LABOR MARKET VALUATIONS OF LIFE
AND LIMB: Empirical Evidence and Policy
Implications

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The empirical analysis of compensating wage differentials received by
496 blue-collar workers yields the first implicit values of injuries ever
obtained and the only implicit values of life that take into account
compensation for other nonpecuniary characteristics. Workers behave
as if they attached a dollar value of $10^4 to nonfatal injuries and $10^6
to death. This value of life estimate exceeds those found in other
studies, not because these earlier estimates are wrong, but simply
because there is not a unique value of life but a distribution of such
values across the population. Detailed discussions indicate the pertinence
of these results not only to occupational health and safety
policies but also to benefit-cost analyses of other policies affecting life
and limb.

Policies to reduce the risks of death and to prevent injuries or illness
have become an increasingly important part of the public decision-
making agenda. This interest in government intervention has been
largely motivated by a growing perception that there are many
important limitations to private choices. The decision-maker may
have limited knowledge of the implications of his actions. This problem
is especially acute for health hazards that are difficult to
monitor and involve very small probabilities. If a worker is locked in
by seniority rights or accumulated pension benefits, he may be reluct-
ant to switch to a safer position after he learns of the hazards
involved. The costs of altering one's past choices suggest that indi-
viduals may have limited control over a health-affecting activity.

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Finally, a person cannot fully insure himself against possible adverse outcomes. Although one can buy insurance that will provide cash or medical care in the event of death or injury, this monetary transfer may do little to restore a person to his original level of welfare. The primary difficulty is that life and health involve nontransferable commodities for which no insurance contract can provide replacements.

Many government programs have been enacted in an attempt to influence the probabilities of adverse impacts on individuals' health. Most of these have led to the promulgation of safety regulations, such as those affecting employment hazards, nuclear reactors, automobiles, and food additives. In addition to programs that alter the probabilities of adverse health outcomes, a variety of efforts is intended to improve individual well-being after illnesses or injuries have struck. Medical insurance, workmen's compensation, and welfare programs have been created to ameliorate the consequences of such unfavorable occurrences. Policies that directly influence the risks of death, injury, or illness are often justified partly on the grounds that these efforts may reduce the costs of such compensation, which are shared by society at large.

In this article, I have two principal concerns. First, I explore new bodies of data on labor market behavior in order to obtain estimates of the values that individuals implicitly attach to death and injury through their employment decisions. Second, in discussing the pertinence of these estimates to policy evaluation, I demonstrate that investigations directed at obtaining an elusive value of life number are largely misdirected. Instead, analysts should be concerned with differences in individuals' values of life and health status and the implications that the resulting distribution of values has for government policy. I do not become involved in subtle value debates as to who should be making such decisions or whether lifesaving should be used to redistribute income to the poor. These matters are thoroughly treated by Zeckhauser (1975) and Zeckhauser and Shepard (1976).

The general approach taken here follows the two basic guidelines established in 1968 by Schelling's classic essay "The Life You Save May Be Your Own." First, the principal matter of concern is, not identified lives, but statistical lives. The value society places on an identified life, such as a trapped coal miner, is likely to be substan-
tially greater than the implicit valuations of life and health status of individuals who cannot be identified, such as the prospective beneficiaries from improved ambulance service or flood control programs. In the latter instance, the policy has a probabilistic effect on the well-being of large numbers of individuals. The lives that have been extended or improved may not be identifiable even on an ex post basis; the prevention of a flood, for example, provides no information on who would otherwise have died.

Second, the willingness-to-pay measure of the value of life and limb is adopted. In the case of individual choice, it is the individual’s valuation that is of consequence. For public choices, the willingness to pay of other members of society must also be tallied to obtain the appropriate estimate for the value of life or health status. The willingness-to-pay measure has been adopted by all the principal economic analyses of the value of life of the past decade.

The alternative measure of the value of life that has attracted the greatest attention is the discounted value of one’s earnings, which is the technique used by Rice and Cooper (1967). Although this is frequently labeled the human capital approach, it has never been espoused by a prominent exponent of human capital theory. The reason for the reluctance to endorse this technique is simple. No conceptual basis exists for linking a person’s future earnings to the value he would place on his life if he were faced with a lottery on life and death. Discounted income measures are not even a reasonable upper boundary for the amount he would pay to avoid certain death, for an individual faced with such a situation might try to earn more income, perhaps even illegitimately, in an effort to preserve his life. For use in policy decisions, the discounted income measure has unacceptable implications, particularly for the nation’s elderly and housewives, as well as others with low earned incomes.

The method used to assess individuals’ willingness to pay to avoid death or injury is similar to that used for obtaining dollar valuations of other components in benefit-cost analysis. In particular, market prices are determined. The market context to be examined is that for potentially hazardous employment. An alternative technique used

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1 For a critique of this and other proposed measures of the value of life, see Mahan (1971), Zeckhauser (1975), and Acton (1976).

2 As the analyses by Zeckhauser (1975) and Zeckhauser and Shepard (1976) have indicated, the use of these implicit prices is by no means straightforward or uncontroversial. I return to this matter in the third section.
by Acton (1973) and Jones-Lee (1976) is the interview method, in which individuals are asked hypothetical questions that can be used to elicit implicit valuations of life. The principal limitation of this approach is that respondents have no incentive to give thoughtful or honest answers. Moreover, if their responses are likely to influence policy decisions, they may have an incentive to misrepresent their underlying preferences. Individual labor market decisions are not subject to these limitations. It is for these reasons that analysts gather data from observed behavior to estimate supply curves, demand curves, and other objects of econometric inquiry rather than simply relying on responses to hypothetical questions.

In the first section of this article, I analyze the labor market behavior of 496 blue-collar workers in order to obtain new estimates of the implicit dollar loss associated with fatalities and to provide the first estimates of the dollar losses associated with nonfatal injuries. These estimates are discussed and compared with existing work in the second section. This section also includes the principal methodological contribution of this article. In particular, it is not a unique value of life that should be the object of debate and econometric inquiry. Rather one should be concerned with the value of life schedules for the entire population. The application of these empirical estimates to the evaluation of government policies affecting life and limb, both in the labor market and in broader contexts, is discussed in the third section. The fourth section sums up my conclusions.

**Empirical Estimates**

**Theoretical Foundations.** Adam Smith articulated the conceptual basis of this investigation two centuries ago when he observed that “the whole of the advantages and disadvantages of the different employments of labor and stock must, in the same neighborhood, be either perfectly equal or continually tending to equality.” In other words, jobs that carry with them certain disadvantages must have other offsetting advantages such as higher wages that make them as attractive overall as jobs without these disadvantages.³

³ This "compensating wage differential" result holds whether or not individuals are risk-averse i.e., whether or not they will demand favorable odds to engage in a lottery. All that is required is
Although the underlying theory is not particularly controversial, it has been only recently that it has been subjected to successful empirical tests. One principal difficulty has been that the most attractive jobs in society tend to be well paid. Unless an analyst has sufficient information to be able to disentangle the role of different personal characteristics from the role of job attributes, including riskiness, the estimates of the wage premiums for risk will be seriously biased.

Description of the Sample. The data set to be used in this analysis is the University of Michigan's 1969–1970 Survey of Working Conditions (SWC). This survey provides the most detailed information available concerning the individual and his job. The analysis here uses only the data on 496 full-time blue-collar workers in the SWC sample, since the survey questions focused primarily on the types of job characteristics pertinent to this group. Using the data provided in this survey, I construct job hazard indices for each worker's job. The worker's earnings are then regressed on these job hazard indices, his personal characteristics, and the job characteristics in order to obtain the implicit monetary price workers receive for risks of death and injury. The results of this analysis are then used to estimate the dollar values that individuals attach to the loss of life or to a work injury.

The means and standard deviations of the principal variables are summarized in Table 1. The workers have a mean age of about 40, roughly 10 years of education, and 9 years of tenure, i.e., experience at their present place of employment. Just under a quarter of the sample is female, and about 12 percent is black. The percentage of workers who belong to unions, 49 percent, is about what one would expect for the blue-collar nonfarm population. In terms of occupational distribution, almost 80 percent of the workers are either operatives or craftsmen, foremen, or kindred workers. In short, the sample appears representative of the blue-collar working population.

The main independent variables of interest are of course the job hazard variables. The SWC includes a self-assessed hazard variable (DANGER) that has a value of 1 if the worker's job exposes him to dangerous or unhealthy conditions and a value of 0 otherwise. For

\[\text{that individuals prefer being healthy to being dead or injured. A more formal statement of the underlying model is provided in Viscusi (forthcoming, b). The state-dependent utility model presented in that article is quite general. The ill health state can be interpreted as either a fatal or nonfatal job injury. Other economic analyses of compensating differentials include the work by Thaler and Rosen (1976), Oi (1973), and Smith (1976).}\]
Table 1. SUMMARY OF SAMPLE CHARACTERISTICS

<table>
<thead>
<tr>
<th>Variable</th>
<th>Mean or fraction in sample</th>
<th>Standard deviation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal background:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>39.71</td>
<td>13.71</td>
</tr>
<tr>
<td>Female</td>
<td>0.234</td>
<td></td>
</tr>
<tr>
<td>Black</td>
<td>0.123</td>
<td></td>
</tr>
<tr>
<td>Education</td>
<td>10.30</td>
<td>3.03</td>
</tr>
<tr>
<td>Tenure</td>
<td>9.09</td>
<td>10.03</td>
</tr>
<tr>
<td>Union</td>
<td>0.492</td>
<td></td>
</tr>
<tr>
<td>Single</td>
<td>0.101</td>
<td></td>
</tr>
<tr>
<td>Job characteristics:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Number of employees at enterprise</td>
<td>562.2</td>
<td>915.3</td>
</tr>
<tr>
<td>EARNINGS</td>
<td>6,809.9</td>
<td>2,870.7</td>
</tr>
<tr>
<td>DANGER</td>
<td>0.522</td>
<td></td>
</tr>
<tr>
<td>INJRATE</td>
<td>15.93</td>
<td>9.26</td>
</tr>
<tr>
<td>DEATH</td>
<td>5.91</td>
<td>8.29</td>
</tr>
<tr>
<td>NONFATAL</td>
<td>1,586.55</td>
<td>921.18</td>
</tr>
<tr>
<td>Occupation:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Craftsmen, foremen, and kindred</td>
<td>0.34</td>
<td></td>
</tr>
<tr>
<td>Service workers</td>
<td>0.17</td>
<td></td>
</tr>
<tr>
<td>Private household workers</td>
<td>0.01</td>
<td></td>
</tr>
<tr>
<td>Laborers</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>Operatives and kindred</td>
<td>0.43</td>
<td></td>
</tr>
</tbody>
</table>

*The standard deviations of the 0–1 dummy variables are omitted, since they can be computed from their fraction m in the sample, where the standard deviation is \(\sqrt{m(1-m)}\).

purposes of this study, the DANGER variable is not of interest in its own right but rather is used in constructing and refining hazard indices for the worker’s job. Detailed examination of worker responses and the hazards cited indicated that the self-assessed hazard variable was consistent with the worker’s occupation and industry. Workers’ perceptions of hazards exhibited a strong positive correlation with the industry injury rate. Moreover, the annual earnings premium for job risks was $375 based on the self-perceived hazards variable and $420 based on the industry injury rate—a difference well within the bounds of error.¹ All available evidence suggests that

¹ These findings are reported in Viscusi (forthcoming, b).
workers' subjective assessments of the risk are plausible. It is unlikely, however, that workers have perfect information about the risks posed by their jobs. The empirical implications of imperfect worker information are discussed in the following section.

Using information about each worker's industry, 1969 Bureau of Labor Statistics (BLS) industry injury rate statistics were matched to the workers in the sample. The most aggregative of these measures was INJRATE, the number of fatal or disabling on-the-job injuries per million hours worked in a particular worker's industry. An injury is defined as being "disabling" if it was "either caused some permanent impairment or made the worker unable to work at a regularly established job for at least 1 full day after the day of injury." Injuries are divided into three categories: death, permanent partial disability, and temporary total disability. On average, for the industries represented by the workers in the sample, death was 0.4 percent of all injuries. Permanent partial disability accounted for 2.9 percent of all injuries, and temporary total disability for the remaining 96.7 percent. For the purposes of this analysis, the two nonfatal injury rate classifications were pooled, for the data were not rich enough to distinguish the compensating differentials for all three types of hazards. The first of the disaggregative injury variables is DEATH, which is INJRATE multiplied by the percentage of injuries that were fatal in the worker's industry. Similarly, the variable NONFATAL was obtained by multiplying INJRATE by the percentage of nonfatal injuries.

Assuming an average workweek of 40 hours and an average of 50 weeks worked per year, these hazard variables can be directly converted into annual probabilities of adverse outcomes. On average, the workers in the sample faced an annual probability of 0.0319 of a fatal or nonfatal job injury, a $1.18 \times 10^{-4}$ probability of death, and a $0.0317$ probability of a nonfatal injury. These risks are a bit higher than the average for all manufacturing industries but lower than the hazard levels in many nonmanufacturing industries such as mining and transportation. They are, of course, incremental death and

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5 All injury rate data are from the U.S. Department of Labor (1971).

6 Since INJRATE is the number of fatalities and injuries per million hours, the number per 2,000 hours is INJRATE divided by 500. DEATH and NONFATAL are the percentages of INJRATE that are fatal and nonfatal, i.e., DEATH + NONFATAL = 100 INJRATE. Hence dividing each by 50,000 converts it to an annual probability.
injury risks, over and above the risks the workers face in the normal course of their daily life.

Three job risk variables were also constructed, using the information as to whether the worker considered his job hazardous, thereby reducing some of the measurement error associated with using an industry-wide risk index. The variables INJRATET1, DEATH, and NONFATAL1 were obtained by multiplying their former values by the 0 to 1 dummy variable DANGER. Thus, these variables are identical in value with INJRATET, DEATH, and NONFATAL except that they equal zero if the worker does not view his job as hazardous.

*Empirical Results.* The earnings equation was estimated in both linear and semilogarithmic form; annual earnings (EARNINGS) and its natural logarithm (LOGEARNINGS) were the two dependent variables. Ideally, one would like to use the hourly wage as the dependent variable rather than total earnings, but the SWC did not provide wage data or other information, such as weeks worked, that would make it possible to construct a wage rate. Since the analysis focuses on full-time workers and includes an overtime work variable, this shortcoming is presumably not very serious.

In addition to various combinations of job risk variables, each equation also contained 22 other independent variables. These included 11 dummy job characteristic variables reflecting the speed of work, whether the worker is a supervisor, overtime work, job security, whether the job requires that the worker make decisions, the presence of a training program, the number of other employees at the enterprise, and three dummy variables denoting the occupational group of the worker. The remaining independent variables pertained to regional economic conditions and the worker’s personal characteristics, including age, race, sex, years of schooling, health status, tenure, and union membership.

It is assumed here that workers act as if the objective hazard indices correspond to their subjective assessments. Imperfect worker information generates underestimates of workers’ implicit value of life for both econometric and economic reasons. First, if workers’ probability assessments are randomly distributed about the true value, one encounters a conventional errors-in-variable situation in which the empirical estimates are biased downward. Second, suppose that workers’ prior probability assessments correspond to the true risk of the job but that these assessments are imprecise. In normal
<table>
<thead>
<tr>
<th>Death risk variable</th>
<th>Other job risk variables included in equation</th>
<th>LOGEARNINGS results</th>
<th>EARNINGS results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Death risk coefficient (std. error)</td>
<td>Implied value of life</td>
</tr>
<tr>
<td>1. Industry death risk (DEATH)</td>
<td>Nonfatal injury rate (NONFATAL)</td>
<td>0.00205 (0.00075)</td>
<td>1,595,000</td>
</tr>
<tr>
<td>2. Industry death risk (DEATH)</td>
<td>Self-assessed dangers (DANGER)</td>
<td>0.00153 (0.00088)</td>
<td>1,185,000</td>
</tr>
<tr>
<td>3. Industry death risk (DEATH)</td>
<td></td>
<td>0.00183 (0.00075)</td>
<td>1,420,000</td>
</tr>
<tr>
<td>4. Industry death risk conditional on self-perceived hazard (DEATH1)</td>
<td>Nonfatal injury rate conditional on self-perceived hazard (NONFATAL1)</td>
<td>0.00189 (0.00072)</td>
<td>1,490,000</td>
</tr>
<tr>
<td>5. Industry death risk conditional on self-perceived hazard (DEATH1)</td>
<td>Self-assessed dangers (DANGER)</td>
<td>0.00076 (0.00093)</td>
<td>600,000</td>
</tr>
<tr>
<td>6. Industry death risk conditional upon self-perceived hazard (DEATH1)</td>
<td></td>
<td>0.00141 (0.00079)</td>
<td>1,080,000</td>
</tr>
</tbody>
</table>

* Complete regression results are not reported here, since they are similar to those reported in Viscusi (forthcoming, b); the only difference is the inclusion of death risk and nonfatal injury risk variables in this analysis. Two of the equations in the aforementioned paper correspond to those in line 1 in Table 3.
LABOR MARKET VALUATIONS OF LIFE AND LIMB

It is important, however, to note that such a magnitude is not what the valuation of life figures represent. Rather, individuals act as if their life were worth the indicated amounts when they are faced with very small incremental risks of death. An individual facing an annual additional death risk of $1.18 \times 10^{-4}$ (the mean for the sample) would receive additional wage compensation of $173 based on the EARNINGS equation coefficient in line 2. The amount that a worker would pay to eliminate the certainty of death is necessarily below the $1 to $1.5 million amount, since the worker's wealth would be reduced as he purchased reductions in the risk of death. This decline in wealth in turn would reduce the value the individual attached to his life, since one's willingness to incur such risks increases as one's wealth declines. In short, there are likely to be important income effects so that the implicit value of life for small changes in the probability of death will greatly exceed the value workers would pay to avoid certain death.

In similar fashion, one can interpret the implied values of all injuries, including death. These values are reported in Table 3. Workers act as if they viewed the average industrial injury as equivalent to a $13,000 to $14,000 drop in income. This result refers to the distribution of all industrial injuries, of which 0.4 percent overall were fatalities, 2.9 percent permanent partial disability, and 96.7 percent temporary total disability. If the death risk premium is distinguished from that for nonfatal injuries, one obtains a value for nonfatal injuries in the $6,000 to $10,000 range. These results are instructive in that they indicate that, in dollar terms, a probability of death is regarded as being 100 times worse than an equal probability of a nonfatal injury.

Comparisons with Other Work

Results from Interview Studies. To date, there have been no other estimates of the implicit value of injuries. Hence these results cannot be compared with other analyses. There have been several investigations of individuals' value of life. The first of these studies was Acton's 1973 investigation in which individuals were asked their

9 Supporting conceptual analysis and empirical evidence are provided in Viscui (forthcoming, b).
<table>
<thead>
<tr>
<th>Injury risk variable</th>
<th>Death risk variable included in equation</th>
<th>LOGEARNINGS results</th>
<th>EARNINGS results</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Injury risk coefficient (std. error)</td>
<td>Implied value of injury</td>
</tr>
<tr>
<td>1. Unspecified job injury (INJRATE)</td>
<td>. .</td>
<td>0.0040 (0.0016)</td>
<td>13,550</td>
</tr>
<tr>
<td>2. Unspecified job injury conditional on self-perceived hazard (INJRATE1)</td>
<td>. .</td>
<td>0.0040 (0.0013)</td>
<td>13,550</td>
</tr>
<tr>
<td>3. Industry nonfatal injury rate (NONFATAL)</td>
<td>Industry death rate (DEATH)</td>
<td>0.932E-5 (0.837E-5)</td>
<td>5,500</td>
</tr>
<tr>
<td>4. Industry nonfatal injury rate, conditional on self-perceived hazard (NONFATAL1)</td>
<td>Industry death rate conditional on self-perceived hazard (DEATH1)</td>
<td>0.136E-4 (0.704E-5)</td>
<td>9,500</td>
</tr>
</tbody>
</table>
valuations of different programs to save the life of heart attack victims. These interviews suggested a value of life in the range of $28,000 to $43,000.

For several reasons, Acton's results are not comparable with those assessed here for the labor market. First, the lives involved are post-heart attack lives and consequently should be valued less highly. Second, the sample size was rather small (36), so that the estimates may not be very reliable. Third, individuals have no incentive to give thoughtful or honest responses to questions asked in an interview.

This final observation is perhaps the most fundamental, for it highlights the inherent limitations of the interview approach. The process of thinking about choices involving small probabilities is notoriously difficult. Indeed, the principal purpose of Schelling's pathbreaking essay was to provide a methodology that would enable private decision makers to conceptualize these issues in a systematic fashion. A person confronted with information about a hypothetical lottery clearly has less of an incentive to evaluate his preferences regarding these risks than he would if he were incurring the same risks daily in his place of employment. Moreover, even if the respondent has given the issues careful consideration, he has no reason to reveal his preferences honestly. He may give the response that he believes will create a favorable impression on the interviewer, a difficulty that is more likely when the life to be saved is not that of the respondent but an anonymous member of the community. A person's altruism may be much greater when he knows he will not be required to back up his statements with out-of-pocket contributions. Finally, individuals may misrepresent their preferences if they believe their responses will affect the benefits they will receive or the taxes they must pay to support a public program to save lives; this is the familiar strategic issue. The fundamental and pervasive nature of these limitations suggests that interview results might best be used to supplement rather than supplant estimates obtained from market behavior.

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10 A similar interview study by Jones-Lee (1976) also has a small sample; only 30 out of 90 people polled responded. The low response rate also raises the problem that the personal characteristics and implicit valuations of life of the respondents may be quite different from those who chose not to answer the questionnaire.
Labor Market Analyses. Thaler and Rosen’s 1976 analysis of implicit valuations of life in the labor market yielded estimates of $220,000 ± $66,000 in 1969 dollars. These figures are more closely comparable with those found in the first section. Their study focused on 900 adult males in hazardous occupations. The death risk variable used was the Society of Actuaries’ incremental death risk for a group of 37 narrowly defined occupations. This variable reflected the death risks of the occupation per se as well as the death risks that were unrelated to work but are correlated with the characteristics and life-styles and income levels of people in different occupations. As a result, the patterns of risk are surprising. Cooks face three times the death risk of firemen, elevator operators face twice the death risk of truck drivers or electricians, waiters face 67 times the death risk of linemen or servicemen, and actors face a higher death risk than fishermen, foresters, power plant operatives, and individuals in many other more physically demanding occupations. Although narrowly defined occupational risk indices may be superior to BLS industry risk data, the inclusion of death risks unrelated to work makes it unclear which variable involves less measurement error.

If, as Thaler and Rosen suggest (p. 287), the BLS injury rate involves more measurement error and if this error is random, my value of life estimates should underestimate the actual value by more than theirs. My figures, however, are already roughly five times the level of their results. Consequently, one cannot use measurement error as the explanation for this difference, because correction for this problem would make the estimates more disparate than they already are.

The principal difference in the death risk variables is that the BLS industry death risk variable pertains to a broad cross-section of industries, but the Society of Actuaries’ measure pertains to only the most hazardous occupations that on average pose an annual death risk ten times larger than that faced in the SWC sample ($10^{-3}$ versus $10^{-4}$). The sample of workers in the Thaler and Rosen study includes only those workers who are least adverse to job risks, but my analysis

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11 The study by Smith (1976) of death risk premiums in the labor market yielded an implicit value of life of $2.6 million. Smith, however, was not particularly confident of the reliability of the results, since all his efforts to find premiums for injuries or other variants of the components of the BLS injury rate were unsuccessful. Moreover, his analysis did not include any job characteristics other than the industry death risk. The results were therefore very likely biased upward.
Table 4. Comparison of samples used in value of life studies

<table>
<thead>
<tr>
<th>Category</th>
<th>Thaler and Rosen sample mean value</th>
<th>SWC sample mean value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Personal characteristics:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age</td>
<td>41.8</td>
<td>39.7</td>
</tr>
<tr>
<td>Education</td>
<td>10.1</td>
<td>10.3</td>
</tr>
<tr>
<td>White</td>
<td>0.90</td>
<td>0.88</td>
</tr>
<tr>
<td>Union</td>
<td>0.45</td>
<td>0.49</td>
</tr>
<tr>
<td>Married</td>
<td>0.92</td>
<td>0.90</td>
</tr>
<tr>
<td>Females</td>
<td>0</td>
<td>0.23</td>
</tr>
<tr>
<td>Occupational characteristics:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operative and kindred</td>
<td>0.27</td>
<td>0.43</td>
</tr>
<tr>
<td>Service workers</td>
<td>0.45</td>
<td>0.17</td>
</tr>
<tr>
<td>Laborers</td>
<td>0.22</td>
<td>0.05</td>
</tr>
<tr>
<td>Annual income</td>
<td>7,194</td>
<td>6,810</td>
</tr>
<tr>
<td>Annual incremental death risk</td>
<td>$1 \times 10^{-3}$</td>
<td>$1 \times 10^{-4}$</td>
</tr>
</tbody>
</table>

* The annual income figures for the Thaler and Rosen sample were calculated by multiplying the average weekly salary by the average number of weeks worked in 1966. The earnings figure in 1967 dollars for the Thaler and Rosen sample was converted into 1969 dollars using the consumer price index for these two years.

focuses on the entire blue-collar population. Table 4 presents detailed comparisons of the two samples. In terms of personal characteristics there is little difference except that the Thaler and Rosen study excluded women from the analysis. The occupational distribution is quite different: their sample included a much higher percentage of service workers and laborers than did the SWC sample.

The most salient difference in the two studies is that the Thaler and Rosen analysis focuses on a group who have shown themselves to be less averse to severe death risks than the rest of the population. Unlike standard consumer items, death risks do not command a single price. The risk is inextricably linked to the job; it cannot be divided to yield a constant price per unit of risk. Those individuals who are least averse to such risks are willing to accept a lower compensation per unit of risk than the rest of the working popula-

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12 Their sample was selected on the basis of the availability of death risk data, which was provided only for the most hazardous occupations.
tion. As a result, they are inclined to accept larger risks with lower wage premiums per unit of risk. Hence the Thaler and Rosen analysis yields a lower implied value of life.

The final important difference in the analysis is that the results reported in the first section are the only value of life estimates obtained from equations in which other nonpecuniary job characteristics, such as nonfatal injuries and the speed of work, were included. To the extent that job risks are positively correlated with other unattractive job attributes, the omission of these attributes leads to overestimates of the value of life.

A suggestive estimate of the extent of the bias can be obtained by examining the results in Table 2. Omission of the nonfatal injury rate from the equations boosts the implied value of life significantly. The increase ranges from 21 to 150 percent, depending on the equation in question. Omission of seven other job attribute variables alters the value of life estimates by much less—usually by about one-third and by as little as 1 percent for one equation. A similar bias in other data sets could account for the fact that Smith's (1976) estimate of the BLS industry death risk premium yielded a value of life of $2.6 million, roughly double that found in this study. By similar reasoning, Thaler and Rosen's estimates may be too high, so that their value of life would actually have been less than one-fifth of the magnitude I found if additional job attribute variables had been included in their analysis.

Value of Life and Limb Schedules. Summarizing, the principal reason that my value of life estimates are several times larger than Thaler and Rosen's appears to be the difference in the level of the risk. Their analysis reflected the preferences of those least averse to risk and who consequently were in very risky jobs. One's natural inclination is to ask which estimate better reflects the value of life. Framing the issue in those familiar terms, however, is not the appropriate way to view value of life problems.

In particular, different members of the population attach different values to their life. Empirical analyses should not be directed at estimating an elusive value of life number; rather they should estimate the schedule of values for the entire population. The line VL in Figure 1 illustrates such a schedule. As the percentage of the popula-

13 The seven variables omitted were all of the eleven job characteristic variables except the number of employees at the enterprise variable and the three occupational dummy variables.
tion incurring the incremental risk increases, so does the marginal valuation of life. Those who price their life the cheapest are drawn into the market first; higher wages must be paid to lure additional workers into risky jobs. Thaler and Rosen focused on the lower tail of the population—those who appeared to value their life at approximately $200,000. The more representative blue-collar SWC sample yielded a value of roughly $1 million. Empirical estimates can most accurately be viewed as weighted averages of points along the marginal valuation of life curve for the population. If the sample contains disproportionately many workers from the occupations posing substantial risks, it generates lower average values of life and limb than if the sample is more representative. For simplicity, the empirical results are illustrated as if they yielded single points on the curve rather than weighted averages of points along it. Thus, for Figure 1, Thaler and Rosen's results yield the intercept at $200,000, but my findings correspond to a marginal value of $10^6 with percentage $f$ of the population incurring the risk.
Table 5. HYPOTHETICAL SAMPLE OF WORKERS

<table>
<thead>
<tr>
<th></th>
<th>GROUP 1</th>
<th>GROUP 2</th>
<th>GROUP 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual risk of death $x_i$</td>
<td>$10^{-6}$</td>
<td>$10^{-5}$</td>
<td>$10^{-4}$</td>
</tr>
<tr>
<td>Average total compensation $y_i$</td>
<td>$1.50$</td>
<td>$10$</td>
<td>$20$</td>
</tr>
<tr>
<td>Implicit value of life</td>
<td>$1.5 \times 10^6$</td>
<td>$10^6$</td>
<td>$0.2 \times 10^6$</td>
</tr>
<tr>
<td>Number in group</td>
<td>10</td>
<td>100</td>
<td>10</td>
</tr>
</tbody>
</table>

The nature of the way the regression analysis averages workers' marginal valuations of life and limb can be illustrated with the aid of a numerical example and a bit of elementary statistics. Consider the sample of workers whose characteristics are summarized in Table 5. For simplicity, the only influences considered are the death risks posed by the job and the compensation for those risks, generating a model of the form $^{14}$

$$y = \beta x$$

Here $x$ is the incremental death risk incurred by the worker, $y$ is the earnings premium for this risk, and $\beta$ is the implicit value of life. The implicit value of life for each of the three groups of workers is obtained by dividing $y$ by $x$ for the group, yielding values ranging from $0.2 \times 10^6$ to $1.5 \times 10^6$.

Suppose that the value of life estimate to be obtained is the simple average of these marginal valuations, weighted according to the number of workers in each group. This approach would yield an average value of life equal to

$$\frac{1}{n} \sum_{i=1}^{n} \frac{y_i}{x_i} = 9.75 \times 10^5$$

It is important to recall that regression estimates do not yield a simple linear average of this type but rather produce an estimated value of life $\hat{\beta}$ given by

$$\hat{\beta} = \frac{\sum_{i=1}^{n} y_i x_i}{\sum_{i=1}^{n} x_i^2} = 2.73 \times 10^5$$

$^{14}$ The intercept for this simplified model is presumably zero, since workers receive no wage premium if they face no additional risk.
Thus, the implied value of life estimates obtained in regression analyses are nonlinear weighted averages of points along the value of life curve in Figure 1.

Investigations that seek a unique value of life rather than points on the value of life schedule implicitly assume that the value of life curves are flat. The stark difference, however, between the Thaler and Rosen results and those of this study combines with the investigation of likely biases in the analyses to suggest that individuals' valuations of life vary substantially.

In addition to influencing the interpretation of the empirical results, the analysis of the value of life curves is important in ascertaining the appropriate value of life to be used in government policymaking. We return to this matter in the last part of the third section.

Policy Applications

Implications for Occupational Health and Safety Policy. The most immediate significance of the empirical results is their implication for labor market performance. If workers were not compensated adequately for the risks they incurred, one would conclude that the market did not function effectively, perhaps because of systematic individual misallocations. The theme of inadequate compensation runs throughout the more sociologically oriented literature on occupational safety.

As the empirical results indicate, the annual compensation for all job risks totals only about $400. Unlike stuntmen and other workers who received clearly significant hazard premiums, blue-collar workers in the more hazardous occupations do not receive additional remuneration that is sufficiently great to be visible to the casual observer. It is also important to note, however, that the risks the workers incur are not very large; the probability of a fatal injury is only about $10^{-4}$. To ascertain whether workers are accepting additional risks for amounts small enough to suggest some form of market failure, one should examine, not the absolute level of com-

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15 For a detailed discussion of the policy issues raised by the valuation of life, see Zeckhauser (1975). In this section, I focus on the narrower issue of the implications of the empirical results for policy choice.
pensation, but the implicit values that workers associate with death or injury. The empirical results indicate that these magnitudes are quite impressive—on the order of $1 to $1.5 million for fatalities and $10,000 for injuries. Although there is no way to ascertain whether these levels of compensation are above or below those that would prevail if workers were perfectly informed, the magnitudes are at least suggestive in that they indicate substantial wage compensation for job hazards. These findings do not imply that the government should not intervene. They do indicate, however, that it is doubtful that one can base the case for intervention on the absence of compensation for risks of death and injury.

The value of life and limb estimates also can be used in assigning dollar values to the impacts of occupational health and safety regulation. If safety standards reduce the death risks or injury risks faced by workers, workers' wages fall in a competitive market. Regulation of job hazards also imposes implicit costs on employers. The amounts of these costs are often difficult to compute directly, since firms have an incentive to overstate the financial burdens of prospective regulations. On a theoretical basis, however, the marginal cost of safety improvements in a competitive market equals the cost of the wage premiums for an incremental change in the level of the risk. How much wages are reduced and cost increased depends on a variety of factors such as the level of risk and the extent to which it is reduced, the types of hazard, and the characteristics of the workers and the workplace, e.g., unionization. Nevertheless, application of the implicit values of life and limb to analysis of the impacts of health and safety regulation might be a useful starting point for policy evaluation.

The Need for Explicit Evaluations. More generally, the empirical results set forth here have important implications for policy analyses of projects involving risks of life and limb. To date, there has been little systematic attempt to incorporate dollar valuations of life and limb into these analyses. Even federal evaluations of water resource projects, which assign somewhat arbitrary values to recreation bene-

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14 In addition to ex ante wage compensation workers also receive substantial tax-free workmen's compensation benefits—up to two-thirds of the worker's gross wages in most states—so that the injury results in particular underestimate the implicit values attached by workers.

15 See Thaler and Rosen (1976) for elaboration of this argument.

16 An important exception is Acton's (1975) innovative study of policies to assist heart attack victims.
fits and other project impacts, ignore the lifesaving consequences of flood control and include only reduced property damage in the tally of benefits and costs. Much of the problem derives from society's reluctance to make explicit the trade-offs between dollars and lives. People are likely to say, "If additional expenditures can save lives, we will spare no expense in doing so." Although this maxim is not entirely implausible when dealing with identified lives, it clearly does not reflect the reality of public decisions or common medical practice, or for that matter private decisions. Public decisions concerned with individual welfare implicitly assign a finite value to life and other health outcomes except in the rare instances in which additional expenditures would accomplish nothing. Ignoring the issue of valuation of life and limb may circumvent the problem of offending people's sensitivities by making the trade-offs explicit. But at the same time it may be very costly in that it sacrifices lives that could have been improved or saved by a more systematic allocation process. An important issue for society as a whole, and one that many people are unwilling to face, is whether lives will be sacrificed in an effort to maintain the illusion that we will not trade off lives for dollars.

The most systematic alternative to valuations of life and limb is the use of cost-effectiveness analysis. Instead of ascertaining which program offers the greatest net benefits to society, one estimates the costs per lives saved of different programs and allocates funds where they are most productive. Although this approach is useful in highlighting clear-cut cases of inefficiency, it has important limitations.

First, suppose that OSHA spends $2 million for each life saved through its coke oven regulations, the Medicare program spends $1 million per life saved, and nuclear safety regulation costs $0.5 million per life saved. Additional lives could be saved if funds were reallocated so that the cost per life saved would be the same across different programs. Even if such a reallocation were made, however, the policy might not be optimal, for there are no means to determine the optimal level of expenditures in the life-extending area.

The second shortcoming of cost-effectiveness analysis is that it provides no guide to action when there is a variety of project impacts of unknown value. Programs that extend lives typically have other health outcomes, such as influencing the probability of illness and the well-being of individuals who are ill. In such instances, one
cannot summarize a program’s effect by saying that it costs $X per life saved, since it has impacts on many objectives.

Finally, analyses of costs per life saved are not meaningful if the lives saved have different lengths and different qualities. Extending the life of an elderly individual or someone in a permanent coma differ greatly in value from reducing the incidence of fatalities among healthy individuals whose lives will be greatly extended by policy intervention. In short, the extent of life lengthening and the quality of the life that is lengthened are important matters of interest not readily subsumed into the simple cost-effectiveness calculation.

Although policy makers can choose among programs with several qualitatively described impacts, in doing so they implicitly assign dollar values, or shadow prices, to the different outcomes. Making policy decisions on this basis raises two key problems. First, there is no guarantee that the attitudes of the policy makers toward the worth of life and limb coincide with those of society as a whole. The preferences of project beneficiaries, not legislators and bureaucrats, should be of a paramount concern and should not be ignored in the decision-making process.\(^1\) Second, if quantitative values are not assigned to different policy impacts, the most productive allocations may not even be included in the list of policy options considered by the decision maker. Typically, the processes of program design and decision are separated, because different groups of individuals are responsible for drawing up the menu of policy options and choosing among these alternatives. Including explicit values of life and limb in the early stages of policy design assists in ensuring that society’s valuations are incorporated in the entire policy choice process.

Externalities and Individual Values. If dollar values are to be assigned to different impacts on life and health, the controversy centers on what these values should be. Implicit values obtained by observing market behavior are instructive in establishing the value of life to the individual. Society at large, however, also has a stake in the health of its members. The group most affected by the external effects of death or illness is the individual’s family. To the extent that the

\(^1\) Two important exceptions should be noted. If beneficiaries systematically misallocate resources and neglect the future, a case might be made for using implicit values of life above those revealed in the marketplace. Moreover, if there are substantial externalities, the preferences of society as a whole must also be incorporated in the analysis. This matter is discussed in the following section.
preferences of other members of the household are taken into account when making one's employment decision, the market estimates reflect such externalities. Although the outcome might not be exactly what one would observe if the external effects were evaluated, a substantial input of this type no doubt affects employment decisions.20

Externalities to individuals other than one's family are not reflected in market estimates. It is unlikely, however, that these amounts are significant when compared with the $1 to $1.5 million value of life estimates that were obtained. Since market behavior is not instructive, interview studies along the lines of Acton (1973) might be used to resolve this issue.

Differences in the Value of Life. The empirical estimates of the implicit values of the loss due to either death or injury pertain to the sample of the working population examined. The value that an individual implicitly attaches to different health outcomes depends on his personal characteristics and on the nature of the lottery he faces. An attempt was made to ascertain whether the job risk variables interacted with personal characteristic variables such as age, race, and health status. The only significant effect found was for the education and death risk interaction term. In the linear form of the earnings equation, the coefficient for the interaction term was positive. The interpretation of this result is unclear, since better-educated workers may be safer workers. The premium may then not reflect differences in preferences but differing efficiency in the production of workplace health and safety. Additional empirical work is required to disentangle influences such as these so that different value of life estimates for people with different characteristics can be obtained.

In the absence of empirical evidence, one can often rely on theoretical analyses to indicate directions of influence. For example, it can be shown that individual aversion to adverse health outcomes necessarily increases as one's wealth increases.21 As a result, the values individuals place on life and limb necessarily decline as the size of the risk increases, since the reduction in wealth that occurs

20 Indeed, almost all labor supply analyses of recent vintage focus on household labor supply rather than individual choice models. Many of the predictions of the household labor supply approach, particularly those pertaining to wives' labor supply, have been borne out empirically.

21 See Viscusi (forthcoming, b).
with the purchase of incremental reductions in the risk also diminishes the unattractiveness of the adverse health outcome.

A related result pertains to the level of the risk faced by an individual. Suppose the individual faces a 0.5 probability of death in the coming year in situation A and a 0.2 probability in situation B. In which instance would he place a greater value on a reduction of the probability of death by 0.1? It can be shown that because assets have a higher marginal value when survival is more certain, the willingness to pay for a reduction in the death risk is greater in situation B.\textsuperscript{22} Individuals' personal characteristics and the nature of the lotteries they face are two important classes of considerations in modifying the value of life and limb estimates to take account of the specific aspects of a policy's effect.

A further class of considerations pertains to the nature of the quality of life after a life is extended or an illness is cured. The value of extending the life of a person with a terminal form of cancer or with a spinal-cord injury that has resulted in permanent paralysis is substantially less than that for an individual who can lead a full and active life. Substantial progress in the conceptualization of quality of life issues has been made by Zeckhauser and Shepard (1976). Additional research to obtain quantitative estimates of the effect of different changes in the quality of life would enhance our understanding of the quality adjustment process. Market evidence can also be useful here. For example, if more disaggregated job hazard information were available, one could estimate the implicit monetary loss that individuals attach to a variety of health outcomes rather than simply investigate the value attached to death and the broad category of nonfatal injuries. Thus, it would be possible to assign dollar values to different qualities of life, whereas we are now forced to use estimates that assume all individuals enjoy an average quality

\textsuperscript{22} For proof of this and a series of related propositions of analytic and policy interest, see Weinstein, Shepard, and Pliskin (1976). This theorem is based on a conjecture by Zeckhauser, which was first proved by Kiffla (1968) for a somewhat different analytic context. The key assumption is that the marginal utility of a given amount of wealth is greater when one is alive than when dead. Although intuitively plausible, this assumption might seem to contradict observed behavior, since many individuals purchase life insurance at actuarially unfair rates in order to transfer additional resources to their family after death. The presence of substantial death duties, however, reduces the value of one's bequest so that the level of wealth after death would be reduced below the value when alive. If, as usually assumed, the marginal utility of wealth is positive but diminishing as the level of wealth increases, the tax system in effect raises the marginal utility of wealth after death so that life insurance purchases might become attractive.
of life. Disaggregation of this type is likely to be most important when the health outcomes involved differ from the typical disabling work injury or fatality that I have investigated.

Voluntary Risks, Involuntary Risks, and Self-Selection. In analyzing the value of life and limb, one should use the information provided by the nature of the risk incurred. In particular, voluntary and involuntary risks should be treated quite differently. To date, the only distinction that has been drawn between these two types of risks is that in a market system prices reflect individuals' value of the risks to life and limb if the risks are incurred voluntarily.\(^{23}\)

In the discussion below I am not concerned with obtaining value of life and health estimates in contexts in which the degree of individual volition in accepting the risk varies. Rather, I assume that the pertinent schedule of values for the population has already been obtained through prior empirical work. The key question is how these schedules are to be used in the policy evaluation process in situations in which individuals incur risks voluntarily and involuntarily. Although the degree of volition involved spans a continuum of possibilities, for simplicity I focus on the polar cases of completely voluntary and completely involuntary risk.

The nature of the risk conveys important information about the implicit value of life and limb being assigned by the affected population. Other things equal, it is those who place the lowest dollar value on the expected loss to their health who choose to incur the risk. If individuals choose to live in a flood-prone area, to drive cars while intoxicated, or to work at hazardous jobs, the government's assessment of the value of the health gains from safety regulation should be quite different from its assessment when no element of free choice is involved.

Suppose, for example, that the characteristics of the affected population are comparable with those of the SWC sample of workers that was examined and that the median value of life corresponds to that of the individual at point \(f\) in Figure 2. Consider the situation in which the risk is involuntary and affects the whole population. Then the use of the median individual's value of life gives correct estimates of the benefits of lifesaving activities if the value of life schedule is linear, as is \(CC\); overstates the benefits if the schedule is concave, as

\(^{23}\) See Mishan (1971).
is \( BB \); or underestimates the benefits for schedule \( AA \). If the risk is voluntary and affects only half of the population, the use of the median individual's preferences at point \( f \) overstates the value of life irrespective of the shape of the value of life curve, since all other individuals who have chosen the risk value their lives at less than the amount for the median individual.

For the purposes of policy evaluation, it is the preferences of the average individual that matter in calculating consumers’ surplus. The value of health-enhancing program benefits to project beneficiaries is computed by multiplying the number of lives saved or injuries prevented by the average value attached to these outcomes. In contrast, market outcomes reflect the preferences of the marginal worker. The valuation of life and limb of the worker who accepts the risky job and who is most averse to the hazards is instrumental in setting the wage rate, not the preferences of all the other inframarginal workers who would be willing to accept less than the going wage for the hazardous job.
Conclusion

Examination of implicit dollar values attached by workers to fatalities and injuries indicates that these health outcomes are evaluated at roughly $10^6$ and $10^4$, respectively. These estimates pertain to a particular subset of the working population and do not represent unique measures of these health outcomes. Indeed, the search for a unique value of life number is largely misguided; one should instead be concerned with obtaining measures of the distribution of individuals' assessments of different health outcomes.

Although much research remains to be done in these areas, policymakers should not be reluctant to use the estimates that are available. These dollar estimates are no less precise than most of the other dollar values assigned to project impacts in benefit-cost analyses. Moreover, the policy decision may not be very sensitive to whether the correct average value of life for the affected population is $1.1$ or $1.5$ million, whereas substantial welfare losses may result if the value assigned to life is only $10,000$ or if the problem is ignored altogether. Although use of dollar values for life and limb may offend some individuals' moral sensitivities, the greater danger is that these trade-offs will be made without systematic analysis. Society will then be paying a substantial implicit price in lives sacrificed in an effort to preserve popular illusions.

Bibliography


