The economic approach to valuing risks to life focuses on risk–money trade-offs for very small risks of death, or the value of statistical life (VSL). These VSL levels will generally exceed the optimal insurance amounts. A substantial literature has estimated the wage–fatality risk trade-offs, implying a median VSL of $7 million for US workers. International evidence often indicates a lower VSL, which is consistent with the lower income levels in less developed countries. Preference heterogeneity also generates different trade-off rates across the population as people who are more willing to bear risk will exhibit lower wage–risk trade-offs.

Keywords
compensating differentials; contingent valuation; deterrence; hedonic models; hedonic prices; human capital; India; life insurance; risk to life; Schelling, T.; Smith, A.; South Korea; Taiwan; value of life; value of statistical life

Issues pertaining to the value of life and risks to life are among the most sensitive and controversial in economics. Much of the controversy stems from a misunderstanding of what is meant by this terminology. There are two principal value-of-life concepts – the amount that is optimal from the standpoint of insurance, and the value needed for deterrence. These concepts address quite different questions that are pertinent to promoting different economic objectives.

The insurance value received the greater attention in the literature until recent decades. The basic principle for optimal insurance purchases is that it is desirable to continue to transfer income to the post-accident state until the marginal utility of income in that state equals the marginal utility of income when healthy. In the case of property damage, it is desirable to have the same level of utility and marginal utility of income after the accident as before. In contrast, fatalities and serious injuries affect one's utility function, decreasing both the level of utility and the marginal utility for any given level of income, making a lower income level after a fatality desirable from an insurance standpoint. Thus, the value of life and limb from the standpoint of insurance may be relatively modest.

The second approach to valuing life is the optimal deterrence amount. What value for a fatality sets the appropriate incentives for those avoiding the accident? In the case of financial losses, the optimal insurance amount, the optimal deterrence amount, and the ‘make whole’ amount are identical; however, for severe health outcomes, such as fatalities, the optimal deterrence amount will exceed the optimal level of compensation.

The economic measure for the optimal deterrence amount is the risk–money trade-off for very small risks of death. Since the concern is with small probabilities, not the certainty of death, these values are referred to as the value of statistical life (VSL). Economic estimates of the VSL amounts have included evidence from market decisions that reveal the implicit values reflected in behaviour as well as the use of survey approaches to elicit these money–risk trade-offs directly. Government regulators in turn have used these VSL estimates to value the benefits associated with risk reduction policies. Because of the central role of VSL estimates in the economics literature, those analyses will be the focus here rather than income replacement for accident victims.

Valuing risks to life
Although economics has devoted substantial attention to issues generally termed the ‘value of life’, this designation is in many respects a misnomer. What is at issue is usually not the value of life itself but rather the value of small risks to life. As Schelling (1968) observed, the key question is how much people are willing to pay to prevent a small risk of death. For small changes in risk, this amount will be approximately the same as the amount of money that they should be compensated to incur such a small risk. This risk–money trade-off provides an appropriate measure of deterrence in that it indicates the individual's private valuation of small changes in the risk. It thus serves as a measure of the deterrence amount for the value to the individual at risk of preventing accidents and as a reference point for the amount the government should spend to prevent small statistical risks. Because the concern is with statistical lives, not identified lives, analyses of government regulations now use these VSL levels to monetize risk reduction benefits.

Suppose that the amount people are willing to pay to eliminate a risk of death of 1/10,000 is $700. This amount can be converted into a value of statistical life estimate in one of two ways. First, consider a group of 10,000 individuals facing that risk level. If each of them were willing to contribute $700 to eliminate the risk, then one could raise a total amount to prevent the statistical death equal to 10,000 people multiplied by $700 per person, or $7 million. An alternative approach to conceptualizing the risk is to think of the amount that is being paid per unit risk. If we divide the willingness to pay amount of $700 by the risk probability of one in 10,000, then one obtains the value per unit risk. The value per statistical life is $7 million using this approach as well.

Posing hypothetical interview questions to ascertain the willingness-to-pay amount has been a frequent survey technique in the literature on the value of life. Such studies are often classified as ‘contingent valuation surveys’ or ‘stated preference surveys’, in that they seek information regarding respondents’ decisions given hypothetical scenarios (see Jones-Lee, 1989; Viscusi, 1992). Survey evidence is most useful in addressing issues that cannot be assessed using market data. How, for example, do people value death from cancer compared with acute accidental fatalities? Would people be interested in purchasing pain-and-suffering compensation, and does such an interest vary with the nature of the accident? Potentially, survey methods can yield insights into these issues.

Evidence from actual decisions that people make is potentially more informative than trade-offs based on hypothetical situations if suitable market data exists. Actual decision-makers are either paying money to reduce a risk or receiving actual compensation to face a risk, which may be a quite different enterprise from dealing with hypothetical interview money. In addition, the risks to them are real so that they do not have to engage in the thought experiment of imagining that they face a risk. It is also important, however, that individuals accurately perceive the risks they face. Surveys can present respondents with information that is accurate. Biased risk perceptions may bias estimates of the money–risk trade-off in the market. Random errors in perceptions will bias estimates of the trade-off downward. The reason for this result can be traced to the standard errors-in-variables problem. A regression of the wage rate on the risk level, which is measured with error, will generate a risk variable coefficient that will be biased downward if the error is random. The estimated wage–risk trade-off will consequently understate its true value.

**Empirical evidence on the value of statistical life**

A large literature has documented significant trade-offs between income received and fatality risks. Most of these studies have examined wage–risk trade-offs but many studies have focused on product and housing risks as well. The wage-risk studies have utilized data from the United States as well as many other countries throughout the world. The primary implication of these results is that estimates of the value of life in the United States are clustered in the $4 million to $10 million range, with an average value of life in the vicinity of $7 million.

Since the time of Adam Smith (1776), economists have observed that workers will require a ‘compensating differential’ to work on jobs that pose extra risk. These wage premiums in turn can be used to assess risk–money trade-offs and the value of life. The underlying methodology used for this analysis derives from the hedonic price and wage literature, which focuses on ‘hedonic’ or ‘quality-adjusted’ prices and wages. Rosen (1986) and Smith (1979), among others, review this methodology.

To see how the hedonic model works, let us begin with the supply side of the market. The worker's risk decision is to choose the job with the fatality risk p that provides the highest level of expected utility (EU). The worker faces a market offer curve w(p) that is the outer envelope of the individual firms’ market offer curves. Let there be two states of the world: good health with utility U(w) and death with utility V(w), where this term is the worker's bequest function. The utility function has the property that good health is preferable to ill health, and workers are risk-averse or risk-neutral, or \( U(w) > V(w) \), \( V' > 0 \), and \( U'' \), \( V' < 0 \). The job choice is to maximize

\[
\max_{p} EU = (1 - p)U(w(p)) + pV(w(p)),
\]

leading to the result

\[
\frac{dU}{dp} = \frac{U(w) - V(w)}{(1 - p)U'(w) + pV'(w)}
\]

The wage-risk trade-off \( dU/dp \) based on the worker's choice of a wage–risk combination for a job is the value of statistical life, which equals the difference in utility between the two health states divided by the expected marginal utility of consumption.

What trade-off rate \( dU/dp \) the worker will select will depend not only on worker preferences but also on the shape of the market offer curve. The best available market opportunities.
will be those that offer the highest wage for any given level of risk, or the outer envelope of the offer curves for the individual firms. Each individual firm will offer a wage that is a decreasing function of the level of safety. The cost function for producing safety increases with the level of safety, so the wage decline associated with incremental improvements in safety must be increasingly great to keep the firm on its isoprofit curve.

Figure 1 illustrates the nature of the hedonic labour market equilibrium. The curves \(OC_1\) and \(OC_2\) represent two possible market offer curves from firms with risky jobs. As the risk level is reduced, firms will offer lower wages. \(EU_1\) and \(EU_2\) are expected utility loci of two workers, both of whom have selected their optimal job risk from available market opportunities. The curve \(w(p)\) represents the locus of market equilibria, which consists of the points at which worker indifference curves are tangent to the market offers. Thus, the empirical estimation of the hedonic labour market equilibrium focuses on the joint influence of demand and supply.

Figure 1
Market process for determining compensating differentials
The trade-offs reflected in market equilibria do not represent a schedule of individual VSL trade-off values at different risks, but rather different VSLs for different workers. Worker 1 chooses risk $p_1$ with associated wage $w(p_1)$, and worker 2 chooses risk $p_2$ for wage $w(p_2)$. However, worker 1 would not accept risk $p_2$ for wage $w(p_2)$ even when that is the point on the hedonic equilibrium curve. Rather, worker 1 will require wage $w_1(p_2) > w_2(p_2)$ to accept this risk.

The canonical hedonic wage equation is

$$\ln w_i = \alpha + \beta_i X_i + \gamma_1 p_i + \gamma_2 \delta_i + \gamma_3 WC_i + \epsilon_i$$

where $w_i$ is worker $i$'s wage, $X_i$ is a vector of personal characteristics and job characteristics, $p_i$ is the worker's fatality risk, $\delta_i$ is the nonfatal injury and illness risk, and $WC_i$ is a measure of the worker's compensation benefits. Not all labour market studies of VSL include the $\delta_i$ and $WC_i$ terms. Moreover, there are some differences in the form of the workers’ compensation benefit term that is included. The most common is the expected workers’ compensation replacement rate, which is the product of the injury risk and the benefit level divided by the wage rate. These differences in the empirical specification account for some of the differences across studies in the estimated VSL.

As a practical matter, there are many systematic differences that have become apparent in these studies. Workers at very high-risk jobs tend to have lower values of life on average since they have self-selected themselves into the very risky occupation. Through their job choices these individuals have revealed their greater willingness to endanger their lives. Workers at lower-risk jobs typically have greater reluctance to risk their lives, which accounts for their selection into these safer pursuits. Such differences are apparent in practice, as the estimated values of life for workers in the average risk jobs tend to be several times greater than those for workers in very risky jobs.

Other differences correlated with worker affluence are also evident. Health status is a normal economic good, and individuals’ willingness to pay to preserve their health increases with income. Blue-collar workers, for example, have a lower value of life than do white-collar workers. In addition, there is a positive income elasticity of the estimated values of risks to life and health. Based on a sample of 50 wage–risk studies from ten countries, Viscusi and Aldy (2003) estimate that VSL has an income elasticity of 0.5 to 0.6.

These differences by income level in the VSL amounts are also borne out in the international evidence on wage-risk trade-offs, such as the study of Australia and Japan by Kniesner and Leeth (1991). Table 1 summarizes representative VSL studies from throughout the world. More affluent countries such as Japan and Canada tend to have higher revealed VSL levels than countries such as South Korea, India and Taiwan. The major international anomaly is the United Kingdom, for which labour market estimates have been very unstable across studies and sometimes quite high. Deficiencies of the UK fatality risk data or correlation of these values with other unobservables may account for this pattern. Because of these limitations, the benefit assessments for risk reductions in the UK are based on stated preference values rather than labour market values, which is the approach taken by US regulatory agencies.

<table>
<thead>
<tr>
<th>Study/Country</th>
<th>Value of statistical life ($ millions)</th>
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<tbody>
<tr>
<td>Australia</td>
<td>4.2</td>
</tr>
<tr>
<td>Austria</td>
<td>3.9 – 6.5</td>
</tr>
<tr>
<td>Canada</td>
<td>3.9 – 4.7</td>
</tr>
<tr>
<td>Hong Kong</td>
<td>1.7</td>
</tr>
<tr>
<td>India</td>
<td>1.2 – 1.5</td>
</tr>
<tr>
<td>Japan</td>
<td>9.7</td>
</tr>
<tr>
<td>South Korea</td>
<td>0.8</td>
</tr>
<tr>
<td>Switzerland</td>
<td>6.3 – 8.6</td>
</tr>
<tr>
<td>Taiwan</td>
<td>0.2 – 0.9</td>
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The quality of the life of the years saved clearly matters as well. Life years in deteriorating health may be less valuable to the individual than years in good health. Some analysts have
and how should VSL levels be assigned to children?

The main empirical controversies concern the tails of the age distribution. To what extent is there a flattening of the VSL–age relation for the very old age groups,
U-shaped relationship with age. A similar pattern is exhibited empirically by lifetime consumption patterns, which some theoretical models have linked to VSL levels over the life

Although empirical estimates of the age effects are still being refined, the available evidence from survey data and market-based studies suggests that there is an inverted-U-

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Smokers and non-smokers face different market offer curves and, most important, these offer curves provide for a flatter wage–risk gradient for smokers. There may be an efficiency-based rationale for these differences, as smokers are more prone to job accidents, so that there safety-related productivity is less.

Studies of the money–risk trade-offs are not restricted to the labour market. There have been a number of efforts to assess price–risk trade-offs for a variety of commodities. The

do not work at hazardous jobs and appear to have wage–risk trade-offs similar to those of men. Other personal characteristics generate more evidence of heterogeneity in preferences.

Cigarette smokers and people who don use seat belts in their automobiles work on risky jobs for less per expected injury than do people who don't smoke and who use seat belts in

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controversial. There may be quite legitimate fears of government efforts to target expenditures by denying health care to those whose life quality is deemed to be low. People often adapt to changes in health status so that external observers may overstate the decline in well-being that occurs with serious illnesses.

Conclusion

Economic estimates of the trade-offs people make between risk and either prices or wages serve a variety of functions. First, they provide evidence on how people make decisions involving risk in labour market and product market contexts. The fact that there are probabilistic health effects does not imply that markets cease to function. Second, these estimates have proved useful in providing a reference point for how the government should value the benefits associated with regulations and other policies that reduce risk. Third, the existence of these estimates and economists’ continuing efforts to refine the values has served to highlight many of the fundamental ethical issues involved, such as how society should value reducing risks to people in different age groups.

See Also

- compensating differentials
- hedonic prices

Bibliography


