Valuation Methodology

Many major contributions to economics, when first introduced, represented highly controversial shifts in perspective, but ultimately were perceived as the clearly correct solution to a problem. Such was the case with Thomas Schelling's classic 1968 essay, "The Life You Save May Be Your Own." By showing how the willingness-to-pay methodology could be applied to value-of-life issues, he extended the domain of economic inquiry to a topic that economists had largely avoided.

Traditionally, issues pertaining to the valuation of human life had been treated as strictly moral concepts, not matters to be degraded through economic analysis of choices and trade-offs. Schelling de-mystified these issues by extending benefit valuation procedures used in other policy contexts. In general, the appropriate benefit measure for risk reductions is the willingness-to-pay to produce the particular outcome.\(^1\) Similarly, the selling price for changes in risk establishes the value for risk increases.

In many decisions—for example, determining what safety characteristics to provide in automobiles—the policy result to be assessed is an incremental risk reduction rather than a shift involving the certainty of life or death. This need to think in terms of statistical lives as opposed to certain lives defines the main character of the choice problem. In particular, the matter of interest is individuals' valuation of lotteries involving life and death.

Addressing value-of-life issues by focusing on our attitudes toward lotteries involving the risk of death provided a methodology for formulating these issues in a sound economic manner. Moreover, Schelling's approach of addressing the issues within the context of ex
ante lotteries serves to diminish the bitterness of the value-of-life debate. Nevertheless, the concerns involved remain inherently sensitive, and we should not be too cavalier in making these judgments.

Perhaps the most important concern is that of the degree of volition of those bearing the risk. As Hammond (1982) has emphasized, if we impose risks on people involuntarily and do not provide them with compensation, then our ex ante value-of-life measure may not be a compelling guide for policy. This concern is, however, pertinent to all benefit valuation issues, not simply those involving the value of life.

A related ex ante-ex post valuation issue is that raised by Broome (1978), who suggests that if lives have an infinite value, the use of value-of-life lotteries cannot provide us with a solution to this intractable problem. This observation does not indicate a flaw in our methodology because an infinite value of life would be mirrored in an infinite value for a lottery involving a risk of death. The fact that we make a myriad of decisions involving life and death—including the animal fats we ingest and the risky but fuel-efficient cars we drive—indicates that we are willing to trade off risks of life for other valued objectives. The approach I will take here will adopt the value-of-life lottery approach, recognizing as did Schelling that this formulation structures the difficult choices, but does not eliminate them.

Because of the central role of individual preferences, individual values of life may differ considerably, just as do other tastes. A central concern is who is valuing the life and for what reason. As Schelling indicates, a particular life may have one value to the individual, another to his family, and still another to society at large.

As the willingness-to-pay methodology has become better understood, the controversy surrounding the entire line of research on the value of life has diminished. Much of the early opposition to the economic valuation of life stemmed from the reliance on value-of-life concepts that had been developed to inform decisions on compensating survivors rather than on reducing risks to life. Initial efforts consequently sought to value life using the human capital approach. In particular, analysts such as Rice and Cooper (1967) and Mishan (1971) estimated values of life based on various measures of earnings. This technique, which continues to be used throughout the United States court system to assess damages for personal injury, addresses only the financial losses involved. The death of a family member, for example, would impose a financial loss on survivors, which would be measured as the present value of the income he would have earned
net of taxes and his consumption. Similarly, the present value of taxes he would have paid represents the financial loss to the rest of society.

Schelling (1968, p. 134) dismissed this widely used accounting approach altogether, observing that "it is doubtful whether the interests of any consumers are represented in a calculation that treats a child like an unfinished building or some expensive goods in process." The battle lines had been drawn between the willingness-to-pay approach and the human capital viewpoint.

Value-of-life issues raise a series of questions for research. The first, which was the focus of Schelling's original essay, is how we should think about these issues methodologically. The second class of issues involves estimating the risk-dollar trade-offs that, in effect, are the value of life. Third, how can individuals make sound decisions regarding the risks they face? Finally, what approach should guide choices when society is making protective decisions?

Although the role of altruism complicates all policy valuations, the final class of questions becomes most problematic when we depart substantially from the private market analogy. When the government is providing risk reductions to a group with similar preferences and similar risks, then matters are relatively straightforward. However, if preferences differ because of wealth, if individuals cannot make fully rational decisions with respect to a risk, or if the parties affected are not currently alive, the choice process involves a greater leap because we become less confident of how hypothetical markets would function if they were perfect.

This chapter will explore the development of Schelling's methodology and its broader ramifications. I begin by briefly reviewing the empirical evidence pertaining to the value of life. An instructive comparison is between the market evidence and the survey evidence that has been developed, including the original survey estimates presented in Schelling's article. As we will see, the general order of magnitude estimated in Schelling's paper remains approximately correct, but advances in empirical methodology have led to considerable refinement of these estimates.

Although Schelling's paper focused on private rather than public valuations of life, he did recognize the importance of public concerns. In practice, value-of-life discussions arise principally in the context of public decision making, which is the focus of the following section.

A continuing theme in Schelling's work has been the role of ethical and strategic issues in decision making. Although decisions involving
the value of life can be analyzed as we would any other economic choice, many of the more intriguing aspects of the topic are related to the distinctive and highly sensitive concerns that may arise. One such set of concerns has to do with rationality and self-control. In particular, if individuals do not make sound decisions on their own behalf, what role should society play in influencing these decisions? Moreover, if we are going to intervene, how do we identify what Schelling terms the "authentic self?" I extend the domain of these considerations from the individual and his alter ego to the mother and her unborn child. If we do not fully trust the decisions individuals make on their own behalf, to what extent should we allow mothers to make decisions on behalf of the fetus, especially if these decisions pose a risk to the child?

The recognition of disparities in wealth poses particularly controversial issues for valuation of life. How we treat this issue may depend on the context in which it arises whether, for example, we are talking about rich and poor groups who are alive today, or future generations that may differ in wealth from our own. I conclude this essay with observations about the appropriate role of economics in framing value-of-life decisions.

Estimates of the Value of Life

The ultimate purpose of the value-of-life literature is to provide some basis for sensitive social decisions. Before investigating how society should make decisions involving the saving of lives, we will first assess whether we can establish an empirical reference point for making trade-offs involving life and health. In the absence of such empirical information there will be few operational contexts in which economic analysis of value-of-life decisions is instructive. Some sense of the order of magnitude of the value-of-life estimates will also assuage many of the concerns expressed about the morality of this line of work. If the appropriate economic value of life is over $1 million, resistance to this methodology will probably be much less than if the estimate is, say, $200,000.

Schelling (1968) identified two ways to establish the value-of-life reference points: using information provided by the price system, and survey-based results. He noted potential inaccuracies with each approach, and similar concerns continue to be expressed in the litera-
ture. However, more detailed empirical data bases and more sophisticated statistical and survey methodologies have enabled us to refine these estimates considerably. The success of these efforts has been much greater than might have been expected two decades ago.

Market-Based Estimates

Since the time of Adam Smith, economists have observed that workers will require extra compensation for hazardous jobs. Similarly, safer products will command a higher price. The problem in analyzing these implicit markets for safety is to disentangle the premium for risk from compensation for other aspects of the job or product. For example, the most attractive jobs in society also tend to be the highest paid; as one becomes richer one will value safety more (provided that safety is a normal economic good). This income effect will make it difficult to disentangle the positive wage premium for job risk, because the level of risk chosen will be negatively related to one’s lifetime wealth. These competing effects account for some of the mixed findings in the literature.³

Because of these difficulties, much of the early research on the link between job risks and wages found a positive relationship. With the advent of large data sets on individual worker behavior, economists were able to sort out the key relationships using detailed information on attributes of the worker, the job, and the structure of compensation.

The diverse sources of job risk information used in such studies have included information on occupational death risks by occupation,⁴ industry death rates,⁵ and self-assessed risk levels for the particular job.⁶ Much of the variation in the empirical results obtained with this econometric methodology can be traced to specific aspects of the death risk and the estimation procedure. Establishing estimates of the value of life using benchmarks from the labor market is no different from other econometric endeavors such as estimating the elasticity of demand for a product or the responsiveness of worker commuting patterns to travel distance. More reliable data lead to better estimates. The progress made in this literature over the past decade owes much to the acquisition of more specific data relating to job safety and the recognition of other factors influencing the wage-job risk trade-off, notably workers’ compensation.⁷
To obtain a sense of the range of the estimates, consider several studies from the literature. Thaler and Rosen (1976) considered wage-risk trade-offs for workers in very risky jobs. Their sample consisted of workers who had an incremental annual mortality risk of 1/1,000 per year, which is an annual death risk roughly ten times as great as the job-related risk for the typical worker. They found an implied value per statistical life on the order of $700,000 (in 1988 prices). Individuals with low rates of trade-off between risk and dollars should select themselves into risky occupations. As a consequence, Thaler and Rosen believed that their estimates of the implicit value of life were relatively low.

Other studies have focused on value-of-life estimates for a more representative group of workers who faced an annual risk of death of 1/10,000. These studies imply a value of life on the order of $3 million, far higher than the original Thaler and Rosen figure. The difference reflects the variation in risk levels faced by the workers. These two sets of results have been reconciled by an explicit estimate of the heterogeneity in the value of life as a function of the job risk, indicating that workers in high-risk jobs place a lower value on life than workers in low-risk jobs.

As Schelling (1968) observed, estimates of the market premiums for risk will be limited by inadequacies in the data. Random measurement error will bias the estimates of the value of life downward, so that market-based estimates are likely to be low. The occupational fatality data used by Thaler and Rosen were not ideal because they did not reflect industry differences in risk; nor did they distinguish risks of the job from other risks correlated with the activities of people in different occupations. Similarly, the Bureau of Labor Statistics (BLS) industry death risk statistics used in many other studies are not free of measurement error either, because they do not take into account occupational differences in risk within an industry. In addition, the BLS uses a sample of deaths to establish an economywide projection.

The reporting error problem was sufficiently serious that in the early 1980s the National Institute of Occupational Safety and Health undertook a census of every occupational fatality in the United States over a five-year period. This effort, the National Traumatic Occupational Fatality Project, yielded a new set of death risk statistics, which presumably should reduce the measurement error associated with
the BLS estimates. Inclusion of the new job fatality variable in a wage equation to estimate compensating differentials doubles the value of life to $6 million.\textsuperscript{10}

Other market contexts also can be used to estimate a risk-dollar trade-off and hence to construct a value-of-life figure. An ingenious effort by Blomquist (1979) inferred a value of life from data on individual seat belt use, with a result similar to that estimated by Thaler and Rosen. For the most part, however, estimates using data other than labor market information have not been as successful because not enough detail is available to isolate the individual’s trade-off between risk and dollars. Labor markets are not only important sources of risk, but (at least now) the best documented; as a result, the market for risky jobs has provided the most fertile area for investigating how individuals in market contexts value risk.

Even if we accepted the reliability of the empirical estimates, they would not resolve all benefit assessment issues. Econometric studies yield estimates of an average valuation across a sample of individuals. Moreover, the risk being valued is a composite of all types of death. In general, our attitudes toward death from cancer, explosions, auto accidents, and other causes may be quite different, but current empirical efforts have not been sufficiently refined to distinguish these differences.

Survey Estimates

If market evidence is unavailable or inconclusive, one can turn to survey evidence to estimate risk-dollar trade-offs. Surveys, however, reflect stated preferences as opposed to actual preferences revealed through individual decisions. The correspondence between stated and actual preferences may not be direct.

The possibility that people may misrepresent their preferences for strategic reasons has long been a concern in the benefit evaluation literature. A more important practical consideration is that respondents may find it difficult to think about and give sensible answers to questions involving risks of death. In Schelling’s (1968) original paper, for example, his sample was better able to address a lifetime risk of 1/10 than a lifetime risk of 1/1,000. For his respondents with an average 1968 income of $20,000 to $30,000, the implicit value of life was on the order of $1 million. In his 1984 revision of the paper,
Schelling updated his statistics to indicate that an implicit value of life of $2 million would be associated with an annual income in the range of $40,000 to $80,000.

These estimates tend to be somewhat lower than those estimated with market data, perhaps because of the more substantial level of the risks involved.11 Most market studies of risks have focused on an annual risk of death on the order of 1/10,000, whereas Schelling's survey addressed risks of 1/10. In addition, whereas the market focuses on individual willingness to accept risk, Schelling's survey focused on willingness-to-pay for risk reduction. For extremely small increments in risk, willingness-to-pay values will equal willingness-to-accept values. However, for large risk increments willingness-to-accept values will exceed willingness-to-pay values, as has been borne out empirically.12

This relationship can be traced to a wealth effect.13 As one purchases successive risk reductions in a willingness-to-pay context, one becomes successively poorer, thus reducing the risk-dollar trade-off for the next incremental reduction in risk. Similarly, if people are paid to bear risk, each additional increase in wage compensation increases their affluence, thus increasing the risk-dollar trade-off. These wealth effects induce a spread between the willingness-to-pay and willingness-to-accept values. Because Schelling's respondents addressed a very considerable risk, the spread is likely to be of substantial consequence.

Perhaps the main shortcoming of survey investigations is that unless a meaningful decision context is recreated for the subjects so as to induce thoughtful and honest responses, the estimates will not be reliable. In an innovative early study of willingness to pay for improved ambulance service, Acton (1973) found that individuals valued lives at less than $100,000. This estimate may have reflected strategic considerations with respect to prospective tax payments; a more fundamental problem may be that individuals were dealing with decisions they did not generally confront and as a consequence did not have a realistic sense of what the appropriate financial trade-off should be.

One way to circumvent this problem is to construct a survey situation that replicates a market decision context. For example, one could ask individuals how they valued differences in risks associated with risky products. This methodology was used for nonfatal risks in a
Table 15.1
Median trade-off rates based on surveys of individual preferences

<table>
<thead>
<tr>
<th>Health outcome of interest</th>
<th>Survey trade-off</th>
<th>Median value of trade-off</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chronic bronchitis</td>
<td>Chronic bronchitis/auto deaths</td>
<td>0.32 probability of automobile fatality</td>
</tr>
<tr>
<td>Chronic bronchitis</td>
<td>Chronic bronchitis/cost of living</td>
<td>$457,000</td>
</tr>
<tr>
<td>Automobile deaths</td>
<td>Automobile deaths/cost of living</td>
<td>$2,286,000</td>
</tr>
<tr>
<td>Chronic bronchitis</td>
<td>Chronic bronchitis/auto deaths, chained with auto death/cost of injuries on medical basis</td>
<td>$800,000</td>
</tr>
</tbody>
</table>

Source: See Viscusi, Magat, and Huber 1989.

chemical labeling study by Viscusi and O'Connor (1984). The structure of the survey methodology was replicated by Gerking, de Haan, and Schulze (1988) in the case of fatalities. They found a willingness-to-pay amount of $2.7 million, which they concluded was roughly in line with the job risk literature.

Construction of Utility Functions for Life and Death

Rather than focusing solely on local risk-dollar trade-offs, Schelling (1968) also suggested the use of hypothetical lotteries to establish utility functions for a variety of health attributes. One could obtain such a scaling by, for example, finding the death-risk equivalent of blindness. This methodology has since become more widespread and has been advocated by the leading textbooks in the area.14

This technique has also been implemented on a large scale in the case of individual valuations of severe chronic bronchitis, a major health effect of air pollution.15 In particular, for the top set of estimates in table 15.1, the median individual in a sample of 400 respondents viewed chronic bronchitis as being equivalent to a 1 out of 3 chance of an automobile death. Chaining this response with the individual's risk-dollar trade-off between automobile deaths and cost of living, which implied a $2.3 million value of life, then establishes the implicit value of chronic bronchitis in terms of the risk-dollar trade-off.
Of course, survey respondents could be asked to put a dollar value on chronic bronchitis risk. It is often difficult to respond sensibly to such questions, however, because they require unfamiliar trade-offs across different classes of attributes. Moreover, survey questions regarding small risk reductions for ailments such as chronic bronchitis presuppose sophisticated abilities to think sensibly about such probability information. In practice, two samples that were asked how much they would be willing to pay for a 1/1,000 risk reduction and a 1/10,000 risk reduction might well give similar responses, even though the risk levels differ by a factor of 10.\textsuperscript{16} When respondents' attention is focused on a risk-risk trade-off in which the risk probabilities are of similar magnitude, they can concentrate on the relative severity of health outcomes such as blindness or permanent disability in relation to other health outcomes such as death without having to deal explicitly with the probability information. Strategic considerations also could taint the responses, but at this stage of development the primary task has been simply to ensure that people understand the risky decision and give thoughtful responses. This literature should ultimately establish a variety of metrics that can be used to measure the attractiveness of different life-enhancing efforts. Although dollars are the usual denominator for economists, a lives saved metric could also be used to put health effects on a comparable basis. The findings in table 15.1 do this using automobile deaths as the reference point, but other approaches are possible as well.

Valuing Life for Policy Decisions

Adopting the willingness-to-pay approach and establishing empirical estimates considerably simplifies the task of addressing value-of-life issues in policy contexts. For private decisions, the dominant concern will be the private willingness-to-pay amount. For public choices, it will be society’s overall willingness-to-pay for the risk reduction. One would expect that the greatest benefit from a life-extension policy will be that received by the individual whose life is directly affected, so private valuation provides a good starting point for assessing the value of life.

Although Schelling (1968) speculates that most externalities will be captured through accounting procedures that reflect an individual’s broader impact on society, such as taxes, the extent and implications of altruistic concerns have yet to be estimated precisely.
Identified versus Statistical Lives

Consider the situation of identified lives that are highly publicized as being at risk. Society is willing to spend a considerable sum to rescue a child who falls down a well or a man who is trapped under a collapsed freeway after an earthquake. The valuation of identified lives involving 0–1 probabilities of life or death will, of course, be quite different from the valuation of statistical lives. On an economic basis, the willingness-to-pay per unit of risk reduction should be lower for large risks than for small risks. In practice, we often observe the opposite. Society exhibits greater life valuations when saving identified lives than for policies with small effects on statistical lives.

Which reaction better reflects our true underlying risk valuations? From an economic standpoint, the statistical life valuation is the more correct approach to valuing statistical lives, but if our individual decision processes cannot deal effectively with probabilistic events, then the valuation of identified lives might be a more meaningful index of our preferences. Because value-of-life questions involve a complex mixture of morality, economics, and decision making under uncertainty, ascertaining the true underlying preference structure that should be used for policy purposes will often be difficult.

The dilemma in ascertaining our true preferences can be illustrated by the following example. Suppose that improved water treatment facilities will reduce the rate of a fatal form of cancer by 1/10,000 for a municipality of 10,000, so that on average one life will be saved. Suppose that we knew in fact that exactly one life would be saved, but we did not know whose it would be. Should our benefit value remain the same as when there was one expected life to be saved? If we are applying a standard Bayesian decision theory approach, there should be no change.

Now suppose that the one life saved is known to be Joe. Should our answer change? Strict application of willingness-to-pay principles suggests that the collective valuation of a 1/10,000 risk reduction by 10,000 people will exceed the value to one person of a risk reduction from 1.0 to 0. The value we are willing to pay per unit of risk reduction is greater for small increments than larger changes because our resources become depleted when we must purchase a large decrease in risk. The role of altruism may, however, alter this relationship. In practice, the societal value for saving Joe’s life may be greater since it is an identified life. Should society’s valuation of Joe’s life be allowed
to reflect the identified aspect? A more appropriate and consistent basis for decision making would result if we were to value one certain life to be saved at random. However, it may be that the reality of dealing with probabilistic events may not be understood until there is more tangible evidence of the risk reduction benefits.

Ascertaining the Pertinent Preferences

Ostensible concern with value-of-life outcomes may actually be related to the process by which these estimates are made. As Zeckhauser (1975) has observed, we often choose not to confront individual beliefs with respect to the life-extending decisions that we make. In many situations we may be forced to make a ceremonial commitment to life extension (e.g., unproductive medical expenditures), even though we do not believe that such expenditures can enhance life substantially.

Questions about true preferences also arise when we observe large discrepancies between the buying and selling prices for risk reduction. People often react with alarm to a risk increase, but may not be willing to spend much to achieve a comparable risk reduction. Substantial gaps cannot be reconciled with consistent, rational behavior. In such instances, which preferences should count, our complacency when faced with opportunities to reduce risk or our extreme reactions to risk increases?

Because of the special status of life-saving decisions, planners in pursuit of some social good may attempt to impose their preferences. As the U.S. smoking population has dwindled, policy efforts to restrict smoking in public places have greatly increased. These restrictions have not emerged from a precise tallying of the risk reduction achieved against the decrease in welfare of smokers. Rather, each side has attempted to convert the smoking debate into a question of rights rather than policy merits. Is it the smokers or the nonsmokers who have the property rights in this particular instance?

Safety regulations present a less dramatic but more prevalent example of this imposition of preferences. Job safety standards reduce the risks faced by workers, but they also reduce the market-based compensation that workers receive. If the worker has knowingly struck a bargain with his employer for extra wages in return for the risk of the job, then regulations that decrease or eliminate this risk will reduce the worker’s well-being, as he perceives it. The fact that policy mak-
ers would not accept the risk for the same trade-off that workers are
willing to accept does not imply that the market has failed or that the
risk necessarily merits regulation. Such efforts at protection may not
enhance the welfare of their intended beneficiaries.

Even if a risk is incurred voluntarily, society may be concerned if
the level of the risk is high. Just as legislators have tried to put a floor
under income levels by setting a minimum wage (although many
economists claim that such efforts simply eliminate low-wage jobs),
society may wish to have a ceiling on any one worker’s level of risk.
Nuclear power plant workers must rotate assignments so that no
single worker receives too large a dose of radiation. Recently, there
have been similar proposals to rotate airline flight crews to limit their
radiation dosage. The resulting policy will not affect the total ex-
pected number of lives lost with a linear dose-response relationship,
but no single worker will be substantially at risk. This example sug-
gests that the motivations for societal action and the subsequent value
of risk reduction benefits may be highly complex, involving attributes
other than the expected health impacts, such as the distribution of the
risk.

The nature of societal interests driving these concerns with health
status may lead to seemingly inconsistent policies. Society does little
to interfere with most labor market operations, such as the deter-
mination of promotions and job assignments. But the same market
processes giving rise to these outcomes also govern the allocation of
labor market risks. These special concerns arise both because health
risks are accorded special status and because the decision processes
involving risks are likely to be particularly flawed. Clearly, however,
we are much more concerned with a failure to assess the risk of death
properly than with an overestimate of the likelihood of promotion.
The stakes are greater, and the altruistic concerns of society with
health are stronger as well.

Rationality and Self-Control

Smoking Behavior

The relationship between personal values and individual decision
making involving risk is often unclear. Schelling (1984a) chose
cigarette smoking as a focus for discussion of these issues. Although a
third of the U.S. adult population continues to smoke, most smokers
either say they want to quit smoking or have attempted to quit in the past. Schelling asks whose preferences should matter.

Is the authentic self the smoker or the person who claims to want to be a nonsmoker? What does it mean when individuals express a desire to quit smoking? Are they physically dependent on nicotine, or is it the act of smoking that they cannot quit?

Nicotine chewing gum provides a ready substitute for those who want one. But it appears that most consumers enjoy smoking as a consumption decision. In 1988 R. J. Reynolds introduced the Premier cigarette. Externally indistinguishable from a traditional cigarette, the Premier had a burning charcoal ember at its tip which heated glycerine crystals coated with tobacco extract. The vapor from these crystals then passed through tobacco and was inhaled after going through a filter. Smokers of the Premier could enjoy the physical movements of holding a cigarette and the oral gratification achieved through cigarette smoking as well as the nicotine that smokers presumably desire. The Premier cigarette was available in regular and menthol flavors. Perhaps the only attribute on which the Premier fell short was its taste. The result was a marketing disaster, and the new product was withdrawn from the market.

The Premier provided an almost perfectly controlled experiment. All the carcinogenic risks of cigarettes were eliminated, with the “look and feel” left intact. The only drawback was in the cigarette’s taste. Surely if cigarette purchases were driven by “addiction” alone, this product would have dominated the market. It seems clear that some fundamental taste on the part of consumers for the smoking experience is at play.

In recent years the addiction label has been liberally applied to a variety of behavioral phenomena. Most residents of Los Angeles claim to want to move out of the city but do not. Similarly, millions of workers profess a desire to leave their jobs, but they do not quit. Self-help psychology paperbacks provide guidance for overcoming addictive relationships.

Two factors appear to be at work here. The first is that the individual would like to purge a particular activity of an undesirable attribute, such as the risk associated with smoking, but such unbundling is not possible. Professing a desire to quit smoking may really mean that one wishes to avoid a particular attribute of the product, while keeping all of the remaining attributes. Second, making changes—
whether in smoking, diet, or exercise patterns—may impose important transactions costs.

To decide which of one's selves is the authentic self, it helps to consider risk-taking decisions in other contexts. If smoking decisions are rational, one would expect smokers to display a lower risk-dollar trade-off than nonsmokers (unless the smoking decision is driven simply by a difference in the taste for cigarettes). An intriguing set of findings pertains to the variations in the job risk premiums workers require with respect to smoking status and seat belt use.\textsuperscript{18} Workers on average receive compensation of $48,000 for each statistical injury serious enough to lead to some loss of work. However, the group of workers who are nonsmokers and who do wear seat belts require the greatest compensation for bearing the risk (equivalent to $81,000 per injury). Smokers on average receive compensation of roughly $26,000 per injury, or just over half of the comparable value for the entire sample of smoking and nonsmoking workers. Although these results do not imply that choices are fully rational, they do provide some evidence of consistency. In particular, the same individuals who accept the risks of smoking also are willing to accept a lower price in exchange for risking their lives on the job.

Consistent biases in risk perception cannot account for these findings. Could the results, for example, be attributable to people systematically underestimating the risks of smoking and risks from their jobs, thus gravitating to hazardous pursuits whose implications are not well understood? The wage-risk trade-offs, however, are based on the risk assessments by the particular workers. If smokers underestimate all kinds of risks, the statistical impact will be a larger estimated wage premium per unit risk rather than the smaller premium that is observed. The given estimated wage premium will translate into a high value of injury when coupled with a low risk perception. One could advance the alternative hypothesis that smokers overestimate the risks they face, which would account for their smaller wage premiums for jobs. If, however, smokers systematically overassess risks, then their smoking behavior presumably is the result of a strong taste for smoking rather than a failure to appreciate the potential hazards of this activity.

A variety of factors consequently influence smoking behavior. First, smokers may have a different attitude toward risk, as reflected in their willingness to take risks other than those of cigarettes. Thus, there is at least some evidence that cigarette smoking is an action of
one's authentic self. Second, there is also substantial evidence that people would like to quit smoking, but the full implications of the survey responses are not clear. Changes in preferences, changes in health status, or information acquisition concerning cigarette smoking all may be involved.

Irrational Behavior and the Value of Life

Such controversies extend well beyond the case of cigarette smoking. Self-control is an issue in many areas, as Schelling (1984a) indicates, and it is often necessary to identify the preferences that should matter from a policy standpoint. A substantial recent literature has documented a wide variety of anomalies in decisions involving risk, in which the task of distinguishing the authentic self is once again important.

Irrationality involving choices made under uncertainty often stems from underlying inadequacies in the way risk perceptions are formed. For example, individuals overestimate the risks associated with low-probability events; they overweight events that lead to complete elimination of the risk (the "certainty effect"); and they overreact to highly publicized and dramatic risks. The irrational behavior in these instances does not stem from the underlying preference structure but rather the risk perceptions. The result is risk-dollar trade-offs that do not accurately reflect the preferences that individuals would have if they understood the risks better. As a practical matter, policy makers may have to overcome the political pressures generated by such preferences;¹⁹ when formulating normative policy guidelines, however, one need not be concerned with excessive or inappropriate reactions stemming from inadequacies in risk perception.

More problematic are certain anomalies that cannot be attributed to simple misperception of the risk. One example is the phenomenon of regret.²⁰ Individuals may attach an additional negative payoff to an unfavorable lottery outcome above and beyond the stated terms of the lottery. Then decision making is complicated by making allowance for regret. Similarly, events associated with the "status quo"²¹ or the current "reference risk level"²² may have special properties as well. People generally avoid lotteries that could lead to a higher risk level. The level of the risk within one's total risk portfolio is not the central issue. Rather the main sensitivity is to an upward shift in a risk to which one has become accustomed.
These situations may involve a legitimate individual preference as opposed to a behavioral anomaly. To what extent should policies override these features of individual preferences? In addition, if individuals display various anomalous preferences, either in the market or in simulated market contexts presented by a survey, to what extent should we use these responses in formulating risk policy? Once risk policies have been framed in sound economic terms, making such distinctions will be a matter of increasing concern.

**Regulation of Genetic Risks**

One of the most sensitive areas of risk regulation pertains to genetic hazards. Controversies become particularly heated when risks are imposed involuntarily. To what extent, for example, should a woman be allowed to expose a fetus to potential birth defects as the result of her excessive drinking? Similarly, should pregnant women be allowed to work in situations involving the risk of potential birth defects (e.g., through exposure to lead in battery plants, or to excessive radiation)?

One would expect the mother to take into account the interests of the child. However, if self-control is a problem when individuals make decisions in their own behalf, how can we be sure that they will behave correctly with respect to the future well-being of the unborn? Society has chosen not to leave these matters to individual discretion. Instead, we regulate risks and control access to jobs on the basis of the risk exposure. These regulations reflect a complex set of concerns involving irrationality as well as a legitimate concern with the health of others.

One policy problem often posed as a matter of ethics is whether pregnant women should be barred from particular hazardous jobs or whether instead the employer should be required to provide positions safe enough for any worker, including pregnant women. This policy decision seems to have been miscast as one of ethics when it is really differences in safety productivity that are more relevant. If some workers pose a much higher degree of risk on the job, presumably the employer should not be required to reduce the risk so that it will be the same for all. Many factory jobs require heavy lifting, which can be done more safely by individuals with greater strength. To ensure that such positions would not impose dangerous back injury risks to any worker, all weight lifting tasks would have to be subdivided into small increments.
The basic principle of allocating individuals to positions in the labor market is that individual differences in productivity should be exploited, not suppressed. Differences in riskiness are just one aspect of productivity differences, and equalization of job risk is no more a matter of ethics than is equalization of other job attributes. Although I have long wished to be a Boston Celtic, I will be unable to fulfill this ambition until rules are instituted so that players who are nine inches shorter than Larry Bird and who cannot jump or shoot with any particular accuracy will be able to have the same productivity as people who can. Indeed we owe our high standard of living and our overall good health to the fact that society has been organized to exploit differences in talents.

The case of alcoholic beverages illustrates the undesirability of equalizing risk levels. Alcohol poses a much greater risk to pregnant women than the adult population at large. The appropriate policy remedy is not to reduce the alcohol content of liquor so that it is equally safe for all to drink. Rather, the preferred policy course has been informational efforts aimed at reducing drinking by pregnant women. This approach recognizes that there is an inescapable heterogeneity in individual riskiness.

Changes in drinking patterns are, however, less costly to achieve than career shifts. When a woman who performs hazardous work becomes pregnant, transaction costs make it difficult for her to find a new job in the outside market. The employer can reduce those costs by providing alternative positions for employees who become pregnant. Because employers value workers' firm-specific skills, they have a strong interest in promoting such internal mobility.

The controversy surrounding pregnancy and hazardous jobs has not focused primarily on the situation of workers who already hold such jobs, but rather on the question of initial access to the risky jobs. Women who plan to have children want risk reduced so that they will face no greater risk on the job. Women who claim that they do not plan to have children want to choose better-paying, but potentially hazardous employment. Since women's preferences as to becoming pregnant may change over time, irrespective of verbal commitments and prior intentions, the reluctance of employers to expose future unborn to major risks, and themselves to substantial future liability, appears quite appropriate. There is a tremendous moral hazard problem involved, particularly given the million-dollar stakes in tort liability awards.
Some women have suggested that they should be permitted access to the positions after providing evidence that they have been sterilized or are otherwise unable to become pregnant. Sterilization prerequisites for jobs have, quite legitimately, evoked substantial controversy. But it must be remembered that it is not the employer who forces the women to become sterilized. (Indeed, women often have other reasons to seek sterilization.) Rather, if workers choose this course it is because they value the higher wage rate they will receive in this position more than the loss associated with sterilization.

Almost all of the complaints on this issue have arisen from people who are seeking promotion to a higher-paying, but potentially riskier job at the firm where they are currently employed. What is at stake here is not survival or avoidance of a poverty threshold, as hazard premiums average less than $1,000 annually for U.S. workers. Rather, the desire for economic advancement has generated a controversy over ethics and morality.

Such problems are likely to be less severe for entry-level jobs. Individuals seeking starting positions at firms have much greater mobility and many more diverse opportunities. Only when they have developed firm-specific expertise do workers become much more concerned with access to higher-paying positions. If society values access, it can approach this issue in the same manner used for the initial risk-dollar trade-off. In particular, we must balance our willingness-to-pay for increased access against the associated efficiency loss and potential increased risk. These are not strictly ethical questions beyond economic analysis. Rather, making such trade-offs lies at the heart of what economics is about.

Similar concerns regarding access occur in other contexts as well. Should we provide wheelchair ramps and parking spaces for the handicapped even when these policies fail a benefit-cost test? If the calculated benefits properly account for the entire value that society places on improved access, from an efficiency standpoint one cannot justify these efforts. The fundamental task is not to promote access at any price, but to acquire a much better basis than we now have for evaluating the benefits of improved access. These benefits are legitimate, but difficult to quantify, so that most policy decisions turn on speculative claims.

The ultimate policy question that must be addressed is what bases for discrimination are acceptable when differences in riskiness are
present. Automobile insurance regulations generally preclude the use of race information in setting rates, and some states prohibit the use of age and sex information as well. Airplanes permit pregnant women to fly, even though the radiation risk to the fetus may be considerable and may not be well understood by the passenger. Overall, society has done very poorly at developing consistent guidelines for allocating risk and determining a sound basis for discriminating on the basis of differing riskiness. If we are to succeed in addressing these concerns, we must recognize that these are not simply issues of equity. Substantial efficiency gains can be reaped by proper allocation of risk, not only increasing productivity but more frequently saving lives and preventing genetic defects.

**Affluence and the Value of Life**

The starting point for any value-of-life discussion is the individual’s own value of life. These values tend to be an increasing function of income. To what extent should we recognize this heterogeneity when making policy? Should one treat all individuals identically, as if they had the same values, or should we be guided by the values that the individuals themselves express?

**Income Distribution at a Point in Time**

Such distributional issues arise with all government programs, which inevitably benefit some parties more than others. Benefit assessment procedures are generally based on the willingness-to-pay of project beneficiaries, rather than on some systematic inflation of benefit values for the poor and compression of those for the wealthy. This approach does not mean that society has no concern for the poor, only that redistribution can be handled more efficiently through focused income transfer programs.

This kind of division of labor is consistent with the well-known Kaldor-Hicks compensation principle. If policy is based on willingness-to-pay guidelines, then the parties that benefit can potentially compensate the losers from the policy. To override the willingness-to-pay values and tilt the policy mix toward risk reduction and environmental preservation, when the poor want education and housing, does not seem to be in anyone’s best interests.
Most policies do not better the lot of some individuals at the expense of others, but benefit one segment of the population disproportionately. Should we place a higher value on promoting airline safety because of the relative affluence of the passengers as compared with improved highway safety, which provides more broadly based benefits for the U.S. population? Reliance on willingness-to-pay would generate more stringent standards for airline safety, which in turn would raise the price that the (more affluent) airline passengers pay for their tickets. Somewhat paradoxically, however, the Federal Aviation Administration sets the least stringent safety regulations of any federal agency, because FAA regulations have been based on the present value of victims' lost earnings, as opposed to willingness-to-pay estimates of the value of life. Rather than raise its standards in areas where the private valuation of the publicly provided benefits is high, the government has for the most part ignored these concerns.

In some situations, of course, it would be difficult or undesirable to make distinctions along income lines. Schelling (1968) notes that the *Titanic* had enough lifeboats for the first-class passengers, but the others were apparently expected to swim ashore. One could imagine an economic argument for making such distinctions, if the wealthier passengers were willing to pay the extra fare needed to support the purchase of lifeboats, whereas the less affluent passengers were not. Of course, there is no evidence that such a rational market process drove the *Titanic* lifeboat decision. In any case such bargains will not hold up in practice, because once the catastrophe happens it is impossible to deny access to the lifeboats to those who did not pay. In situations that lead directly to a certainty of life or death rather than a small probability of death, denial of lifesaving alternatives based on income is highly controversial and objectionable to many. For similar reasons, if medical support measures can preserve a life that would otherwise be lost, society spares little expense in doing so, whatever the patient's income.

Differences in safety protection are less troublesome when death is not an inevitable prospect but remains a more modest probability. Because of the heterogeneity in the value of life, market pressures have led to the introduction of airbags and antilock braking systems for the luxury car segment of the market. Cars such as the Mercedes-Benz and the Acura have introduced such safety-enhancing measures
because their more affluent customers value them, whereas the Yugo and the Hyundai have avoided such devices, which would lead to a dramatic price increase. There has been no public outcry that all cars should be equipped with the thousands of dollars' worth of extra safety equipment as in the luxury class. It is highly unlikely that less affluent drivers would favor requirements that all cars meet the highest possible safety standards.

Schelling (1984a, pp. 11–16) explores this class of issues, using as an example a policy that will improve airport runway lights. He grapples with both efficiency and distributional issues by proposing a sequence of tests. Whatever its distributional impact, the policy should not be pursued unless it passes a benefit-cost test: the total willingness-to-pay of the beneficiaries should exceed the cost.

Suppose that there are two airports, one serving affluent passengers and the other serving the poor. The affluent value safety highly, at a level that we will assume exceeds the costs of improved lighting, whereas the poor value the lights at less than their cost. If the ticket purchasers pay for safety and there is no evidence of irrational behavior, Schelling suggests that we let the private preferences decide the outcome, leading to lights only for the affluent airport. If, however, the money comes from public funds, the issue becomes much more controversial. An ideal solution in Schelling's view would be to install the lights for the rich and provide the poor with some other services that they value more highly. The difficulty is that single mission agencies cannot readily make such compromises in an effort to avoid selective provision of benefits to the more affluent.

Recognizing heterogeneity could have substantial implications for the design and targeting of risk policies. Individual value-of-life estimates range from $1 million to $10 million or more.\textsuperscript{24} Moreover, for the range of risks now faced by American workers, risk valuations seem to be highly responsive to income (income elasticity is on the order of 1.0).\textsuperscript{25} The role of individual income in assessing the value of life has long been accepted in legal contexts, where the basis for compensation is the present value of earnings or some other linear function of income, consumption, and taxes. As our estimates of the value of life become increasingly refined, policies will probably be designed to reflect these differences, thus replicating the outcomes that would be expected if individuals could express their attitudes toward risk in a market for safety.
Income Differences across Countries

Heterogeneity is particularly relevant to international trade policies. A desire to equalize risk levels throughout the world has led to proposals that the United States not export any products that violate any U.S. safety regulations, or import products from countries in which manufacturing processes are less safe than in the United States.26

Worldwide standards for risk are not appropriate, however, because individuals' attitudes toward risk are likely to vary considerably, depending on their countries' stage of development. Imposing the risk standards of an economically advanced society on less developed countries will reduce their welfare by retarding economic growth and the benefits it provides. The main reason for the United States's higher safety standards is not superior awareness of safety's importance but rather a greater ability to afford the luxury of greater safety. In many underdeveloped countries, increased income has a major impact on the individual's prospect of survival, and it would be highly detrimental to impose our regulatory standards on societies that have quite rationally made different risk-taking decisions. Indeed, America made similar decisions in its earlier stages of development.

The rationale for controlling the risks of exported goods is stronger than the rationale for not importing goods produced unsafely. Two considerations with respect to the export of hazardous goods are most salient. First, there may be an informational problem if foreign consumers purchase goods, believing that they meet U.S. quality standards. Exportation of substandard products may lead to unexpected welfare losses and may have damaging effects on the perceived quality of other U.S. products that meet high quality standards. Second, if the U.S. producer is the sole world supplier of a product, then the foreign purchasers are not buying in a competitive market. In such a context they should not suffer the imposition of a substantial risk because of the market power of the U.S. producer.

Neither of these rationales for regulating the export of risky products assumes an obligation to produce equally safe products for all markets. The assessment of the adequacy of the risk hinges instead on identification of a market failure in the recipient country. In particular, is regulation of product risk warranted from the standpoint of improving product market efficiency in the importing country? The resulting policies will not be of a caveat emptor variety but instead
will require a careful assessment of the rationale for regulation. Automatically imposing U.S. standards is not appropriate, but neither is having no standards whatsoever.

Age-Related Variations

Differences in the value of life also could arise with respect to age. The young have more to lose than the old, and the special societal concern with averting risks to children reflects this difference.\textsuperscript{27} Fine tuning life-saving decisions to reflect differences in life expectancy between thirty-year-olds and fifty-year-olds may not be of great consequence because of the offsetting effects of wealth increases over a lifetime and the discounting of future utility streams.\textsuperscript{28} In addition, most life-saving policies benefit broad segments of the population—for example, all residents who drink water that may be contaminated by toxic wastes. Medical contexts offer the greatest potential for discrimination on the basis of age, but the issue has not become salient, because of the role of societal norms and patients' ability to pay for care through insurance and first-party payments.

Changes in Income over Time

Heterogeneity is also an issue with respect to valuing lives across time. If future generations are more affluent than we are, their value of life will be proportionally higher. Although in many cases we can simply let future generations spend more later, for irreversible effects on the environment or policies with long-term effects, decisions must be made now.

The growth of the benefit value over time will be indicated by the growth rate \( g \), and the discount rate used will be \( r \). If one recognizes the heterogeneity in the value of life, then the effective discount rate is approximately \( 1 + r - g \), but if one ignores the heterogeneity, the discount rate rises to \( 1 + r \). Even in the case in which heterogeneity is recognized, \( r \) will exceed \( g \) somewhat because of the presence of a pure rate-of-time preference for consumption now rather than later.\textsuperscript{29} Thus, in each case there will be a positive rate of discount, but it will be greater when heterogeneity is suppressed than when it is recognized.

Recognition of heterogeneity in the valuation of life in this instance will foster more future-oriented policies. Policies addressing global
warming and other long-term risks to society will appear more attractive. In contrast, if we ignore growth in the value of life over time as incomes rise, policies with deferred impacts will be put at a substantial disadvantage.

When making decisions with respect to our own internal welfare, we should not simply abstract from our own increases in well-being over time, because we will be richer selves in twenty years. The more appropriate economic procedure would be to consider our valuation of risk reductions at the time they will occur. Similarly, appropriate recognition of heterogeneity will lead to more stringent, less short-sighted environmental and risk regulation policies that will benefit future generations.

Appropriate recognition of the heterogeneity in the value of life could lead to either more stringent or less stringent risk regulation policies, depending on the situation. Adopting a uniform valuation of life is in no way more responsible or more stringent from a risk-management standpoint. Appropriate recognition of the heterogeneity of the value of life will permit more sensible and consistent policy choices that are based on the benefits provided.

Conclusion

The value-of-life literature has gone through a number of stages. The main thrust of the early efforts was to get our thinking straight on the general value-of-life issue and to begin casting the fundamental trade-off in meaningful economic terms. Much of the research throughout the 1970s was directed at developing an empirical basis for making these judgments, and in the 1980s we began to use these estimates for policy making. Indeed, the value of life approach is now required by the Office of Management and Budget as a standard practice for all new major federal regulations.30

Once an unmentionable issue, value-of-life trade-offs are now recognized as quite amenable to economic analysis. The substantial magnitude of the empirical estimates of the value of life, together with the proper valuation of policies based on willingness-to-pay principles (as opposed to earlier benefit techniques, such as lost earnings), has led to much more ambitious risk regulation efforts. Indeed, the first major application of value-of-life principles showed that the Occupational Safety and Health Administration (OSHA) hazard communication standard offered benefits ten times greater than OSHA had originally
estimated using earnings-based measures of the value of life, enabling OSHA to overcome the original objections of the Office of Management and Budget and to issue the regulation.

Proper application of value-of-life principles will not necessarily make risk regulations less ambitious. It will put them on a sounder economic basis, however, so that we allocate our resources to the most appropriate risk-reducing policies.

As techniques for refining value-of-life estimates improve and as the use of these procedures spreads, more and more questions formerly seen as ethical issues will be structured through this methodology. At a broad level, reliance on willingness-to-pay principles and society's valuation of different outcomes raises no new ethical concerns not present in any other benefits area.

The fact that many of these issues are amenable to economic analysis does not imply that the answers are straightforward. One salient problem is the difficulty in ferreting out individuals' true underlying preferences toward risk in situations where their rationality is suspect. Society's willingness to make an appropriate commitment to the well-being of future generations is also likely to be controversial.

None of the major economic issues or policy debates will be resolved definitively in the near future. The terms of the debate, however, have now been framed in a meaningful manner. In this as in other areas, we owe a substantial debt to Thomas Schelling for extending the domain of economic inquiry.

Notes

Richard Zeckhauser, John Pratt, and several other anonymous readers provided helpful comments.

1. See any standard text such as Stokey and Zeckhauser 1978.


3. For surveys of the literature on wage premiums for risk; see Smith 1979 and Viscusi 1983.


5. Studies in this vein are reported in Smith 1979 and Viscusi 1979 and 1983.


7. The bias resulting from the omission of workers' compensation from a wage equation is documented in Moore and Viscusi 1990.
8. See Viscusi 1979. The risk measure used was based on Bureau of Labor Statistics estimates of the industry death risk. The econometric analysis also considered compensation for nonfatal injuries as well as a variety of other job attributes, so that one could more successfully disentangle the compensation for job hazards from other premiums that might be present.


10. See Moore and Viscusi 1990.

11. Viscusi and Evans 1990 show that risk premiums required by chemical workers vary with the extent of the risk reduction.

12. Striking evidence of this spread appears in Viscusi, Magat, and Huber 1987.

13. Utility functions consistent with this effect have been estimated in Viscusi and Evans 1990.


15. See Viscusi, Magat, and Huber 1991.


17. See Viscusi, Magat, and Huber 1987.


19. This class of issues is discussed more fully by Zeckhauser and Viscusi 1990.

20. See Bell 1982 for an analysis of regret.


22. See Viscusi, Magat, and Huber 1987.

23. It should also be noted that Larry Bird wishes he were three inches taller. See Bird 1989.


26. For advocacy of each of these proposals, see Ashford 1976.

27. See Zeckhauser and Shepard 1976 for development of the quality-adjusted value of life, recognizing both the duration of life and its quality.


29. Discounting issues are discussed in Fuchs and Zeckhauser 1987 and Moore and Viscusi 1990.

References


