.3 million	-
Thaler and Rosen (1976)	Survey of Economic Opportunity, 1967	\$580,000	-
Viscusi (1979)	Survey of Working Conditions, 1970-71	\$2.9-\$3.9 million	\$23,000-\$34,000
Viscusi (1981)	Panel Study of Income Dynamics, 1976	\$7-\$11 million*	\$32,000-\$35,000
Viscusi and O'Connor (1984)	Survey of Chemical Industry Workers	-	\$10,000-\$13,000

*All prices are in 1982 dollars. The asterisked results for the Leigh and Viscusi studies are evaluated at the mean risk level for the sample for models in which the heterogeneity in wage-risk tradeoffs was assessed. The appropriate implicit values were calculated from the regression equations using the appropriate $\partial w/\partial p$ and $\partial w/\partial q$ values discussed in the text.

heterogeneity of values of individual risk and self-selection of workers with low values into high-risk jobs, one should expect to obtain a lower value of life using a sample of workers in risky jobs.

For purposes of policy analysis, the appropriate value of life depends on whose values we wish to assess. If a regulation affects individuals who have voluntarily put themselves into high-risk activities, a value of life around \$600,000 seems appropriate. For risks that are more modest or have been incurred involuntarily, the appropriate value of life will be that of a more representative worker, which is in the range of about \$2 to \$3 million or

more. Very small, involuntary risks, such as those associated with nuclear or airline safety, may command much higher values.⁵

The only other health outcomes that have been assessed using market wage studies are nonfatal work accidents. These accidents involved one or more lost workdays in about half the cases. Once again, there is a reasonably broad range of estimates.⁶ The findings by Leigh (forthcoming) may be somewhat higher than the previous studies suggested, since he did not include a detailed set of nonpecuniary job characteristic variables. Therefore, his injury risk variable will reflect premiums for omitted job attributes correlated with riskiness. An estimate of a value of a nonfatal injury of about \$20,000 to \$30,000 might best be viewed as the consensus injury value range based on these studies.

The market risk studies have at least indicated the general order of magnitude of individuals' monetary valuations of life and injury. Perhaps the greatest research need is to expand the scope of health effects for which benefit values can be determined.

Nonmarket Valuations

Court Awards and Workers' Compensation

Work and seatbelt decisions are not the only choices involving risks from which one might attempt to impute a value of life. This literature began with an examination of life insurance policies (see Eisner and Strotz 1961). Life insurance does not, however, affect individual health. Instead it is directed at providing compensation after one's death. Examination of life insurance policies may provide information regarding the optimal bequest, but it does not indicate how much it is worth to extend lives.

Settlements in court cases tend to have a similar focus since the emphasis has been on compensating victims for monetary losses, principally foregone wages and medical expenses, rather than for pain and suffering. These nonmonetary aspects may be the dominant concern in the case of severe health impacts. The average bodily injury payment for fatalities in product liability cases is about \$212,000 (1982 prices), which is about one-tenth or less than the values of life obtained in studies of market risk premiums.⁷

Nevertheless, there are some instances, particularly those involving scarring and brain damage, in which court awards may provide some guidance regarding the implicit value attached to nonmonetary aspects of health outcomes.⁸ Table 7-2 summarizes the distribution of bodily injury payments for various types of health outcomes. What is most noteworthy is the comparatively small magnitudes involved, except in cases such as brain damage, quadraplegia, and paraplegia where the medical expenses are particularly high. These product liability payments reflect not only jury verdicts, but also out-of-court settlements, which generally are for consider-

Table 7-2. Distribution of payments by injury diagnosis, bodily injury cases

Injury diagnosis	Percent of successful claimants with this injury	Average payment
Amputation	2.6%	\$112,988
Asphyxiation	1.0	69,787
Bruise-abrasion	3.8	5,165
Burn	7.6	78,786
Concussion	0.7	32,479
Dermatitis	2.1	1,468
Dislocation	0.3	32,120
Electrical shock	0.3	31,728
Fracture	16.7	21,146
Laceration	14.5	11,240
Poisoning	16.1	1,102
Strain-sprain	3.4	25,198
Disease-respiratory	0.6	59,621
Disease-cancer (including Hodgkins disease, leukemia)	0.3	166,883
Disease-other	0.9	17,414
Paraplegia	0.1	319,620
Quadriplegia	0.1	505,355
Brain damage	0.8	357,482
Other	28.1	16,127
Total	100.0%	\$25,680
Unknown	-	\$39,592

Source: Insurance Services Office (1977: 116). All figures are in 1977 prices.

ably lower amounts. Exploration of the jury verdict subsample may be instructive in providing insight into the values society at large attaches to various health outcomes.

Workers' compensation benefit levels also provide a potentially useful source of information on the valuation of various health outcomes (Oi 1973). As the payment schedules in Table 7-3 indicate, there appears to be very little attempt to fully reflect the values from the standpoint of prevention, which include the health impact as well as the monetary consequences. The loss of a thumb, for example, has an upper benefit limit not unlike the average value of a work accident involving at least one lost workday, which will typically be much less severe than losing one's thumb. This disparity is to be expected. The appropriate value of life and health from the standpoint of compensation will generally be less than for prevention. As a result, analysis of levels of *ex post* compensation will provide only an underassessment of the value of prevention.

A final possible source of information for assessing the appropriate value of health risk prevention is to examine the values implied by past societal decisions.⁹ Although potentially instructive as a very rough means for

Table 7-3. Income benefit range under workers' compensation payments, 1983

Scheduled injuries	Low	High
Arm at shoulder	\$10,000	\$125,460
Hand	8,675	102,510
Thumb	3,250	31,248
First finger	1,800	18,257
Second finger	1,350	15,624
Third finger	924	12,475
Fourth finger	600	11,475
Leg at hip	9,360	125,460
Foot	6,000	81,340
Great toe	1,200	19,960
Other toes	480	11,475
Eye	6,000	84,150
Hearing (one ear)	2,000	24,950
Hearing (both ears)	8,000	87,325

Source: U.S. Chamber of Commerce (1983).

assessing the opportunity cost in terms of the performance of a program compared with other life-enhancing efforts, this technique is based on the implausible assumption that past decisions were optimal. Most legislative mandates of risk regulation agencies are not based on a balancing of the costs and benefits to ensure that policies maximize society's welfare; they are much narrower in scope. Therefore, it is inappropriate to analyze past decisions as if such an optimization were taking place.

There are also numerous practical difficulties in terms of comparability. Since agencies have used different discount rates and underlying technical assumptions, the results often are not comparable across different policies.¹⁰ In addition, risk-reducing policies typically have multiple health impacts, not simply one. Since no previous analysis has attempted to make the necessary adjustments to take these multiple effects into account, this produces a possibly spurious variation in the apparent efficacy of different agencies' programs.

Interviews and Contingent Valuations

Risk-dollar tradeoffs based on actual decisions offer the advantage that these choices presumably reflect individuals' underlying preferences. An alternative, more direct approach is simply to ask individuals what their tradeoffs are or how much they would be willing to pay for a particular risk reduction (Jones-Lee 1976). This interview approach has gained increasing popularity recently in the environmental area, where it has been dubbed contingent valuation and is now being applied to health risks by several research groups.¹¹ Although some of these efforts are focusing on traditional concerns, such as mortality risks, others are addressing consumers' valua-

tions of hand burns, choramine gas poisonings, and poisonings to children from bleach and liquid drain opener.

The first study of this type was by Acton (1973), who surveyed individuals' willingness to pay for improved ambulance service for heart attack victims. This study, which was innovative in many respects, produced a comparatively low value of life – under \$100,000. This result may be an aberration due to the small sample size (36) or the focus on post-heart attack lives, which should be valued less. A more likely possibility is that individuals did not think carefully about the inherently difficult questions concerning willingness to pay for improved ambulance service and its link to their health.

Another potential limitation of interviews is that the subject may misrepresent his preferences either to impress the interviewer or to influence policies affected by the numbers. For familiar strategic reasons a respondent might have the incentive to misrepresent his willingness to pay for publicly supported risk reduction efforts, particularly if he will not be required to back up his responses financially. Appropriately structured questionnaires can reduce this difficulty.

Interview techniques have inherent shortcomings and may not be a good substitute for market risk premium analyses when these are feasible. However, if undertaken in a manner that closely resembles market behavior, interviews do represent a potentially promising mechanism for expanding the range of health outcomes for which we can assess the benefits.

An Example: OSHA Chemical Labeling

This section provides a brief illustration of a derivation of the value of life and health based on an assessment of the OSHA chemical labeling regulation.¹²

This illustration will not be a benefit-cost analysis but rather a cost-effectiveness analysis, since benefit-cost tests are frequently ruled out by agencies' legislative mandates. In addition, the appropriate value of the health outcome is often a key and controversial parameter. Rather than bury the health valuation assumption in a complex analysis, it seems preferable to indicate the cost per unit health impact, which policy makers can then compare with results such as those in Table 7-1 to ascertain whether the program is reasonable.

In the case of the chemical labeling standard there was an additional major uncertainty. OSHA claimed that the standard would eliminate 10 percent of all chemical-related injuries and illnesses, whereas OMB viewed a 5 percent figure as being more reasonable. Table 7-4 provides a sensitivity analysis using these two assumptions. The first line of the table lists the discounted costs of the regulation less all discounted benefits that have been monetized. By netting out all nonhealth impacts, such as the reduced

Table 7-4. Health impacts prevented and cost health impact

	Lost work-day equivalents			
	Weights – 1, 1, 20* Effectiveness		Weights – 1, 5, 20* Effectiveness	
	5%	10%	5%	10%
Net discounted costs less monetized benefits	2.632×10^9	2.616×10^9	2.632×10^9	2.616×10^9
Total lost work-day equivalents (discounted)	9.5×10^4	18.9×10^4	24.7×10^4	49.7×10^4
Net discounted cost/lost work-day equivalent	\$27,900	\$14,000	\$10,700	\$5,300

*These are the relative weights placed on lost work-day cases (always 1), disabling illnesses (1 or 5), and cancers (always 20) in constructing a measure of lost work-day equivalents.

costs of fires, the analysis can address the cost and health concerns alone.

Doing so is not straightforward, however, since there are three general classes of health effects – accidents, disabling illnesses, and cancer – to be placed on a common metric. Suppose, as a tentative value judgment, that a case of cancer has value comparable to the value of life of a worker in a high-risk job. In this case it should receive a benefit value roughly 20 times that of a lost work-day accident. As a result, preventing a discounted case of cancer would be treated as equivalent to preventing 20 work-day accidents. One could potentially justify a relatively higher cancer weight, but doing so will not be necessary for regulation to be desirable. In this case, the object was to perform a sensitivity test to see whether the regulation was desirable. Use of higher cancer values, which may increase benefits by a factor of 5 or more, will increase benefits accordingly.

The relative severity of disabling illnesses due to chemical illnesses is less clear, so weights of 1 and 5 lost work-day case equivalents were used, implying a value between \$30,000 and \$150,000. Under all assumptions outlined in Table 7-4, the cost-effectiveness is at or above the levels needed to issue the regulation, which the Reagan administration did.

The two principal ingredients in this analysis that may be useful for future studies are the use of a cost-effectiveness framework and a sensitivity analysis that attempts to weight multiple health impacts. The standard approach of calculating magnitudes, such as the cost per life, implicitly ignores all other health implications and may provide a misleading index of a policy's efficacy.

Conclusions

Despite the inherent sensitivity of valuing risks to life and health, these tasks are not beyond the capabilities of policy analysis. The underlying theoretical issues have been examined in detail, and there is a consensus among economists that the willingness-to-pay approach is appropriate for valuing health risks. In the case of some risks, particularly those for mortality, a good deal of research has already been done. A major task is to expand the scope of health impacts for which we have benefit values and to better utilize the findings we do have in policy analyses.

It is noteworthy how far the policy approach to these issues has advanced in recent years. For the past few years, agencies such as EPA and OSHA have introduced the willingness-to-pay measure into their regulatory analyses, basing these values on labor market estimates of the risk-dollar tradeoff.

Indeed, as of 1984, the valuation of life has become a generally accepted component of the debate over risk regulation. The recent debate over an OSHA construction industry standard epitomizes this change.¹⁴ Rather than claiming that the value-of-life issue was too sensitive to be discussed, there was an open policy debate over the appropriate value of life. OSHA used a value of life of \$3.5 million in its regulatory analysis based on results for the average blue-collar worker. OMB took a different approach, citing evidence regarding the heterogeneity in the value of life. After noting the high and well-known risks associated with construction jobs, OMB urged that OSHA use a lower value of life of \$1 million. One Congressman viewed both of these estimates as too low, advocating a \$7 million figure in line with results for the Panel Study of Income Dynamics. In each case, the willingness-to-pay approach was accepted, as was the importance of using labor market studies as a reference point.

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Notes

1. This Russian roulette analogy and its solution have been part of the oral tradition in the risk regulation area for over a decade. The originator was Zeckhauser (1975). See Weinstein, Shepard, and Pliskin (1980) for related work.
2. Although the most extensive analysis of anxiety effects and their relation to the marginal value of life is in Viscusi (1979), pivotal antecedents in the literature are the papers by Zeckhauser (1974) and Schelling (1968).
3. Hylland and Zeckhauser (1979) formalize this point for the general redistribution case.
4. Such a gap is to be expected. See Shepard and Zeckhauser (1984).

5. During a discussion at the Users Workshop, a consensus of the participants indicated a range of \$3-\$7 million.
6. Olson (1981) also finds nonfatal injury premiums but does not report an implicit value.
7. The payment data in 1977 prices appear in the Insurance Services Office (1979:113).
8. Scarring appears to be the chief health-related variable that has an impact on product liability settlements beyond its monetary implications.
9. See, e.g., Broder and Morrall (1983), Graham and Vaupel (1983), Viscusi (1983), Miller and Yandle (1979), and Morrall (forthcoming).
10. A principal exception is the careful analysis by Broder and Morrall (1981).
11. For a critique and review of this approach, see Cummings, Brookshire, and Schulze (1984).
12. W. Kip Viscusi, 'Analysis of OMB and OSHA Evaluations of the Hazard Communication Proposal.' Report Prepared for Secretary of Labor Donovan, March 15, 1982. The assumptions altered from those in the OSHA analysis included, among others: the effectiveness assumption, the incidence of disabilities, the fraction of cancer cases affected by labeling, medical cost inflation, and time lags before there is an effect on diseases that occur with a lag.
13. See the *New York Times*, March 23, 1984, p.13 (national edition) for discussion of the regulation and the role of this analysis in Vice President Bush's decision to issue the regulation despite OMB's earlier objections.
14. See the *Washington Post*, Oct. 24, 1984, p.A15, and the *New York Times*, Oct. 26, 1984, p.8 (national edition).

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