New Directions in Mortality Risk Valuation and Stated Preference Methods: Preliminary Results

by Alan Krupnick, Anna Alberini, Robert Belli, Maureen Cropper, and Nathalie Simon

I. Introduction

Although benefits estimates of environmental regulations often hinge on the values assigned to changes in risk of death over the life cycle, no major, in-person survey has been conducted in the U.S. to value such changes. Most benefit-cost analyses rely instead on estimates produced by compensating wage studies, even though the estimates are inappropriate when valuing risk changes produced by environmental programs. The objective of our work is to develop a questionnaire that could be used in a large, in-person survey to value mortality risk reductions. We report on our experience to date with pretests of a survey instrument in the U.S. and in Japan.

The main shortcoming of labor market studies is that they measure compensation received by prime-aged men for immediate reductions in risk of death. Reductions in exposure to air pollution, by contrast, primarily benefit persons over age 65. Since older people have fewer life-years remaining than prime-aged males, the compensation received in labor market studies may overstate the value of risk reductions to persons over age 65. Secondly, exposure to pollution (especially to carcinogens) can result in delayed effects. When valuing improvements in exposure today that do not reduce risk of death until the future, policy makers must know what people will pay today for future risk reductions.

Contingent valuation (CV) studies, which ask people directly what they would pay to reduce their risk of dying, can, in theory, be tailored to value risks in any context. However, studies that have asked people to value small reductions in their probability of dying have often produced answers that are not internally consistent. For instance, in recent CV surveys (e.g.,[1]), WTP for reductions in mortality risks often did not increase with the size of the risk reduction, as theory would suggest it should. This problem may be due to respondent difficulty in dealing with small probabilities, but also the way in which changes in the risk of death are presented. The goal of this research is to present information on changes in risk of death in such a way that subjects’ responses to CV questions are internally consistent. Specifically, we ask people to value a change in their risk of dying over the next 10 years, effective immediately, and a reduction in their probability of dying between ages 70 and 80. This will allow us to value both immediate changes in risk of dying, as

1 Respectively, the authors are with Resources for the Future, University of Colorado, University of Michigan, University of Maryland and the World Bank, and the World Bank.
well as those that occur later in life, and in so doing will address the shortcomings of existing risk estimates.

II. Using Surveys to Value Risk Reductions.

Absent transactions in markets in which people’s preferences about risk can be observed, researchers have resorted to survey-based approaches to value mortality risk reductions. In a typical CV survey, respondents are confronted with a hypothetical policy that would result in an improvement in the present level of environmental quality, public good or risk. Respondents are asked to report their maximum WTP to secure this improvement. Average WTP multiplied by the relevant population yields an estimate of the benefits of the proposed policy.

In most recent CV surveys, the payment question has been asked using a “dichotomous choice” format, calling for a simple “yes” or “no” answer. Respondents are asked whether they would pay $X for the change, or whether they would vote in favor of or against the policy, should approval result in a cost of $X to the respondent’s household. The amount $X is varied across respondents.

CV surveys have occasionally been used to value mortality risk reductions to be attained from environmental, transportation safety and health programs[1,2,3]. These studies have found that while many respondents report positive WTP amounts to secure such risk reductions, a large fraction of the respondents is likely to have WTP equal to zero. Some respondents fail to grasp the basic notion of probability, and others ascribe similar WTP amounts to grossly different risk reductions. With few exceptions [2], these studies have dealt with accidental death risks, as opposed to risks involving latent or late-in-life risk. Recent attempts to value extensions to life expectancy conditional on survival to later ages [4] have been fraught with problems including the use of telephone surveys, precluding the use of visual aids, ill-defined commodities and implausibly large risk reductions.

Our work attempts to fill some gaps in the valuation literature by developing a survey instrument to elicit WTP for an immediate reduction in risk and for a reduction in risk to be incurred at a later age. In contrast to earlier studies, our questionnaire is administered in-person and makes extensive use of visual aids.

III. The Mortality Risk Questionnaire

Throughout our survey, we are motivated by two important concerns: (1) that respondents find the commodity to be valued meaningful, and (2) that they accept that mortality risks can be mitigated at a cost and that many people, if not themselves, perform such mitigation as part of everyday life. The first section introduces probabilities and proposes simple practice questions to familiarize the respondents with these concepts. The second section presents respondents with leading age- and gender-specific causes of death and introduces common risk-mitigating behaviors. We then educate our respondents about the costs associated with these behaviors and continue with the valuation part of the survey. The fourth section elicits information about WTP for risk
reductions of a given magnitude, occurring at a specified time. This is followed by an extensive debriefing section.

We begin the WTP section by introducing a base-line risk tailored to the respondent's age and gender. The respondent is asked how he would feel if he learned that his chances of dying over the next 10 years were a specified amount and is asked to accept this risk as his own. The respondent is then asked to consider two risk reductions occurring over the next 10 years. The first risk reduction reduces the baseline risk by 5 in 1,000 while the second change reduces risk by only 1 in 1,000. Before asking the his WTP, the respondent is asked to create his own base-line risk graph by darkening squares on a grid.

Our WTP questions differ from those in earlier CV surveys in four respects. First, they differ in the timing of the risk reductions, and, second, in the attention given to the timing of the payment. Third, the baseline risk is tailored to the individual according to age and gender group. Fourth, we depart from the recent CV literature and the NOAA panel recommendations [10] in that, instead of specifying in detail the payment vehicle and policy under which the risk reduction is to be delivered, we keep the circumstances surrounding the risk reduction extremely abstract.

We argue first, that in the discounting human lives literature, respondents are willing and able to make choices among abstract life-saving programs[9]. In addition, we argue that being specific about the attributes of the risk and mitigation approach may lose as many people as it gains because some respondents will not believe that the specifics apply to them. While we do provide the respondent with some specific examples of mitigating activities that could produce the risk reductions in question, we emphasize that the activity could take any number of forms, allowing respondents to focus on the size of the risk reduction itself. To ensure that the respondent understands the implications of the risk reduction in question, he is now asked to erase the appropriate number of squares shaded earlier.

We have chosen to use an annual payment made over 10 years because the risk reductions to be valued are considered “large” for any one year (1 in 1,000 and 5 in 1,000). Obtaining risk reductions of these magnitudes would require repeated actions over time from the respondent. We ask respondents about risk reductions of two sizes to see if they are able to differentiate between small probabilities and to see if the value of a risk change increases with the size of the reduction.

Our final series of dichotomous choice questions focuses on future risk reductions. These questions are especially important for valuing environmental improvements related to conventional air pollutants and carcinogens, since the benefits accruing to the population would tend to occur later in life as reduced deaths in any given year from heart disease, chronic obstructive pulmonary disease, and cancers. The WTP questions are preceded by a question concerning the chances of surviving to future ages. Specifically, the respondent is asked to assess his chances of living to age 70. This question encourages the respondent to think about his future. A variety of surveys [4,7] have shown that individuals are reasonably good at estimating future survival probabilities and are able to value risk changes occurring in the future.
The respondent is then shown a risk graph with the chances of dying between ages 70 and 80 for the average person and is asked, through a series of dichotomous choice questions, his WTP today for a future risk reduction beginning at age 70 of 5 in 1,000 (from 360 to 355 in 1,000). The reduction is indicated on the risk graph using darker colors, and is fully exogenous to the respondent.

Finally, the strength of the respondent's conviction is checked by the remaining questions. The respondent is reminded that there is a chance he may not survive to age 70, making a payment today useless. He is then given the opportunity to revise his bid. The final question asks how certain the respondent is that he would be willing (or not willing) to pay the amount stated. A detailed series of debriefing and demographic questions follow the main body of the questionnaire.

III. Evidence from Two Pre-tests

Thus far we have developed and refined the mortality risk questionnaire based on a total of 27 personal, "think-aloud" interviews lasting approximately one hour each and are in the process of completing a 60-person pre-test of the survey instrument. In addition, the Fuji Research Institute, a non-profit research group receiving funding from Japan's Ministry of International Trade and Industry (MITI), is employing a very similar questionnaire in Tokyo, developed using the same protocols. The principal difference between the Japanese version and that used domestically is that the Japanese questionnaire uses a dichotomous choice format with two follow-up questions. The Japanese instrument has been pre-tested on a total of 316 individuals in Tokyo. While administering a full survey using this new questionnaire falls outside of the scope of this project, the preliminary, small-sample results of both pre-tests are quite interesting.

A. Results from the U.S.

The Survey Research Center at the University of Maryland has conducted 10 interviews using the survey instrument described above with respondents from College Park, MD. Using maximum likelihood estimation techniques, we fit a series of distributions to the double-bounded WTP responses for each of the three risk categories, including the normal, log normal, Weibull, exponential, logistic and log logistic distributions. The mean WTP, median WTP, and distribution with the best fit for each of these categories below in Table 1. Assuming a 5% discount rate, we find VSL estimates ranging from $132,000 to $402,000. According to these preliminary results, the mortality risk questionnaire shows exceptional promise. Although WTP fails to increase in proportion to the size of the risk reduction, as one would expect from expected utility theory, respondents were willing to pay more for larger risk reductions than for small ones. In addition, although most respondents felt the baseline risk was too high, they accepted the quoted risk for the purposes of the survey. Also, all subjects, except those answering no to both dichotomous choice questions,

\[ VSL = \text{present discounted value of median WTP divided by the risk reduction.} \]

\[ \text{Subjects answering NN were not asked about the reasonableness of paying today for future risk reductions. We plan to ask this of all subjects in future interviews.} \]
felt that paying today for a product that would not affect one's health until age 70 was reasonable. The sample size at this stage, however, precludes the use of statistical tests.

Table 1: Preliminary Evidence from the U.S.

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Median WTP</th>
<th>Std Error</th>
<th>Mean WTP</th>
<th>Best Fit</th>
<th>Implied VSL</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 in 1,000 risk change over next 10 years</td>
<td>$197</td>
<td>$86</td>
<td>$367</td>
<td>Log Normal</td>
<td>$304,000</td>
</tr>
<tr>
<td>1 in 1,000 risk change over next 10 years</td>
<td>$52</td>
<td>$35</td>
<td>$220</td>
<td>Log Normal</td>
<td>$402,000</td>
</tr>
<tr>
<td>5 in 1,000 risk change from age 70 to age 80</td>
<td>$86</td>
<td>$52</td>
<td>$214</td>
<td>Weibull</td>
<td>$132,800</td>
</tr>
</tbody>
</table>

B. Results from Japan

While we are only just beginning the analysis of the data from the Japanese pretest, the preliminary results are equally encouraging. The survey was administered to 316 residents in the Tokyo area, a large enough sample to allow statistical inference. Out of the 316 completed interviews, only 6 failed the internal scope test and almost 80 percent of the respondents accepted the baseline risk as their own. Of those who were not able to accept the baseline risk, 57 percent felt their risk was higher than that given. When questioned about whether it is reasonable to pay today for a risk reduction that would not occur until age 70, over half of the subjects responded "no" or "don't know". Using the same estimation techniques described above, we find VSL amounts ranging between $40,000 and $386,000.

Table 2: Preliminary Evidence from Japan

<table>
<thead>
<tr>
<th>Commodity</th>
<th>Median WTP</th>
<th>Standard Error</th>
<th>Best Fit</th>
<th>Implied VSL</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 in 1,000 risk change over next 10 years</td>
<td>$113</td>
<td>$13</td>
<td>Weibull</td>
<td>$175,000</td>
</tr>
<tr>
<td>1 in 1,000 risk change over next 10 years</td>
<td>$50</td>
<td>$6</td>
<td>Weibull</td>
<td>$386,000</td>
</tr>
<tr>
<td>5 in 1,000 risk change from age 70 to age 80</td>
<td>$22</td>
<td>$4</td>
<td>Weibull</td>
<td>$40,000</td>
</tr>
</tbody>
</table>

IV. Conclusions

Mortality risk reductions associated with improvements in air quality are not easily valued. These mortality risks are generally realized later in life. Only one study to date [4] has been able to incorporate this characteristic. In addition, CV studies of mortality risk present convincing evidence that small changes in probabilities are being successfully communicated to respondents. Our work, however, seems to successfully bridge this gap in the literature. Not only have we developed a survey instrument that focuses on mortality risks realized in the future, but the questionnaire is administered in-person with extensive use of visual aids and tests of cognition are imbedded in the instrument. Preliminary results from the pre-tests of the questionnaire indicate
that individuals are able to distinguish between different magnitudes of small probabilities and are able to make judgements on future risks. We intend to continue testing and refining our questionnaire and eventually to administer it to a full sample of randomly selected individuals.

References