



Risk in Perspective

Valuing Lifesaving: Is Contingent Valuation Useful?



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For policies that save lives, economists have long argued that the benefits are most appropriately measured by the affected population's willingness to pay money to reduce risk (or by its willingness to accept monetary compensation in lieu of a risk reduction). Although it seems repugnant to put a price on human life, all of us make decisions every day in which we balance—perhaps implicitly—mortality risk against monetary costs and other burdens. Examples include choosing the foods we eat, how fast we drive, and whether we buy (and maintain) smoke and carbon-monoxide detectors for our homes.

In this issue of **RISK IN PERSPECTIVE**, I examine the scientific basis for monetary estimates of the value of reducing mortality risk. These estimates play an important role in benefit-cost analyses of public-health and environmental regulations. In particular, I consider the validity of estimates based on "contingent valuation," a method which relies on responses to survey questions about hypothetical choices.

"Investigators need to develop methods for conducting contingent-valuation studies of mortality risk that yield demonstrably valid results."

ESTIMATING THE "VALUE OF A STATISTICAL LIFE"

The rate at which people are willing to substitute money for mortality risk can be estimated by examining either the choices they make in daily life or the choices they say in surveys they would make. The first method is called "revealed preference." It assumes that people act in their self-interest and prefer the alternative they choose to the alternatives they forego. The second method is called "contingent valuation." It assumes that people's statements about how they would act contingent on a specified hypothetical setting accurately reflect their preferences.

Revealed-preference methods are considered more credible than contingent valuation since "actions speak louder than words." It is reasonable to assume that people's real choices are more thoughtful and better informed than their responses to survey questions. However, revealed-preference estimates of the value of mortality risk can only be obtained in settings where the alternatives that

an individual passes up can be identified and the differences in risk, cost, and other important dimensions can be estimated. Moreover, unobservable differences between individual risks and actuarial risk estimates can produce misleading results.

A few studies have examined consumer choices regarding products such as residential smoke detectors, foods, and types of automobiles. Most estimates of the monetary value of mortality risk have been obtained by comparing workers' pay and on-the-job fatality risk. After controlling for education and other factors that influence the opportunities available to a worker, these studies find that workers in high-risk jobs receive higher wages than those in safer jobs. For example, workers facing an annual occupational-fatality risk of 3 in 10,000 receive about \$500 more in annual wages than workers with jobs in which the risk is only 2 in 10,000.

The rate of compensation for risk is commonly expressed as a "value per statistical life" (VSL). In this example, the VSL is \$5 million ($= \$500 \sqrt{1/10,000}$). Since workers who prefer the safer, lower-risk job are willing to give up \$500 per year for the risk reduction, 10,000 such workers would together be willing to give up \$5 million per year to prevent one expected death among them.

Are the estimates of VSL obtained from occupational-risk studies appropriate for evaluating the benefits of environmental and public-health regulations? A number of factors suggest they may not be.

First, the target populations may include different types of people. Wage-risk studies by necessity reflect the preferences of workers in high-risk jobs, who are generally healthy, male, and young adults. In contrast,

environmental and public-health regulations may primarily benefit children or the elderly, or people who are unusually susceptible to pollution due to chronic lung disease, HIV-impaired immune systems, or other factors.

Second, wage-risk studies are based on the preferences of people who accept high-risk jobs, who implicitly reveal a greater willingness to accept risk for money than otherwise similar people who do not accept these jobs.

Third, the types of mortality risks differ. Wage-risk studies are largely based on fatal-accident risks. The mortality benefits of environmental regulations more often come in the form of lower risk of cancer or other disease, which people may value differently.

If the results of wage-risk studies are of limited application to environmental risks, contingent valuation (CV) may be a valuable alternative. CV is an extremely flexible method. One can ask almost any sort of question about a hypothetical choice between alternative situations varying in risk and monetary consequences, and experience suggests that most survey respondents will answer. Moreover, the questions can be addressed to the population most likely to benefit from an environmental regulation—the elderly, those with chronic disease, or others with relevant characteristics.

EVALUATING CONTINGENT VALUATION

How valid is contingent valuation? The fact that survey respondents will answer questions about how they would act in hypothetical situations does not imply that those answers are either thoughtful or

informed. We need criteria to evaluate CV results.

One criterion is the extent to which the values estimated from CV studies agree with estimates from revealed-preference approaches. Some comparisons have been made which show rough consistency between CV and revealed-preference estimates. Yet comparison requires applications in which revealed-preference estimates are available, and so is not applicable in the cases where CV is most needed. Also, one might expect that CV would work better in cases where survey respondents are familiar with the choice than in cases where they have no prior experience (where revealed preference may not be possible).

A second criterion is the consistency between CV estimates and theoretical predictions about which factors should, and should not, affect willingness to pay (WTP). For mortality-risk reduction and many other goods one would expect that WTP for a benefit would be larger for people with higher incomes, all else being equal. By contrast, WTP should not depend on logically inessential aspects of the question, such as whether the risk reduction is described as a change in probability (from 0.0003 to 0.0002), frequency (from 3 in 10,000 to 2 in 10,000), or odds (from 1 in 3,333 to 1 in 5,000).

PROPORTIONALITY OF WTP TO THE RISK REDUCTION

One theoretical prediction that has received much attention is "sensitivity to scope," that is, the extent to which estimated WTP depends on the size of the risk reduction or other benefit. CV has been criticized on the grounds that estimates of WTP are

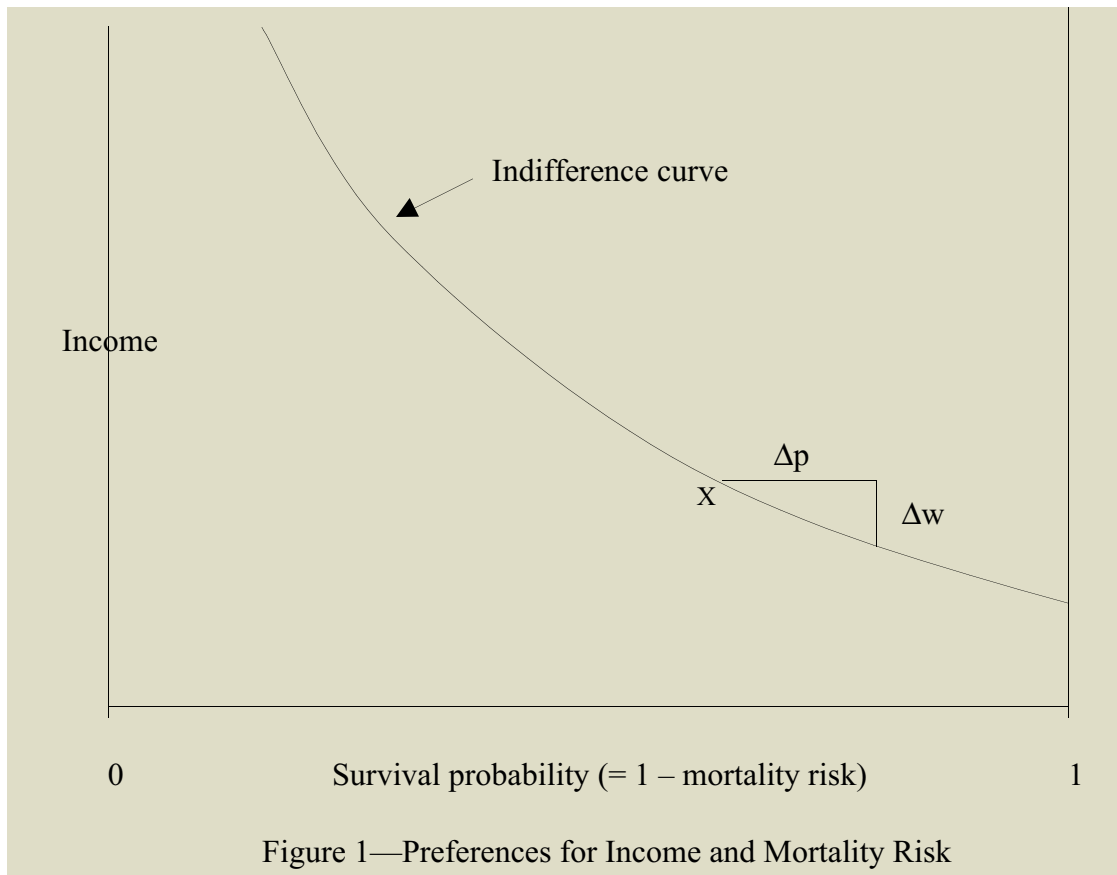
inadequately sensitive to differences between the items that are valued.

In applications to environmental quality, for example, respondents may indicate virtually the same WTP for protection of substantially different wilderness areas or numbers of wildlife. When respondents indicate they are willing to pay the same amount for improvements of widely differing magnitude, it raises a concern that they are simply expressing general support for environmental protection rather than valuing the specified improvement.

For environmental quality, it is reasonable to expect that WTP should be larger for a greater improvement, but there seems to be no clear answer to the question of how much larger is enough. For small reductions in mortality risk, however, it is reasonable to assert that WTP should be nearly proportional to the reduction in risk.

Consider an individual with annual income of \$40,000 (the approximate average for US households) facing a 28 in 10,000 chance of dying in the next year (the approximate average for US residents aged 25-54). Assume the individual's VSL is \$5 million (a standard estimate). How much would he pay to reduce his risk by 1 in 10,000 and by 2 in 10,000?

The individual's VSL describes the rate at which he would pay for tiny reductions in risk. In Figure 1, VSL is the slope of the indifference curve at the individual's current position, which is labeled X. (The indifference curve divides combinations of income and risk that the individual prefers to his current position, which lie above the curve, from those he disprefers, which lie below the curve.) The most the individual would be willing to pay (Δw) for a small



risk reduction (Δp) is $VSL \times \Delta p$.

As the individual buys successive risk reductions, his VSL will fall as he moves to a flatter part of his indifference curve. The indifference curve becomes flatter as both his remaining income and his risk decline. For small changes in risk, these effects should be small.

Empirical studies—using both revealed preference and CV—find that VSL is not very sensitive to income. Typical estimates suggest that a 1% change in income yields less than a 1% change in VSL—often 0.5% or less.

Smaller risk decreases VSL through the "dead-anyway" effect. An individual facing a high risk of dying soon may as well spend profligately on risk reduction as he may not have the opportunity to spend his money on anything else. As his risk falls, he is more likely to have other spending opportunities

and should be willing to pay less for risk reduction. Under the standard model, the magnitude of this effect should be smaller than the proportional change in survival probability.

The individual's WTP for the first infinitesimal reduction (from 28/10,000) is proportional to his initial VSL—\$5 million. His WTP for the last infinitesimal reduction (to 27/10,000) is proportional to his VSL at the smaller risk and income position. Because his total WTP for the reduction is less than \$500 ($= \$5 \text{ million} \times 1/10,000$), his final income must be greater than \$39,500 and the reduction in income reduces his VSL by no more than the fractional income loss, 1.25%. The dead-anyway effect is negligible in comparison as it reduces his VSL by no more than the proportional difference in survival probabilities, about 1/10,000. Combining these effects, the individual's VSL at the smaller risk level is at least \$4.93 million.

Consequently, his WTP to reduce risk from 28/10,000 to 27/10,000 is between \$493 and \$500.

Similarly, the individual's WTP to reduce his risk from 28/10,000 to 26/10,000 depends on the change in VSL between those positions. Since WTP for this increment is less than \$1,000 his final income exceeds \$39,000. The dead-anyway effect cannot decrease VSL by more than 2/10,000. Combining these effects, VSL at the final risk of 26/10,000 must be at least \$4.87 million and his WTP to reduce risk from 28/10,000 to 26/10,000 is between \$974 and \$1,000. Thus, WTP to reduce mortality risk by 2/10,000 is very nearly double WTP to reduce risk by 1/10,000.

The near-proportionality of WTP to change in mortality risk depends on several factors. First, the effect of reduced income cannot be too large, which implies that it is unreasonable to expect near-linearity if the payments are a substantial fraction of income (or if the sensitivity of VSL to income is much larger than current estimates suggest).

Second, the result does not hold for some theories of decision making that allow for thresholds in the way people evaluate probabilities. For example, if an individual views an annual mortality risk of 27/10,000 as "acceptable" but a risk of 28/10,000 as "unacceptable," then he would pay something to reduce his risk from 28/10,000 to 27/10,000 but nothing for the further reduction to 26/10,000. Thus, his WTP for the larger and smaller risk reductions would be equal.

Although such a result is possible, probability thresholds seem to be an ad hoc and context-specific rationalization. The existence of probability thresholds could

also yield a much greater than proportional relationship between WTP and risk change. If an individual views a reduction of 1/10,000 as negligible but a reduction of 2/10,000 as meaningful, WTP for the smaller reduction might be zero while WTP for the larger one would be positive.

Another possibility is that respondents to CV surveys do not report their values for the numerical risk change specified in the question. Instead, they may combine the stated risk reduction with their own prior estimates of how effective the hypothetical program might be to form a revised, posterior estimate of the risk reduction. Even if the respondents' reported values are proportional to their posterior risk estimates, they may not be proportional to the risk reductions specified in the survey. Moreover, it is impossible to estimate the respondents' preferences for money and risk unless the posterior risks they value can be ascertained.

The dead-anyway effect should not cause a significant non-proportionality between WTP and risk reduction. The effect depends on the individual's total mortality risk rather than the level of risk from any specific cause. Whether the risk reduction to be valued involves a small or large fractional change in a particular risk (for example, road accidents) is irrelevant, unless the value of income if one dies depends strongly on the cause of death.

The argument for near proportionality of WTP to change in risk does not require that the individual be willing to pay the same amount to reduce different risks, since it concerns WTP to reduce the same type of fatality risk by different amounts. An individual might be willing to pay different amounts to reduce his risk of dying in a traffic accident and from cancer by 1 in

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FURTHER READING

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10,000. Nevertheless, he should be willing to pay nearly twice those amounts to reduce each risk by 2 in 10,000.

THE STATE OF THE FIELD

In a recent article, John Graham and I reviewed the results of every CV study we could find that was published since 1980 and estimated WTP for reductions in numerically specified health risks. We sought to determine whether estimates of WTP were proportional to the risk reduction.

Of the 25 studies we identified, only 14 provided information on how estimated WTP varied with the magnitude of risk reduction. Eight studies involved fatality risks. Of these, WTP was statistically significantly related to the magnitude of risk reduction in six cases, and not significantly related in two. In every case, WTP varied much less than proportionately to the risk reduction. Some of these studies asked the same respondents to value larger and smaller risk reductions and found that many reported they would pay the same amount for both reductions.

Six of the 14 studies evaluated nonfatal risks and revealed a similar lack of sensitivity to the magnitude of benefit. WTP was significantly related to the risk change in five studies but was always much less than proportional to the magnitude of the change.

One reason that CV studies usually yield estimates of WTP that are inadequately sensitive to the risk reduction may be the difficulty of accurately communicating small risk changes to survey respondents. To date, there has been little formal testing of the effect of risk-communication methods in CV, although several investigators have recently begun to conduct such tests.

Our own preliminary results suggest that verbal probability analogies (for example, "2 in 10,000 is like 105 minutes in a year") are not helpful but some types of visual aids can be. Characterizing the benefit as an increase in life expectancy rather than a reduction in annual risk may also improve the relationship between estimated WTP and the magnitude of the benefit.

CONCLUSION

Contingent valuation is an extremely flexible method for eliciting preferences about health risks. There are few alternatives for obtaining empirical estimates of the value of reducing mortality risk to a specified population. For CV to fill this need, investigators need to develop methods for conducting CV studies that yield demonstrably valid results. An important criterion for evaluating validity is consistency with other information, including the predictions of reasonable theories of decision making and valuation of health risk.