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Public Choices Between Life Saving Programs: The Tradeoff Between Qualitative Factors and Lives Saved

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Abstract

In a telephone survey 1000 adults were confronted with pairs of life saving programs that differed in number of lives saved and asked which program in each pair they would choose to implement. Respondents were also asked to rate qualitative program characteristics on 10 point scales. For most respondents, lives saved are significant in explaining program choices, as are psychological risk characteristics. The rate of technical substitution between these characteristics and lives saved is, however, inelastic. It is noteworthy that for about 20 percent of respondents, choices among programs appear to be insensitive to lives saved.

Key words: health and safety regulations, risk characteristics, voluntariness, environmental health

JEL Classification: H4, Q2, I1

If the goal of health and safety programs were to maximize the number of lives saved, one would expect the cost of saving a life, at the margin, to be equalized among programs. Studies, however, reveal large disparities among programs in cost-per-life (or life-year) saved (Tengs et al., 1995; Morrall, 1986), with environmental regulations often having a much higher cost than other health and safety programs. For example, a program of annual mammograms to detect breast cancer among women over the age of 50 has been estimated to cost between $20,000 and $90,000 per life year saved (Eddy, 1989), while the cost-per-life-year saved of a regulation to reduce airborne exposure to benzene is approximately $5,000,000 (Van Houtven and Cropper, 1996).

There are at least two explanations for such discrepancies. One is that societal expenditures reflect people's preferences, and that people care about more than the number of lives a program saves (Viscusi, 1992). They prefer to reduce risks that are involuntary, risks that are difficult to control, risks that are "dreaded," and risks that are unfamiliar (Slovic, Fischhoff, and Lichtenstein, 1985; Mendeloff and

Kaplan, 1989). Environmental health risks often fall in these categories, whereas many public health risks do not. This implies that the marginal social utility of saving a life via an environmental program may be higher than the marginal social utility of saving a life through other health and safety programs. If, however, resources are allocated efficiently, the ratio of costs-per-life-saved should reflect the rate at which people, in their role as social decision makers, are willing to substitute lives saved by one program for lives saved by another.

A completing explanation is that disparities in cost-per-life saved do not reflect public preferences, but inefficiencies in resource allocation. Such inefficiencies may result from the way in which health and safety programs are funded. Environmental health regulations are often off-budget items whose costs are not transparent to the public, whereas public health programs are usually funded from tax dollars. Since there is no mechanism that forces policymakers to compare costs across the two sets of programs, there is no reason to believe that observed ratios of costs-per-life-saved reflect the marginal social utility of saving lives through different programs. If this is the case, a better understanding of the rate at which people are willing to trade lives saved by one program for lives saved by another would indicate the degree of inefficiency in resource allocation.

1. Objectives of the research

Our goal in this paper is to examine the rate at which people are willing to trade lives saved by environmental health programs for lives saved by other health and safety programs, and to understand the factors influencing these choices. This is in the spirit of Wes Magat's work on risk-risk trade-offs (Magat, Viscusi, and Huber, 1996) in which respondents are asked to choose between two cities that differ in health and safety risks in deciding where to live. Through repeated questioning one can determine the rate at which a person is willing to substitute one health risk for another, and thus infer the relative desirability of reducing the two risks. We wish to determine the desirability of reducing health risks via different public programs and thus, in contrast to Magat et al. (1996), place respondents in the role of social decision makers.

In a national telephone survey we confronted a random sample of 1,000 households with choices between pairs of environmental and public health programs.[1] Each program in a pair was described and the respondent, acting a social decision maker, was asked which he would choose to implement, assuming that the two programs saved the same number of lives. The ratio of lives saved was varied and the choice repeated.

This allows us to infer the ratio of lives saved that makes the median respondent indifferent between the environmental and public health programs. It measures, for example, how many lives saved by drinking water treatment are equivalent to a life saved by a colon cancer screening program. The question is how this ratio compares with the ratio of cost-per-life-saved for each program at current levels of implementation. Are the rates of substitution between lives saved in one program and lives saved in another as extreme as the ratios of costs-per-life saved? If so, then the allocation of resources across life-saving programs may indeed reflect public preferences. If not, then there may be inefficiencies in the allocation of resources across life-saving programs.

We also wish to explain the rate at which respondents are willing to substitute lives saved by one program for lives saved by another. Is this influenced by the psychological aspects of the risks reduced (e.g. voluntariness, controllability) or by other characteristics of the programs (e.g., how each program is funded, whether the program is judged to lie within the proper scope of government activity)? This is accomplished by asking each respondent to place each program on a series of 10-point scales, one for each qualitative characteristic. Assuming that these attributes enter the respondent's utility function along with lives saved, we estimate the marginal rates of technical substitution between qualitative program characteristics and lives saved.

This enables us to answer the following questions:

- Which qualitative risk and program characteristics are important in explaining people's choices among environmental and public health programs?
- Does the number of lives saved matter in choices among programs?
- How important are risk and program characteristics in relation to the number of lives saved by a program? Specifically, what is the marginal rate of technical substitution between qualitative characteristic and lives saved?
- Given a vector of qualitative characteristics describing each program, how many more lives would one program have to save compared to another to make the median respondent indifferent between them?

The answers to these questions are presented below. Our results indicate that, in choosing among life-saving programs, people care both about the qualitative characteristics of regulatory programs and about number of lives saved: All but one of the program characteristics discussed in the next section are statistically significant in predicting program choices, as is the number of lives saved.

To measure the relative importance of qualitative factors versus lives saved, we calculate the number of lives Program A must save relative to Program B to make the median respondent indifferent between the two programs, given his perception of their qualitative attributes. For the six pairs of the programs in the survey, this ratio is never greater than 2.5—far lower than the disparities in cost-per-life saved reported in the literature. This focus on the median respondent, however, ignores heterogeneity of preferences. For 20 to 30 percent of respondents, the qualitative aspects of air and water pollution control programs are so important that respondents always choose these programs regardless of the number of lives saved by the public health program in the pair. There is, therefore, a significant minority with lexicographic preferences who could help to explain observed disparities in costs-per-life saved.

The paper is organized as follows. The next section presents the qualitative risk and program characteristics on which the study focuses and discusses the choice of life saving programs used in the survey. Section 3 presents the conceptual framework and the statistical model used to formalize the relationship between people's choices of life-saving programs, qualitative program characteristics and lives saved. Section 4 describes the survey methodology and the structure of the questionnaire. Section 5 presents the results of the study, and Section 6 concludes.

2. Qualitative characteristics and preferences for life-saving programs

2.1. Choice of characteristics studied

The characteristics on which we focus are those that, in general, differ between environmental and public health programs. These characteristics, listed in Table 1, fall into two groups. The first group consists of characteristics of the *risks* targeted, which have been studied previously in the psychometric literature (Slovic, Fischhoff, and Lichtenstein, 1985; Mendeloff and Kaplan, 1989). They include (1) the voluntariness of the risk, i.e., whether people are to blame for being exposed to the risk (*Blame—voluntariness*); (2) the controllability of the risk; i.e., how easy it is to avoid the risk (*Ease of avoiding risk—controllability*); (3) the seriousness of the risk (*Seriousness of risk*) and (4) whether the risk affects the respondent personally (*Personal risk*).

The second group comprises characteristics of the particular *programs* to control health and safety risks. These characteristics, which deal with the perceived intrusiveness of programs, how they are funded and how effective people believe them to be, have not been studied as extensively in the literature on preferences for risk regulation (Horowitz, 1993; Horowitz and Carson, 1991; 1992; 1993). They include the perceived effectiveness of the program (*Efficacy of the program*), whether the program lies within the proper scope of government activity (*Appropriateness of government intervention*), whether the funding of the program is considered equitable, given who benefits from the program (*Fairness of the funding mechanism*), and whether there is a lag before the program begins to save lives (*Lag before program saves lives*).

Program characteristics were selected on the basis of focus groups in which respondents often described environmental health programs as more effective than public health programs (because they require less cooperation from beneficiaries than do public health programs) and believed that pollution control (environmental health) was a more appropriate form of government activity than the direct delivery of health services (public health). Fairness of funding was included because of differences in the distribution of costs and benefits between environmental health and public health programs. Typically public health programs are funded out of general tax revenues but are targeted at high-risk groups rather than at the general population. Most pollution control programs, by contrast, are paid

Table 1. Perceived differences in program characteristics

Ratio of mean value of characteristic in Program A to characteristic in Program B

Program characteristics	Smoking education v. Industrial air pollution control	Colon cancer screening v. Drinking water pollution control	Dual airbags in automobiles v. Auto emission control program	Pneumonia vaccine program v. Industrial air pollution control	Radon control in homes v. Smoking ban in the work place	Radon control in homes v. Pesticide ban on fruit
Blame (Voluntariness)	1.73	1.20	1.92	0.98*	0.78	0.87
Ease of Avoiding Risk (Controllability)	2.55	1.31	1.96	1.75	1.06*	1.31
Seriousness of Risk	1.03*	1.01*	1.09	0.79	0.79	0.81
Personal Risk	0.87	1.11	1.22	0.81	0.70	0.60
Efficacy of Program	0.95	1.04	1.13	1.05	0.87	0.95
Appropriateness of Government Intervention	0.89	0.86	0.96*	0.87	0.94*	0.78
Fairness of Funding	0.83	1.12	1.05*	1.07*	0.88	1.07*
Time Lag before Lives Saved	0.95*	0.85	0.53	0.57	1.36	1.28

Note: The ratio of the mean value of characteristic A to mean value of characteristic B is statistically significantly different from 1 except where marked by an asterisk.

for either by the persons who benefit from the pollution (stockholders, employees and consumers of the polluting firm), or by people who benefit from pollution control (drinking water treatment paid by user fees). The time dimension of life saving was included to see if people's tendency to discount future lives saved (Cropper, Aydede, and Portney, 1994) was robust to the inclusion of other characteristics in the description of life-saving programs.

2.2. Choice of program pairs

Respondents in the survey were each confronted with two program pairs, drawn from the list of six pairs in Tables 1 and 2. Each pair consisted of one public health program and one environmental health program. For the purposes of the survey we defined environmental health programs as programs that improve health by controlling exposure to pollution. These included programs to reduce air pollution from automobiles and factories, drinking water treatment, regulations to limit pesticide residues on food and a workplace smoking ban. Public health programs included colon cancer screening, smoking education and pneumonia vaccinations, as well as regulations to require passenger-side airbags in cars and radon tests in

Table 2. Percentage of respondents choosing each program when both save the same number of lives

	Percentage of respondents	Total number of respondents	Disease targeted
1. Smoking education	45	259	Heart and lung disease
Industrial air pollution control	55		
2. Colon cancer screening	46	359	Colon cancer
Drinking water pollution control	54		
3. Dual airbags in automobiles	46	402	Auto deaths
Auto emission control program	54		
4. Pneumonia vaccine program	37	251	Lung disease
Industrial air pollution control	63		
5. Radon control in homes	35	250	Lung cancer
Smoking ban in the workplace	65		
6. Radon control in homes	28	178	Cancer
Pesticide ban on fruit	72		

homes. A key feature of our public health programs is that they serve people "one at a time," whereas the reductions in exposure delivered by environmental health programs are public goods.[2]

Our choice of environmental health programs was guided by the following criteria. We selected programs that (a) target the greatest environmental risks to human health (USEPA, 1987; 1990); (b) include regulations that have been cited as objectionable because of the high cost-per-life saved (OMB, 1993); and (c) primarily yield benefits in the form of life-saving, rather than reductions in illness or benefits to ecosystems. Public health programs were chosen to target the same health endpoint as the environmental programs—cancer, respiratory illness and heart disease.[3] The first four program pairs—(1) Smoking education v. industrial air pollution control, (2) Colon cancer screening v. removing trihalomethane from drinking water, (3) Mandatory passenger side airbags v. auto emission controls and (4) Pneumonia vaccines v. industrial air pollution control—provide the cleanest examples of public v. environmental health programs. The last two, which pair mandatory radon testing in homes with (5) a workplace smoking ban and (6) a ban on pesticide residues on fruit, were chosen to provide variation in perceived risk and program characteristics.

To see whether respondents perceived the programs in each pair as differing in the eight characteristics of interest, Table 1 presents the ratio of the mean scale ratings that respondents assigned the two programs in each pair for each characteristic. To illustrate, for Pair 1, the ratio 1.73 under *Blame* (*voluntariness*) implies that the mean *Blame* score assigned to smoking (in the smoking education program) was 1.73 times the mean score assigned to *Blame* for being exposed to air pollution (in the industrial pollution prevention program).

Our conclusion stands out: For the program pairs studied, people perceived greater differences between the environmental health and public health programs in risk characteristics than in other program characteristics. The difference in mean ratings for risk characteristics of environmental health and public health programs is statistically significant in 20 out of 24 cases and differs by 20% or more in 16 cases. Risks targeted by public health programs are, in general, judged to be more voluntary and more controllable than risks targeted by environmental health programs. With the exception of colon cancer (from non-environmental causes) and auto accidents, people view themselves to be personally more at risk from environmental health risks than from the risks targeted by public health programs.

The program characteristics that we hypothesize should help to explain choices are not perceived as differing as much between environmental and public health programs as the traditional risk characteristics. Although mean scores assigned to program characteristics differ significantly in 18 out of 24 cases, the only really large difference occurs in *Lag before program saves lives*.

As will be seen below, however, large differences in perceived characteristics do not necessarily imply that these characteristics are important in predicting choices. Indeed, four of the characteristics in Table 2 that do not differ much in their mean ratings—*Seriousness of risk*, *Efficacy of program*, *Appropriateness of government intervention* and *Fairness of funding*—turn out to be the most significant qualitative factors explaining program choices.

3. A model of choice between life-saving programs

We assume that an individual's utility from a life saving program is a function of the number of lives saved by the program, X, and a vector of qualitative risk and program characteristics, **C**. Since respondents were asked to choose the program that would be *best for society*, this utility function represents the social utility of the program to the respondent. The wording of our questionnaire implicitly assumes utility is multiplicatively separable in X and **C**,

$$U = f(\mathbf{C})X,$$

implying that the choice between any two life-saving programs will depend on the *ratio* of lives saved by the two programs.[4]

Consider now the respondent's choice between two life-saving programs, A and B. In our empirical work we assume that the utility functions of person i take the form,

$$U_{Ai} = (C_{A1i})^{\beta 1}(C_{A2i})^{\beta 2}(C_{A3i})^{\beta 3}\ldots(C_{AKi})^{\beta K}X_{Ai}\varepsilon_{Ai} \tag{1}$$

$$U_{Bi} = (C_{B1i})^{\beta 1}(C_{B2i})^{\beta 2}(C_{B3i})^{\beta 3}\ldots(C_{BKi})^{\beta K}X_{Bi}\varepsilon_{Bi} \tag{2}$$

where X_{Ji} = Number of lives saved by Program J, J = A, B, as presented to respondent i, $i = 1, 2, \ldots, n$
C_{Jki} = Characteristic k of Program J (as perceived by respondent i), $k = 1, 2, \ldots, K$
ε_{Ji} = unmeasured characteristics of Program J as perceived by respondent i.

The $\boldsymbol{\beta}$ vector, $\boldsymbol{\beta} = \{\beta_1, \beta_2, \ldots, \beta_K\}$, gives the marginal rates of technical substitution between the number of lives saved by a program and the perceived program and risk characteristics.

The individual will prefer Program A if $U_A > U_B$,

$$\varepsilon_{Bi}/\varepsilon_{Ai} < (1/\sigma)\ln(X_{Ai}/X_{Bi}) + \Sigma(\beta_k/\sigma)\ln(C_{Aki}/C_{Bki}), \tag{3}$$

where $E(\varepsilon_{Bi}/\varepsilon_{Ai}) = 0$ and $V(\varepsilon_{Bi}/\varepsilon_{Ai}) = \sigma^2$. If $\{\varepsilon_{Bi}/\varepsilon_{Ai}\}$ are independently and identically distributed for all i, the individual's choice between the two programs is described by a random utility model. Two features of the survey design determine the specific form that the likelihood function takes. First, we use a double bounded dichotomous choice approach to improve the efficiency of our parameter estimates. After choosing between Program A and Program B at a given lives saved ratio, the ratio is varied and the individual is asked to choose once again.[5] We assume in modeling the double-bounded choice that the individual's utility function, including the error term, does not change between the first and second choices.[6] Secondly, each respondent is presented with two program pairs, with double-bounded dichotomous choice questions used in each program pair. We allow the ratio of the errors from the two program pairs to be correlated in estimating the model.

Letting H and J denote the two program pairs, we denote $\varepsilon_i^H = \varepsilon_{Bi}^H/\varepsilon_{Ai}^H$ and $\varepsilon_i^J = \varepsilon_{Bi}^J/\varepsilon_{Ai}^J$ and assume ε_i^H and ε_i^J are bivariate normally distributed with $E(\varepsilon_i^H) = 0$, $E(\varepsilon_i^J) = 0$, $Var(\varepsilon_i^H) = Var(\varepsilon_i^J) = \sigma^2$ and $Cov(\varepsilon_i^H, \varepsilon_i^J) = \rho/\sigma^2$. [The details of the estimation appear in Appendix A.] Maximization of the likelihood function yields estimates of $\boldsymbol{\beta}/\sigma$, the coefficients of the risk and program characteristics, normalized by the variance of the error term, and $1/\sigma$, the coefficient of lives saved.

Estimation of the model thus enables us to determine which risk and program characteristics are most important in explaining choices among life-saving programs, and by solving for $\boldsymbol{\beta}$, to compute the marginal rate of technical substitution between each qualitative characteristic k and the number of lives saved. The model also allows us to infer whether the disparities in the cost-per-life saved between environmental and public health programs are reflected in people's preferences. To do this, we compute the number of lives a public health program would have to save relative to an environmental program to make the median respondent indifferent between both programs. The policy question is whether this ratio is as large as disparities in cost-effectiveness between the two programs would suggest.

4. Survey methodology

4.1. Survey administration

We asked people to choose between life-saving programs in a telephone survey conducted by the University of Maryland Survey Research Center between September and December of 1993.[7] Using a random digit dialing procedure, a national random sample of 1,476 households was selected. Of these households, 8% could not be contacted and 4.3% had miscellaneous problems, such as language difficulties or illness. Of the remaining 1,294 households, 21.7% refused to participate. This study is based on the 1,013 interviews that were completed. When compared to the U.S. population, our sample has a smaller representation of blacks (9.7% compared to a national figure of 12.4%), a higher representation of college-educated people (27.9% versus 18.4%), fewer younger people (7.6% between 18–24 years old compared to a national figure of 14.1%) and a smaller percentage of households earning below $50,000 (69.7% instead of 74.2%).

4.2. Structure of the questionnaire

The survey, which took an average of 23 minutes, began with a set of questions that introduced the respondent to the environmental and public health theme of the study and to the idea of choosing between alternatives. To control for the possibility that one or both programs in a pair might already have been implemented in the respondent's state, respondents were told that the setting for the questions was in a hypothetical state, other than the one in which he or she lived.[8]

The main section of the survey confronted each respondent with two randomly selected program pairs. Using Pair 1 for illustration, the first program in the pair, the Smoking Education program, was briefly described and the objective of the program explicitly stated.[9] The respondent was asked to rate the efficacy of the program on a 10-point scale, 10 being "highly effective" and 1 "not at all effective." If the individual gave the program an efficacy rating of 3 or less, we considered him unlikely to believe claims about lives saved by the program, and therefore branched him to a different pair of programs.[10]

The respondent was then told how the program would be funded—in this case, out of tax dollars. Similar information was presented for the second program in the first pair, the Industrial Air Pollution program.

The respondent was then asked to choose between the Smoking Education and the Industrial Air Pollution programs with the costs and lives saved by the programs held constant.

> Suppose that the smoking education program and the air pollution control program would save the SAME number of lives EACH YEAR.
>
> If both programs cost the same, which one do you think would be best for society? Remember, the two programs save the SAME number of lives EACH YEAR.

As noted above, a double-sampling strategy was adopted as a means of tightening the bounds on the respondent's choice and improving the efficiency of the parameter estimates. The program that was not chosen was made more attractive, so that it saved x times more lives than the program favored initially.

> (For those who chose the Smoking Education program)
>
> Suppose that instead of saving the same number of lives, the AIR POLLUTION CONTROL PROGRAM saved MORE lives than the smoking education program. Suppose that it saved [fill x] TIMES as many lives as the smoking

> education program. Would you still favor adopting the smoking education program or would you change your mind?

The [fill x] value was selected randomly from one of four values. Respondents who initially chose the Industrial Air Pollution control program were given a similar follow-up question with the new ratio of lives saved selected randomly from one of four values. [Design values appear in Cropper and Subramanian (1999).]

Respondents were asked the reasons for their choices, first when both programs saved the same number of lives, as well as in the second round, when the ratio of lives saved by the two programs was varied. These open-ended responses enabled us to verify that respondents understood the questions and reacted thoughtfully in choosing programs. They also elicited spontaneous factors that influenced respondent choices.

Immediately after the open-ended responses, the respondent was asked a series of questions to see if he believed the information in the program descriptions and to see whether he had considered non-life-saving benefits in making his choices. Specifically, the respondent was asked whether he believed that both programs could save the same number of lives for the same cost, and, if not, which program would cost more. He was also asked what benefits other than lives saved had influenced his choice between the two programs.

After receiving a second pair of programs, the respondent was asked to place each of the four programs with which he had been confronted on 10-point psychometric scales, one for each of the remaining characteristics in Table 1. (Recall that Efficacy was rated within each program pair.) For example, respondents were asked:

> How appropriate do you think it is for the government to require schools to educate children about the dangers of smoking? If 1 means not at all appropriate and 10 means very appropriate, what number from 1 to 10 best describes how appropriate it is for the government to require schools to educate children about the dangers of smoking?

The survey concluded with questions about the respondent's age, race, marital status, income and education. Also included were questions exploring the respondent's attitude toward a national health insurance plan, his smoking behavior, and whether he had lost a friend or relative to cancer or lung disease.

5. Survey results

5.1. Choices among life-saving programs: The impact of lives saved

Figures 1 through 6 summarize respondents' choices between life-saving programs. Each graph shows the percentage of respondents choosing Program A (the public

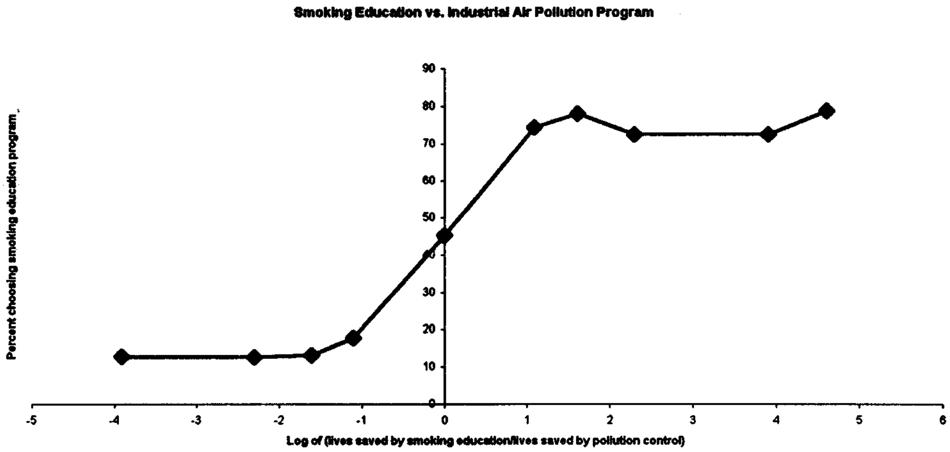

Figure 1

health program) as X_A/X_B varies. Two results stand out:

(1) When both programs in a pair saved the same number of lives (i.e., when $\log(X_A/X_B) = 0$), a majority of respondents favored the environmental program (Program B) rather than the public health program (Program A).
(2) When the number of lives saved was varied between programs in a pair, there was a clear shift in respondent preference to the program that saved more lives.

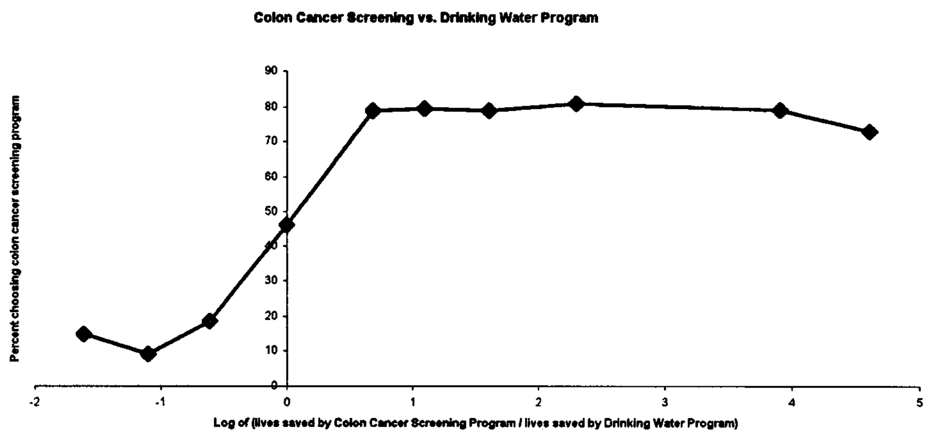

Figure 2

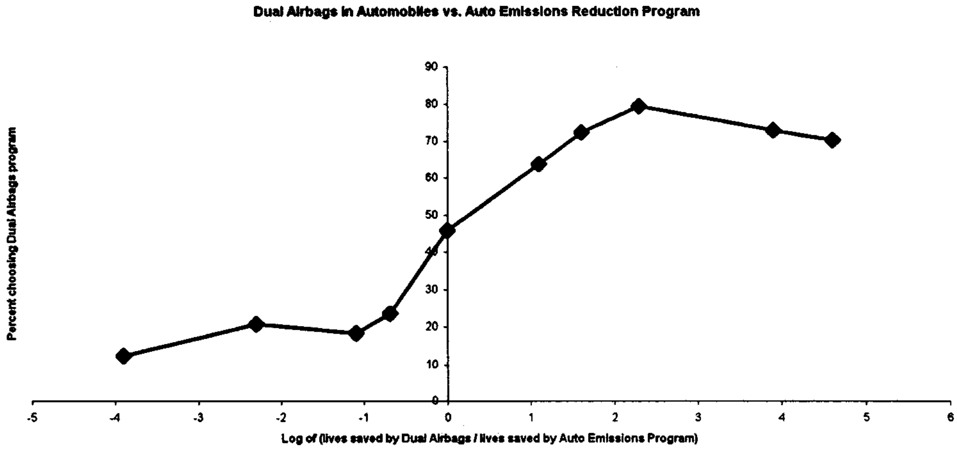

Figure 3

When both programs saved the same number of lives, the percent of respondents choosing the environmental health program (Program B) ranged from 54 percent (Pair 3) to 72 percent (Pair 6). In all cases, the percent of respondents choosing the environmental health program was significantly higher than the proportion of respondents choosing the public health program at the .01 level. When the ratio of the number of lives saved by both programs was varied, the majority of respondents

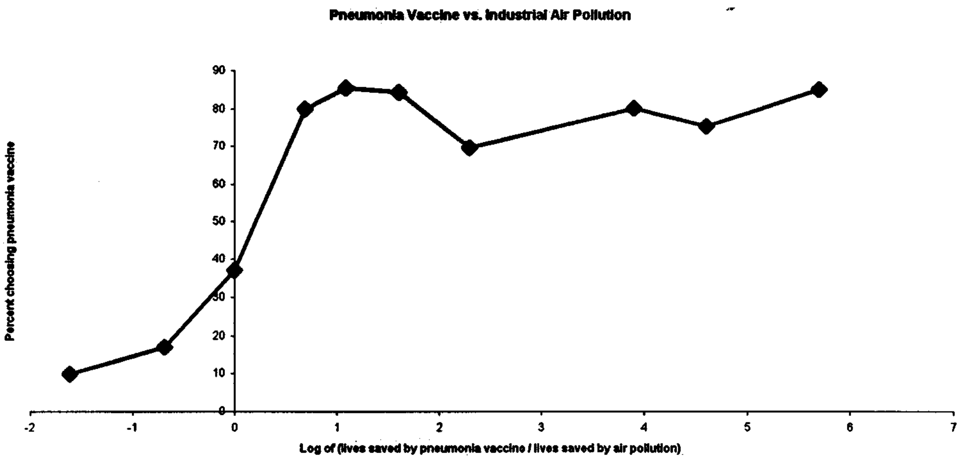

Figure 4

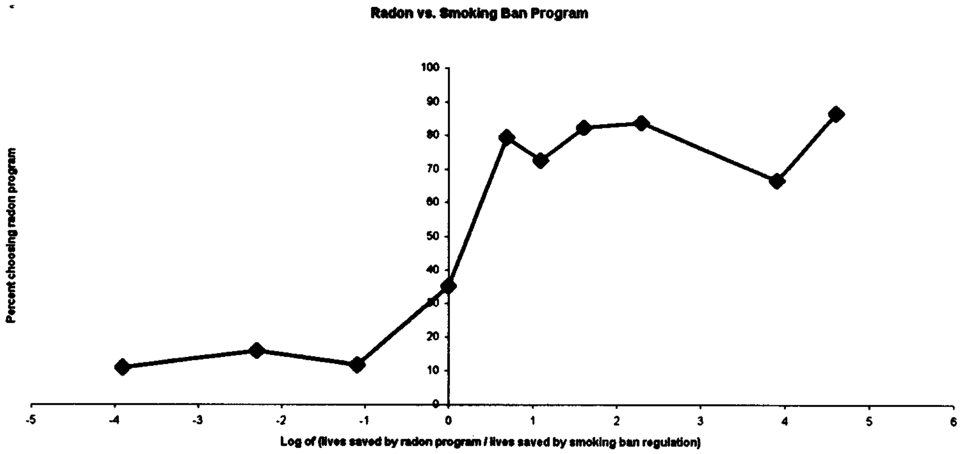

Figure 5

switched to the program that saved more lives. However, as is evident from Figs. 1–6, the percentage of respondents choosing the program that saved more lives did not increase monotonically with the ratio of lives saved. The lack of monotonicity implies that people appeared to be reacting to whether one program saved more lives than the other did, but not to the magnitude of the change.

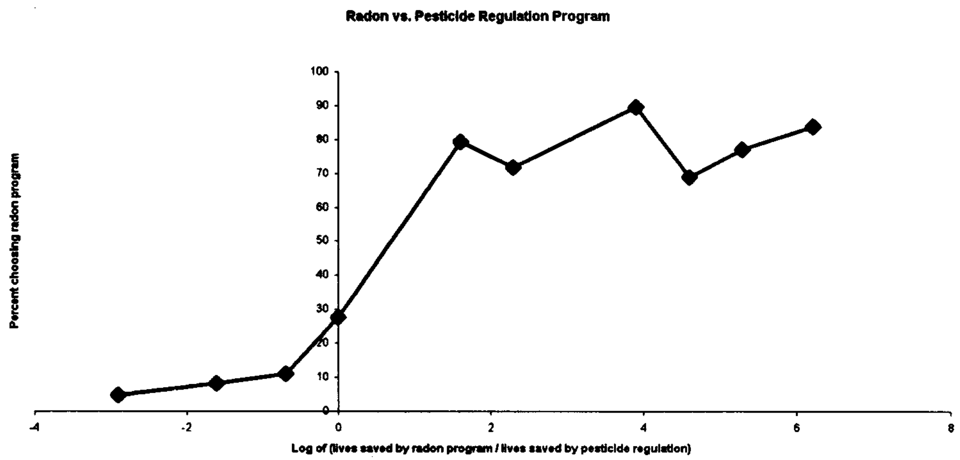

Figure 6

Another interesting finding concerns the percent of respondents who stayed with the program they had originally chosen, even when the alternative program saved 50 to 100 times more lives. This number, which was as high as 30 percent for some programs, suggests that a significant fraction of the population is indeed insensitive to the number of lives saved. In Fig. 1, for example, approximately 20 percent of people continued to favor the Industrial Pollution Control program when the Smoking Education program was alleged to save 100 times more lives. By contrast, 13 percent of people who originally favored the Smoking Education program continued to favor it even when the pollution control program was alleged to save 50 times more lives. (The corresponding percentages for all program pairs appear in Table 3.)

A possible explanation for these findings is that people did not believe the extreme ratios of lives saved that appear in Table 3. However, we have evidence, based on open-ended comments, that people were willing to accept the assumptions stated in the survey. The hypothesis that people did not accept our assumptions, furthermore, cannot explain why the ratio of people with lexicographic preferences varies across programs. A striking finding in Table 3 is that between 20 and 30 percent of respondents continued to choose the pollution control program in Pairs 1 through 3, even when the public health program saved 100 times more

Table 3. Percentage of respondents who did not switch preferences at extreme lives saved ratios

Program pairs	Lives saved ratio X_A/X_B	Percentage of respondents	Choice in second round
1. Smoking education	0.02	12.9	AA
Industrial air pollution control	100.0	21.1	BB
2. Colon cancer screening	0.20	14.8	AA
Drinking water pollution control	100.0	26.9	BB
3. Dual airbags in automobiles	0.02	12.3	AA
Auto emission control program	100.0	29.7	BB
4. Pneumonia vaccine program	0.20	10.0	AA
Industrial air pollution control	300.0	15.0	BB
5. Radon control in homes	0.02	10.9	AA
Smoking ban in the workplace	100.0	13.4	BB
6. Radon in homes	0.05	4.75	AA
Pesticide ban on fruit	500.00	16.0	BB

lives. Indeed, Table 3 strongly suggests that people were less sensitive to the number of lives saved for environmental programs than for public health programs.

5.2. Other factors affecting program choice

Although respondents were told that the two programs in each pair cost the same, the difference in the perceived costs of Programs A and B could have been a factor that implicitly affected the choice between public health and environmental health programs. In order to control for beliefs about program costs, respondents were asked if they thought both programs would cost the same if they saved the same number of lives, and if not, which program would cost more. As seen in Table 4, most respondents did not believe that both programs would cost the same. Respondents perceived the environmental health program to cost more in Pairs 1 and 4 (industrial air pollution program), and Pair 3 (auto emissions program). In fact, more than 75% of the respondents thought that the environmental program would cost more in Pairs 1 and 3. The exception to the belief that environmental programs cost more was Pair 2, in which a majority of respondents believed the colon cancer screening program to be more costly than a drinking water treatment

Table 4. Respondent beliefs about other program benefits and program costs

Program pairs	Percentage who cited benefits other than lives saved	Percentage who mentioned environmental benefits	Percentage who mentioned other health benefits	Percentage who believed that Program A costs more (Program B costs more)
1. Smoking education	56	6	23	5
Industrial air pollution control	60	43	11	73
2. Colon cancer screening	42	0	35	44
Drinking water pollution control	51	3	15	22
3. Dual airbags in automobiles	26	0	19	16
Auto emission control program	59	41	10	53
4. Pneumonia vaccine program	37	0	27	13
Industrial air pollution control	61	39	12	66
5. Radon control in homes	25	4	11	58
Smoking ban in the workplace	54	9	16	17
6. Radon control in homes	25	5	10	30
Pesticide ban on fruit	43	14	10	31

program that would save the same number of lives. The cost of treating cancer cases may play a role here. Radon control was viewed by 58% of respondents as more costly than a workplace smoking ban (the "costless" health program), but no more costly than a pesticide control program.

Another possible explanation for respondents' tendency to favor environmental programs is that they ascribed other benefits to these programs besides saving lives. To control for such benefits, respondents were asked what other benefits they had associated with each program. Environmental programs were seen as generating global environment benefits (reduced depletion of the ozone layer, reduced greenhouse gas emissions) as well as providing cleaner air or purer water. Respondents also believed that environmental health programs would improve overall health by reducing illnesses and would aesthetically enhance surroundings. From Table 4 we see that over half of the respondents who chose an air pollution control program mentioned other benefits as a reason for choosing the program. These environmental benefits were sometimes global (reduced acid rain and ozone depletion) and sometimes local ("cleaner air"). The other benefits most frequently mentioned in connection with public health programs were reductions in illness or injury, savings of health care costs and increased awareness about health risks.

5.3. Econometric analysis of program choices

To analyze the contributions of the 8 qualitative factors, other program benefits, cost considerations and lives saved to program choice, we estimated the random utility model described in Section 3. Dummy variables representing perceived benefits of programs other than lives saved are included in the model (*Other Benefits from Program A* and *Other Benefits from Program B*). Similarly, dummies to represent perceived differences in program costs have also been included (*Program A Costs More* and *Program B Costs More*). Six dummies are included, for each of the program pairs (*Pair i*, where $i = 1, 2, \ldots, 6$), to capture intrinsic variations among the six pairs of programs that are not reflected in the qualitative characteristics or the number of lives saved.

5.3.1. Significance of qualitative characteristics in explaining program choices. When the model is estimated (see Table 5), seven of eight qualitative characteristics are statistically significant. All have the expected signs.[11] All of the program attributes —*Efficacy of program*, *Appropriateness of government intervention*, *Fairness of funding mechanism*, *Lag before program save lives*—are statistically significant in explaining the probability of choosing a program. Among the risk characteristics, *Ease of avoiding risk* (*Controllability*), *Seriousness of risk*, and *Personal risk*, are statistically significant. The only variable among the qualitative risk characteristics that is insignificant is *Blame* (*Voluntariness*).[12]

One possible explanation for the insignificance of *Blame* (*Voluntariness*) may be due to its correlation with *Ease of avoiding risk* (*Controllability*). In the case of

Table 5. Bivariate probit model to predict probability of choosing Program A (Public health program) [n = 942]

Program characteristic	Utility function coefficients	t-statistics	Expected sign
BLAME (VOLUNTARINESS)*	−0.0215	−0.79	Negative
EASE OF AVOIDING RISK (CONTROLLABILITY)*	−0.1125	−4.01	Negative
SERIOUSNESS OF RISK*	0.6301	10.06	Positive
PERSONAL RISK*	0.0655	2.07	Positive
EFFICACY OF PROGRAM*	0.5295	5.98	Positive
APPROPRIATENESS OF GOVT. INTERVENTION*	0.3178	6.13	Positive
FAIRNESS OF PROGRAM FUNDING*	0.1271	3.42	Positive
TIME LAG BEFORE LIVES SAVED*	−0.0667	−2.11	Negative
LIVES SAVED**	0.4150	48.83	Positive
OTHER BENEFITS FROM PROGRAM A	0.2501	3.99	Positive
OTHER BENEFITS FROM PROGRAM B	−0.2654	−4.51	Negative
PROGRAM A COSTS MORE	−0.0827	−1.07	Negative
PROGRAM B COSTS MORE	−0.1143	−1.75	Positive
PAIR 1 DUMMY	0.1657	1.64	
PAIR 2 DUMMY	−0.0223	−0.33	
PAIR 3 DUMMY	−0.0328	−0.54	
PAIR 4 DUMMY	0.0185	0.24	
PAIR 5 DUMMY	0.2481	3.16	
PAIR 6 DUMMY	−0.2463	−3.18	
Rho	0.0981	2.48	
Log Likelihood	−2299.6078		

* LN (Characteristic of Program A/Characteristic of Program B);
** The coefficient for Lives Saved Ratio is $1/\sigma$.

smoking, people often blame the smoker for voluntarily exposing himself to a risk; by the same argument, they believe that the smoker could easily avoid the risk by quitting. Simple correlations between the qualitative characteristics indicate that *Blame* (*Voluntariness*) and *Ease of avoiding risk* (*Controllability*) are indeed highly correlated. To examine if there is any change in coefficient estimates, when the model is estimated with *Ease of avoiding risk* (*Controllability*) excluded from the model, there is little change in the estimated coefficient or standard error of *Ease* *of avoiding risk* (*Controllability*). Similarly, excluding *Blame* (*Voluntariness*) from the model does not significantly change the coefficient or the standard error of *Ease of avoiding risk* (*Controllability*).

A possible explanation for our results is that, although people rate programs differently in terms of how much people are to blame for needing them, respondents do not let *Blame* affect their decision about whether a program should be implemented. In other words, we are dealing with a class of risks where there are factors that, to some extent, mitigate personal responsibility for being exposed to the risk.

5.3.2. Significance of lives saved and other variables in explaining program choices. While qualitative factors are significant in explaining program choices so, clearly, are lives saved. The coefficient of *Lives Saved* is estimated with great precision. Both of the "other benefit" variables, *Other Benefits from Program A* and *Other Benefits from Program B* are also significant with the expected signs. If respondents believed that there were benefits from Program A other than life saving benefits, then the probability of choosing Program A increased. In contrast, if respondents believed that there were benefits from Program B other than life saving benefits, then the probability of choosing Program A declined.

Of less significance are variables indicating which program the respondent believed was more costly (*Program A Costs More* and *Program B Costs More*). Indeed, respondents who believed the environmental program (Program B) cost more were more likely to choose the public health program (Program A). One explanation for this anomaly is that the *Program B Costs More* is correlated with the *Pair* 1 and *Pair* 3 dummy variables, and thus captures some of the unmeasured, desirable effects of air pollution control programs.[13]

Dummy variables representing the unmeasured properties of the programs in a pair are statistically significant only for *Pair* 5 and *Pair* 6. The negative sign of the coefficient of *Pair* 6, for instance, implies that the unmeasured positive characteristics of the pesticide ban program outweigh the unmeasured benefits of the radon program, thus lowering the probability that the radon program is selected. In contrast, the unmeasured qualities of the radon program when compared to the smoking ban program enhance the probability that it is chosen in Pair 5. One possible explanation for this difference between the two radon program pairs could be caused by a factor that is not explicitly included in the model—familiarity. Risks from exposure to radon and to pesticide residues are relatively unknown to the lay person. However, people are very familiar with smoking risks. Therefore, they may prefer to regulate radon, which is the more unfamiliar risk in Pair 5.

5.3.3. Testing for program pair "order" effects. It is important to ask whether our results depend on the order in which program pairs were presented to respondents. To test for this, the bivariate probit model was estimated interacting with each explanatory variable a dummy variable indicating whether the variable pertained to the first pair or second pair of programs the respondent received.[14] Table 6

Table 6. Bivariate probit model incorporating order of program pairs [n = 942]

	Parameter	t-statistic
Rho	0.1284	3.057
Blame (Voluntariness)	−0.0188	−0.446
Ease of Avoidance (Control)	−0.0993	−2.459
Seriousness of Risk	0.6397	7.491
Personal Risk	−0.0405	−0.911
Efficacy of Program	0.4683	3.932
Appropriateness of Government Intervention	0.2758	3.466
Fairness of Funding	0.0756	1.398
Time of Lag before Lives Saved	−0.0862	−1.907
Other Benefits from Program A	0.1641	1.820
Other Benefits from Program B	−0.3307	−3.959
Pair 1	0.1275	1.382
Pair 2	0.0992	1.029
Pair 3	−0.0023	−0.029
Pair 4	−0.0983	−0.933
Pair 5	0.1729	1.558
Pair 6	−0.2093	−2.022
Lives Saved Ratio	0.4440	32.930
Blame (Voluntariness)	−0.0260	−0.661
Ease of Avoidance (Control)	−0.1253	−3.112
Seriousness of Risk	0.6439	6.914
Personal Risk	0.1976	4.055
Efficacy of Program	0.6823	5.118
Appropriateness of Government Intervention	0.3609	4.855
Fairness of Funding	0.2002	3.740
Time Lag before Lives Saved	−0.0464	−0.982
Other Benefits from Program A	0.2869	3.123
Other Benefits from Program B	−0.2347	−2.831
Pair 1	0.0755	0.708
Pair 2	−0.1646	−1.916
Pair 3	−0.1149	−1.314
Pair 4	0.0713	0.696
Pair 5	0.3099	3.207
Pair 6	−0.4438	−3.919
Lives Saved Ratio	0.3977	28.620
Loglikelihood	−2275.0301	

presents the coefficients from this model. A likelihood ratio test rejects the null hypothesis that order effects do not matter at the .01 significance level.

When order effects are incorporated in the model, however, our fundamental results do not change. Although the point estimates of characteristic coefficients change slightly between the first and second pairs, the key characteristics—*Ease of avoidance* (*Controllability*), *Seriousness of risk*, *Efficacy of program*, *Appropriateness of government intervention* and *Fairness of funding*—remain statistically significant in both cases, as does *Lives saved*.

5.4. *The relative importance of qualitative characteristics versus lives saved*

As noted above, each β_k measures the rate at which respondents are willing to substitute a qualitative characteristic for lives saved. Table 7 presents the β_k and corresponding standard error for each qualitative characteristic. For example, the rate of substitution between lives saved by a program and the *Seriousness of risk* it addresses, is -1.52. This implies that if Program J is judged to a control a risk 100% more serious than the risk controlled by Program H, Program H must save 152% more lives than Program J to make respondents indifferent between the two programs. If, however, the risk controlled by Program J is 100% more difficult to

Table 7. Marginal rate of technical substitution between lives saved and qualitative characteristics

Program characteristic	−(MRTS* between lives saved and qualitative characteristic)	Standard error
BLAME (VOLUNTARINESS)	−0.0468	0.0653
EASE OF AVOIDING RISK (CONTROLLABILITY)	−0.2759	0.0676
SERIOUSNESS OF RISK	1.5215	0.1508
PERSONAL RISK	0.1568	0.0761
EFFICACY OF PROGRAM	1.2749	0.2113
APPROPRIATENESS OF GOVERNMENT INTERVENTION	0.7669	0.1253
FAIRNESS OF FUNDING	0.3015	0.0892
TIME LAG BEFORE LIVES SAVED	−0.1565	0.0762

* MRTS denotes the Marginal Rate of Technical Substitution.

avoid (control) than the risk controlled by Program H, Program H need save only 28% more lives than Program J. In contrast, the rate of substitution between lives saved and *Blame* (*Voluntariness*) is close to zero. Even if the extent to which people are to blame for exposure to a risk decreases by 100%, a program would have to save the same number of lives to be acceptable to respondents.

A striking feature of Table 7 is that the point estimate of the marginal rate of technical substitution between lives saved and the qualitative characteristics examined is greater than one only for *Seriousness of risk* and *Efficacy of program*. If one tests the null hypothesis that each β_k coefficient is less than or equal to one against the alternative that is greater than one, the null hypothesis is rejected only for *Seriousness of risk*. The interpretation of the coefficient on *Efficacy of program* is slightly different from the interpretation of the other β_k's. Instead of representing the rate at which the individual is willing to substitute lives saved for a characteristic, it determines by how much the respondent scales down number of lives saved because he believes a program to be ineffective. While the ratio of lives saved given to the respondent is X_{Ai}/X_{Bi}, the *effective* ratio of lives saved is $(C_{Aki}/C_{Bki})^{\beta k}(X_{Ai}/X_{Bi})$, where $(C_{Aki}/C_{Bki})_J$ = Ratio of efficacy rating given by the respondent to Program Pair J.[15] Examining the coefficient (1.2749) on *Efficacy of program* and its standard error (0.2113) implies that one cannot reject the hypothesis that $\beta = 1$.

All of the remaining coefficients are significantly below one and, as noted above, *Blame* (*Voluntariness*) has a β coefficient that is insignificantly different from zero. Table 7 does not suggest that people are very sensitive to the characteristics studied in choosing among life saving programs.

It is, of course, possible that we have failed to capture the characteristics that really matter to people when they consider life saving programs. To guard against this criticism, we use the model, which implicitly incorporates other characteristics in the dummy variables for each program pair, to predict people's choices among life saving programs. Specifically, we use the model to calculate the ratio of lives saved that makes the median respondent indifferent between both programs in each pair, assuming that his perceptions of program characteristics (the C_i's) satisfy mean values. Table 8 presents the ratio of lives that must be saved by both programs in a pair to make the median respondent equally likely to choose either program. The median respondent is indifferent between the two programs in a pair when $E(U_{Ai}) = E(U_{Bi})$.

What stands out is that this ratio is never greater than 2.2—a value achieved only by the two radon programs—and is usually considerably lower. For example, the colon cancer screening program and the program to treat drinking water are almost equivalent in qualitative attributes in the median respondent's view. The former need only save 7% more lives than the latter. The difference is a little greater for the auto emissions program—it must save 20% more lives than the dual airbag program.

When it is true that the median respondent is indifferent between public and environmental health programs only if the public health program saves more lives,

Table 8. Number of lives saved by each program that makes median respondent indifferent between them

Program pairs	Number of lives saved
1. Smoking education	159
Industrial air pollution control	100
2. Colon cancer screening	107
Drinking water pollution control	100
3. Dual airbags in automobiles	100
Auto emission control program	120
4. Pneumonia vaccine program	162
Industrial air pollution control	100
5. Radon control in homes	206
Smoking ban in the work place	100
6. Radon control in homes	213
Pesticide ban on fruit	100

the number of lives involved (as a multiple of the lives saved by the environmental program) is small. In particular, this multiple is far smaller than the ratio of the cost-per-life-saved of environmental programs to the cost-per-life-saved of public health programs typically observed in the literature.

6. Conclusions

The purpose of this project was to see what choices people would make when asked whether to implement a public health or an environmental health program. We also wished to see whether the choices made would reflect information about lives saved by the two programs and people's own perceptions of the qualitative characteristics of the programs. The answer, for the programs and characteristics studied, is that both qualitative characteristics and lives saved matter. Lives saved and seven out of eight qualitative characteristics studied are statistically significant in explaining program choices. It is, however, interesting to note that the risk characteristics most often cited to explain people's preferences for environmental programs—the involuntariness of the environmental risks and their lack of controllability—do not seem to matter much in explaining choices between environmental and other health programs.

Indeed, for the median respondent most qualitative characteristics do not matter much. The marginal rate of technical substitution between lives saved and qualitative characteristics is greater than one only for one characteristic—*Seriousness of risk*. More importantly, taking all qualitative characteristics into account, the ratio of lives saved by two programs that makes the median respondent indifferent between them is never greater than 2.5. Put somewhat differently, a life saved by the environmental programs we consider is never more than two-and-one-half times more valuable than a life saved by the public health program with which it is paired.

If the preferences of the median voter determined the allocation of funds among public and environmental health programs, we would expect the ratio of marginal costs-per-life-saved to equal the rate at which the median voter would substitute lives saved by one program for lives saved by another. To illustrate, if the median voter allocated society's life saving budget we would expect, based on Table 8, that the ratio of the marginal costs per life saved for a program to control pesticide residues on food and a radon control program to be 2.2. In reality, one observes ratios much greater than this, depending on the pesticide in question.[16] Why is this the case?

One answer, suggested by the paper, is that while the rate of substitution between lives saved by different programs is not very large for the median respondent, it is in fact infinite for a significant fraction of respondents. As Fig. 1 and Table 3 indicate, over 20 percent of respondents who were faced with a choice between three of our environmental health programs and a comparable public health program continued to choose the environmental program even when it saved 100 times as many lives as the public health program. This suggests that a significant (and perhaps vocal) minority of citizens will not trade qualitative program attributes for lives saved. Moreover, these people have a strong preference for environmental programs. For this explanation to be convincing, however, one must believe that the current levels at which environmental and public health programs are implemented reflect the preferences of this minority.

Another answer, which we find more convincing, is that there is currently no mechanism to ensure that tradeoffs are made across environmental and public health programs. The two are approved and funded in distinct ways: Public health programs are often funded out of tax dollars, as a result of legislative votes. Because their costs are salient, it is more likely that they are considered when the level of implementation is decided.

Environmental regulations, by contrast, are controlled only indirectly by the legislative process. Legislators fund regulatory agencies and write enabling legislation for these agencies, but they do not write individual environmental regulations. The cost of complying with these regulations is, moreover, less apparent than the tax burden associated with public health programs. We believe it is these facts that may help to explain the apparent discrepancies between the findings of this study and program implementation.

7. Appendix: Econometric model and questionnaire

7.1. An econometric model of program choice

This appendix presents the bivariate probit model used to estimate the parameters of respondents' utility functions. Let H and J denote the two pairs of programs with which respondent i is confronted. Let A and B, respectively, denote the public health and environmental health program in each pair. The utility of each program in Pairs H and J is given by

Program Pair H:

$$\mathbf{U}_{\mathrm{Ai}}^{\mathrm{H}} = \left(\mathbf{C}_{\mathrm{A1i}}^{\mathrm{H}}\right)^{\beta 1}\left(\mathbf{C}_{\mathrm{A2i}}^{\mathrm{H}}\right)^{\beta 2}\left(\mathbf{C}_{\mathrm{A3i}}^{\mathrm{H}}\right)^{\beta 3}\ldots\left(\mathbf{C}_{\mathrm{AKi}}^{\mathrm{H}}\right)^{\beta \mathrm{K}}\mathbf{X}_{\mathrm{Ai}}^{\mathrm{H}}\varepsilon_{\mathrm{Ai}}^{\mathrm{H}} \tag{A.1}$$

$$\mathbf{U}_{\mathrm{Bi}}^{\mathrm{H}} = \left(\mathbf{C}_{\mathrm{B1i}}^{\mathrm{H}}\right)^{\beta 1}\left(\mathbf{C}_{\mathrm{B2i}}^{\mathrm{H}}\right)^{\beta 2}\left(\mathbf{C}_{\mathrm{B3i}}^{\mathrm{H}}\right)^{\beta 3}\ldots\left(\mathbf{C}_{\mathrm{BKi}}^{\mathrm{H}}\right)^{\beta \mathrm{K}}\mathbf{X}_{\mathrm{Bi}}^{\mathrm{H}}\varepsilon_{\mathrm{Bi}}^{\mathrm{H}} \tag{A.2}$$

Program Pair J:

$$\mathrm{U}_{\mathrm{Ai}}^{\mathrm{J}} = \left(\mathrm{C}_{\mathrm{A1i}}^{\mathrm{J}}\right)^{\beta 1}\left(\mathrm{C}_{\mathrm{A2i}}^{\mathrm{J}}\right)^{\beta 2}\left(\mathrm{C}_{\mathrm{A3i}}^{\mathrm{J}}\right)^{\beta 3}\ldots\left(\mathrm{C}_{\mathrm{AKi}}^{\mathrm{J}}\right)^{\beta \mathrm{K}}\mathrm{X}_{\mathrm{Ai}}^{\mathrm{J}}\varepsilon_{\mathrm{Ai}}^{\mathrm{J}} \tag{A.3}$$

$$\mathrm{U}_{\mathrm{Bi}}^{\mathrm{J}} = \left(\mathrm{C}_{\mathrm{B1i}}^{\mathrm{J}}\right)^{\beta 1}\left(\mathrm{C}_{\mathrm{B2i}}^{\mathrm{J}}\right)^{\beta 2}\left(\mathrm{C}_{\mathrm{B3i}}^{\mathrm{J}}\right)^{\beta 3}\ldots\left(\mathrm{C}_{\mathrm{BKi}}^{\mathrm{J}}\right)^{\beta \mathrm{K}}\mathrm{X}_{\mathrm{Bi}}^{\mathrm{J}}\varepsilon_{\mathrm{Bi}}^{\mathrm{J}} \tag{A.4}$$

Since Program A is chosen over Program B iff $U_{Ai} > U_{Bi}$, the choice between the two programs depends on the ratios of the characteristics, lives saved and error terms in each pair. Define $\varepsilon_i^H = \varepsilon_{Bi}^H/\varepsilon_{Ai}^H$ and $\varepsilon_i^J = \varepsilon_{Bi}^J/\varepsilon_{Ai}^J$. We assume that ε_i^H and ε_i^J are independently and identically normally distributed for all H, J and i with correlation coefficient ρ, $E(\varepsilon_i^H) = E(\varepsilon_i^J) = 0$ and $\mathrm{Var}(\varepsilon_i^H) = \mathrm{Var}(\varepsilon_i^J) = \sigma^2$.

The respondent is asked to choose twice between Programs A and B in Pair H, once at a ratio of lives saved equal to 1, and then with X_{Ai}/X_{Bi} varied. Let AA^H denote the choice of Program A in both rounds of questioning, and define the other three possible responses analogously, i.e., AB^H, BA^H, BB^H. Since there are, likewise, four possible choices for pair J, there are 16 possible outcomes for each respondent (Table A.1).

Each respondent's contribution to the likelihood function is the probability that he chooses the outcome in Table 9 that he in fact chose. As an illustration, the probability that an individual chose Program A in both rounds of question H and

Table 9. Bivariate model: Possible program choices

		Question H			
		Π_{AAi}^H	Π_{ABi}^H	Π_{BBi}^H	Π_{BAi}^H
Question J	Π_{AAi}^J	$P(AA^J \cap AA^H)$	$P(AA^J \cap AB^H)$	$P(AA^J \cap BB^H)$	$P(AA^J \cap BA^H)$
	Π_{ABi}^J	$P(AB^J \cap AA^H)$	$P(AB^J \cap AB^H)$	$P(AB^J \cap BB^H)$	$P(AB^J \cap BA^H)$
	Π_{BBi}^J	$P(BB^J \cap AA^H)$	$P(BB^J \cap AB^H)$	$P(BB^J \cap BB^H)$	$P(BB^J \cap BA^H)$
	Π_{BAi}^J	$P(BA^J \cap AA^H)$	$P(BA^J \cap AB^H)$	$P(BA^J \cap BB^H)$	$P(BA^J \cap BA^H)$

question J is given by:

$$\mathbf{P}(\mathbf{AA}^{\mathbf{J}} \cap \mathbf{AA}^{\mathbf{H}})$$

$$= \int_{-\infty}^{1/\sigma \ln(X^2_{AH}/X^1_{BH}) + \boldsymbol{\beta}'/\sigma \ln(\mathbf{C}_{AH}/\mathbf{C}_{BH})} \int_{-\infty}^{1/\sigma \ln(X^2_{AJ}/X^1_{BJ}) + \boldsymbol{\beta}'/\sigma \ln(\mathbf{C}_{AJ}/\mathbf{C}_{BJ})} \phi \, d\varepsilon_H \, d\varepsilon_J$$

where

$$\phi\left(\varepsilon_i^H, \varepsilon_i^J, \boldsymbol{\rho}\right) = \frac{1}{2\pi\sqrt{1-\rho^2}} \exp\left[-1/\left[2(1-\rho^2)\right]\right]\left[\left(\varepsilon_i^H\right)^2 + \mathbf{2}\varepsilon_i^H \varepsilon_i^J + \left(\varepsilon_i^J\right)^2\right]$$

denotes the standardized bivariate normal density function and superscripts "1" and "2" denote the value of X in the first and second rounds of questioning, respectively. Similar expressions can be written for the other outcomes in Table 9.

7.2. Survey questions for program pair 1

I'd like to ask you some questions about government programs to help control health problems in the U.S.

I'm going to describe health problems in a state that is NOT the state you live in. The reason we are asking about ANOTHER state is because we'd like you to tell us what you think would be the best program for SOCIETY, rather than the best program for you personally.

I'll describe the programs that the government of this OTHER state could adopt to reduce the number of deaths that occur each year, and ask you whether or not you think that state should adopt these programs.

I am going to tell you about ways to reduce deaths from heart and lung disease.

Smoking is one cause of deaths from heart and lung disease. One way to reduce these deaths is to teach elementary school children about the health risks of smoking, so that fewer of them become smokers.

In the state I described, a program has been proposed that would require all elementary schools to provide education to discourage children from becoming smokers.

On a scale of 1 to 10, where 1 means not at all effective and 10 means very effective, how effective do you think such programs are in discouraging children from becoming smokers?

Why did you choose that rating?
If the smoking education program is adopted, the cost of the program would be paid for out of state taxes.

On a scale of 1 to 10, where 1 means not at all important and 10 means very important, how important is it that the state adopt this program?

Air pollution is another cause of deaths from heart and lung disease. One way to reduce deaths from air pollution is to put pollution controls on industry.

In this same state a program has been proposed that would place pollution controls on industry.

On a scale of 1 to 10, where 1 means not at all effective and 10 means very effective, how effective do you think such programs are in reducing people's exposure to air pollution from industry?

Why did you choose that rating?

If the air pollution control program is adopted, the cost of the program would be paid for by the industries' stockholders, employees and by consumers of the industries' products.

On a scale of 1 to 10, where 1 means not at all important and 10 means very important, how important is it that the state adopt this program?

Suppose that the smoking education program and the air pollution control program would save the SAME number of lives EACH YEAR.

If both programs cost the same, which one do you think would be best for society? Remember, the two programs save the SAME number of lives EACH YEAR.

⟨1⟩ SMOKING EDUCATION (Go to F1.)
⟨2⟩ CONTROL OF INDUSTRIAL POLLUTION (Go to F2.)
⟨8⟩ DK (Go to F1.)

Why is that?

F1. Suppose that instead of saving the same number of lives, the AIR POLLUTION CONTROL PROGRAM saved MORE lives than the smoking education program. Suppose that it saved [fill x1] TIMES as many lives as the smoking education program. Would you still favor adopting the smoking education program or would you change your mind?

⟨1⟩ STILL FAVOR SMOKING EDUCATION PROGRAM
⟨2⟩ CHANGE MIND
⟨3⟩ OTHER (SPECIFY)
⟨8⟩ DK

Why is that? (Go to F3.)

F2. Suppose that instead of saving the same number of lives, the SMOKING EDUCATION PROGRAM saved MORE lives than the air pollution control program. Suppose it saved [fill y1] TIMES as many lives as the air pollution control program. Would you still favor adopting the air pollution control program or would you change your mind?

⟨1⟩ STILL FAVOR AIR POLLUTION CONTROL PROGRAM
⟨2⟩ CHANGE MIND
⟨3⟩ OTHER (SPECIFY)
⟨8⟩ DK

Why is that?

F3. In choosing between the two programs, did you think about any other benefits that might result from the smoking education program besides saving lives?

⟨0⟩ NO
⟨1⟩ YES —What were they?: SPECIFY
⟨8⟩ DK

(In choosing between the two programs) did you think about any other benefits that might result from the air pollution control program besides saving lives?

⟨0⟩ NO
⟨1⟩ YES —What were they?: SPECIFY
⟨8⟩ DK

In choosing between the two programs, did you think that the cost of the programs would be the same?

⟨0⟩ NO
⟨1⟩ YES
⟨8⟩ DK

Which program did you think would cost more?

⟨1⟩ SMOKING EDUCATION PROGRAM
⟨2⟩ AIR POLLUTION CONTROL PROGRAM
⟨8⟩ DK

When I asked you about the programs, did you think about them occurring in [fill respondent's state], another state, or nowhere in particular?

⟨1⟩ [fill respondent's state]
⟨2⟩ SOME OTHER STATE
⟨3⟩ NOWHERE IN PARTICULAR
⟨8⟩ DK

Now I would like to learn more about your attitudes toward government health and safety programs. [Note: for brevity we present questions for only the Smoking Education Program.]

(I'd like to ask you) how serious a health problem do you think smoking is? If 1 means not at all serious and 10 means extremely serious, what number from 1 to 10 best describes how serious a health problem smoking is?

⟨1–10⟩ RECORD ACTUAL NUMBER FROM 1 TO 10
⟨88⟩ DK

(I'd like to ask you) how appropriate do you think it is for the government to require schools to educate children about the dangers of smoking? If 1 means not at all appropriate and 10 means very appropriate, what number from 1 to 10 best describes how appropriate it is for the government to require schools to educate children about the dangers of smoking?

⟨1–10⟩ RECORD ACTUAL NUMBER FROM 1 TO 10
⟨88⟩ DK

(I'd like to ask you) how fair do you think it would be for the smoking education program to be funded out of state tax revenues? If 1 means not at all fair and 10 means very fair, what number from 1 to 10 best describes how fair it is to fund the smoking education program out of state tax revenues?

⟨1–10⟩ RECORD ACTUAL NUMBER FROM 1 TO 10
⟨88⟩ DK

(I'd like to ask you) how easy do you think it is for young people to control whether or not they start to smoke? If 1 means not at all easy and 10 means very easy, what number from 1 to 10 best describes how easy is it for young people to control whether or not they start to smoke?

⟨1–10⟩ RECORD ACTUAL NUMBER FROM 1 TO 10
⟨88⟩ DK

(I'd like to ask you) how long do you think it would be before the program to educate children about smoking would BEGIN to save lives? If 1 means right away and 10 means not for a long time, what number from 1 to 10 best describes how long before the program to educate children about smoking would begin to save lives?

⟨1–10⟩ RECORD ACTUAL NUMBER FOR 1 TO 10
⟨88⟩ DK

(I'd like to ask you) how much do you think young people are to blame for smoking? If 1 means not at all to blame and 10 means very much to blame, what number from 1 to 10 best describes how much young people are to blame for smoking?

⟨1–10⟩ RECORD ACTUAL NUMBER FROM 1 TO 10
⟨88⟩ DK

(I'd like to ask you) how likely do you think it is that smoking will cause a health problem for you or for someone in your family? If 1 means unlikely and 10 means likely, what number from 1 to 10 best describes how likely it is that smoking will cause a health problem for you or for someone in your family?

⟨1–10⟩ RECORD ACTUAL NUMBER FROM 1 TO 10
⟨88⟩ DK

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Notes

1. Throughout the paper we use the term "public health" to refer to health and safety programs of a non-environmental nature. These include the direct provision of health care to people who cannot afford it and non-environmental health and safety regulations.
2. Thus radon control, because it occurs on a house-by-house basis, is classified as a public health program, whereas controlling air pollution from factories and banning smoking the workplace are considered environmental health programs because of the greater number of people affected.
3. The Dual Airbags-Auto Emissions Reduction program pair is an exception to the rule that both programs must target the same disease: Both programs reduce deaths "related to automobiles" but from different causes. Though the link here is tenuous, the combination provides for rich variation in program characteristics, such as appropriateness of government intervention and timing of benefits.
4. In focus groups and pretests, respondents found it easier to understand and respond to ratios rather than absolute numbers or differences. Therefore, the number of lives saved by the two programs were given to the respondents as ratios.
5. It is well known in willingness to pay (WTP) studies that the use of a double-bounded dichotomous choice question increases the efficiency of parameter estimates for a given sample size (Hanemann, Loomis, and Kanninen, 1991).
6. In analyzing WTP responses Cameron and Quiggin (1994) find that respondents may have different WTP values in each round of questioning, which may be correlated but are not identical. They argue that a bivariate probit binary response model should be applied instead of a double-bounded model. Alberini (1995), on the other hand, finds that the double-bounded estimates are more efficient and have smaller Mean Squared Error than the bivariate probit estimates in Monte Carlo simulations of two WTP surveys.
7. In order to develop the questionnaire, we held eight focus groups, followed by a series of pretests (Desvousges and Smith, 1988). The focus groups not only helped in the selection of programs and qualitative characteristics to be studied, but also helped identify terminology with which people were familiar. The pretests helped to identify and resolve problems with the questionnaire. The most significant of these pretests was a national pilot survey of 202 respondents. See Cropper and Subramanian (1999) and Subramanian (1998) for further details.
8. In focus groups, respondents sometimes failed to choose programs that they liked because they believed programs already to be fully implemented. Our efforts in this regard were fairly successful, judging from the fact that only 30% of respondents said they thought that the programs were to be implemented in their own state when they answered the questions. More than 57% of respondents said they thought of these programs occurring "nowhere in particular" and 10% thought that the programs were to be implemented in other states.
9. The exact wording of the questions for Pair 1 appears in the Appendix B. The complete questionnaire is available upon request from the authors.
10. In branching respondents to alternate program pairs, care was taken to ensure that no respondent received the same program in two pairs. For instance, since both Pairs 1 and 5 contain an Industrial Air Pollution program, an individual could receive only one of the two pairs.
11. If Program A is perceived as more effective than Program B, or $\ln(Efficacy_A/Efficacy_B) > 0$, the median respondent has a greater probability of choosing A. Therefore the expected sign of *Efficacy* is positive. Similarly, if Program A saves lives at a later time than Program B or $\ln(Time\,lag_A/Time\,lag_B) > 0$, we would expect that the median respondent has a smaller probability of choosing Program A, implying that the expected sign of *Lag before program saves lives* is negative.
12. It is possible that respondents' ratings of the qualitative characteristics are correlated with their program choices. We attempted to address the possible endogeneity of the explanatory variables by using variables such as race, gender, and education as instruments for risk and program characteristics. We were, however, unsuccessful in identifying enough instruments.

13. A dummy was created equal to 1 if respondents were confronted with Pair 1 or Pair 3, and equal to zero otherwise. The Pearson correlation coefficient between this dummy and *Program B Costs More* was 0.375 and was statistically significant at the 0.01 level.
14. Of the 942 respondents, 757 answered two separate questions or program pairs. Of the 185 respondents who attempted only one question (or program pair), 101 responded to the pair as their first question and 84 respondents attempted this as their second question.
15. The lives saved ratio is modified by the *Efficacy ratio*. Absolute modification of lives saved by *Efficacy* score has no meaning here.
16. It is, of course, difficult to estimate the marginal cost per life saved; typically, only average cost-per-life-saved figures are published. EPA (1991) estimated that the cost-per-life-saved of a radon program that would test for radon in each home and remediate levels in excess of 4 pi/L is approximately $650,000 (1990$). The cost per life saved of programs to eliminate pesticide residues on foods is often in the tens of millions of dollars (Cropper et al., 1992).

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