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Public Choices between Lifesaving Programs

How Important Are Lives Saved?

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Do funding priorities for health and safety policies reflect irrational fears — the "disaster of the month" — rather than address more fundamental problems? A thousand people were surveyed to gauge popular feelings about funding choices between environmental and public health programs.

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Summary findings

In developing and industrial countries alike, there is concern that health and safety policy may respond to irrational fears — to the "disaster of the month" — rather than address more fundamental problems.

In the United States, for example, some policymakers say the public worries about trivial risks while ignoring larger ones and that funding priorities reflect this view. Many public health programs with a low cost per life saved are underfunded, for example, while many environmental regulations with a high cost per life saved are issued each year.

Does the existing allocation of resources reflect people's preoccupation with the qualitative aspects of risks, to the exclusion of quantitative factors (lives saved)? Or can observed differences in the cost per life saved of environmental and public health programs be explained by the way the two sets of programs are funded?

Cropper and Subramanian examine the preferences of U.S. citizens for health and safety programs. They confronted a random sample of 1,000 U.S. adults with choices between environmental health and public health programs, to see which they would choose. The authors then examined what factors (qualitative and quantitative) seem to influence these choices.

Respondents were asked about pairs of programs, among them: smoking education or industrial pollution control programs, industrial pollution control or pneumonia vaccine programs, radon eradication or a program to ban smoking in the workplace, and radon eradication or programs to ban pesticides.

The survey results, they feel, have implications beyond the United States. They find that, while qualitative aspects of the life-saving programs are statistically significant in explaining people's choices among them, lives saved matter, too. Indeed, for the median respondent in the survey, the rate of substitution between most qualitative risk characteristics and lives saved is inelastic. But for a sizable minority of respondents, choice among programs appears to be insensitive to lives saved. The interesting question for public policy is what role the latter group plays in the regulatory process.

This paper — a joint product of the Environment, Infrastructure, and Agriculture Division, Policy Research Department, and the Environment and Natural Resources Division, Asia Technical Department — is part of a larger effort in the Bank to see what can be learned about efficient environmental policy by examining the U.S. experience with environmental regulation. Copies of the paper are available free from the World Bank, 1818 H Street NW, Washington, DC 20433. Please contact Anna Maranon, room N10-031, telephone 202-473-9074, fax 202-522-3230, Internet address amaranon@worldbank.org. August 1995. (71 pages)

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I. INTRODUCTION

There is concern in the U.S. that the public worries about trivial risks while ignoring larger ones. For example, people worry about traces of trihalomethane in their drinking water, but will not buckle their seatbelts or give up smoking. Even more troubling is the fact that large amounts of money are spent on programs that reduce trivial risks while programs that are more cost-effective and address more serious risks are ignored.

A. Disparities in Cost-Per-Life Saved of Environmental and Public Health Programs

An example that is often cited to support this view is that many public health programs with a low cost-per-life saved are underfunded, while many environmental regulations with a high cost-per-life saved are issued each year. To illustrate, a program to detect and treat breast cancer among women over the age of 50 has been estimated to cost less than $15,000 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 1994).

If resources were allocated to life-saving programs to maximize the social utility from saving lives, then the ratio of marginal costs-per-life (or life-year) saved would, indeed, equal the ratio of marginal utilities received from saving lives in one program versus another. In the above example, the ratio of marginal costs-per-life-year saved would imply that society considered a life-year saved by preventing exposure to benzene to be 333 times as valuable as a year of life saved through the breast cancer screening program.

It is not, however, obvious that disparities in cost-per-life saved reflect public preferences. Rather, many of the differences in the cost-per-life saved of environmental and public health programs can be explained by the way in which the two sets of programs are funded. Environmental health programs generally are off-budget items whose costs are not transparent to the public, whereas public health programs typically are funded from tax dollars. Since there is no direct mechanism to compare costs across the two sets of programs, it is difficult to infer the value people place on life-saving programs simply by observing the amounts that are currently spent on various programs.

B. Public Choices Between Life-Saving Programs

For these reasons, we decided to confront people directly with choices between hypothetical environmental health and public health programs to see which they would choose. In a national survey of 1,000 households, we asked people to choose between implementing life-saving programs in the pairs listed in Table 1. Specifically, we described in detail the programs in one of the pairs (selected randomly from the table) including the number of lives saved. Respondents were asked to choose which of the programs they favored implementing. The choice was then repeated for another program pair.

By varying across respondents the ratio of lives saved by the programs in each pair, we are able to infer the ratio--for each pair of programs--that makes the median respondent indifferent between both programs. This gives us a measure of how many lives saved by drinking water treatment, say, are equivalent to a life saved by a colon cancer screening program. The question of interest is how this ratio compares with the cost per life saved by the two programs at current levels of implementation. Are rates of substitution between lives saved in one program and lives saved in another as extreme as cost figures suggest?

C.. The Effect of Qualitative Characteristics on Preferences for Life-Saving Programs

We are, however, interested not only in the choices that people make when confronted with pairs of life-saving programs, but in the reasons for their choices. Chauncey Starr (1969) suggested many years ago that the existing allocation of resources among life-saving programs reflects people's preoccupation with the qualitative aspects of risk. People are concerned not only with the number of lives a program will save; they care about whether the risk is voluntary or involuntary, whether it is "dreaded", or whether it is familiar or unfamiliar, and so on (Slovic, Fischhoff and Lichtenstein 1985).

We wished to see whether people's choices among life-saving programs are indeed influenced by qualitative attributes of risk (voluntariness, controllability) and by other qualitative aspects of each program--how the program is funded, whether the nature of the program is judged to lie within the proper scope of government activity. To do this we asked each respondent--after he had made his choices for both program pairs--to place each program on a series of 10-point scales, similar to those used in the psychometric literature. This gave us the respondent's perceptions of 8 qualitative characteristics (described below) for each program. Under the assumption that perceived qualitative characteristics of risk-reducing programs enter the consumer's utility function along with the number of lives saved, we have estimated the weights people place on qualitative characteristics versus 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 the risk and program characteristics in relation to the number of lives saved by a program? Specifically, what is the elasticity of each qualitative characteristic with respect to the number of 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 people care both about the qualitative and other characteristics of hypothetical regulatory programs and about number of lives saved in choosing among life-saving programs: All but one of the program characteristics discussed in the next section are statistically significant in predicting program choices. The number of lives saved is also strongly significant.

As a measure of 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 above. 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 whose willingness to trade qualitative program characteristics versus lives saved might well be characterized as irrational in the sense of Starr (1969) and Viscusi (1992).

The paper is organized as follows. The next section discusses in detail the qualitative characteristics on which the study focuses and relates them to the literature on risk perception and preferences for risk regulation. Section III 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 IV describes the survey methodology and the structure of the questionnaire. Sections V and VI present the results of the study. Section V describes the findings from the raw data, while section VI presents results from the formal statistical model. The paper ends with a discussion of the policy implications of the survey.

II. QUALITATIVE CHARACTERISTICS AND PREFERENCES FOR LIFE-SAVING PROGRAMS

The characteristics on which we have chosen to focus are those that, in general, differ between environmental and public health programs. These characteristics, listed in Table 2, 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). The second 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 perceive them to be, have not been studied in the literature on preferences for risk regulation.

A. Risk Characteristics Studied

In the focus groups that we conducted prior to our survey, two of the risk characteristics studied in the psychometric literature--voluntariness and controllability--were often mentioned as reasons for choosing pollution control programs over other health and safety programs.

Blame (Voluntariness)

Exposure to air and water pollution was viewed by most focus group members as involuntary--people were not responsible for being exposed to air and water pollution and therefore not to blame for their exposure. By contrast, health risks such as heart disease (caused by diet or inactivity) or lung cancer (from smoking) were perceived as risks for which people are themselves partly to blame. Henceforth we use the term *Blame* refer to how responsible people are for being exposed to a risk.

Ease of Avoiding Risk (Controllability)

Related to the concept of blame, yet distinct from it, is the notion of how easy it is to avoid a risk.[1] In the literature on risk reduction, how easy it is to avoid (or control) risks is an important determinant of desires for risk regulation. If a risk is perceived as difficult to avoid, then people are more likely to want the government's help in controlling the risk. In our focus groups, environmental risks such as air pollution or pesticide residues on food were

[1]To see that the two concepts are distinct, consider the following examples. People are certainly not to blame if a carcinogen enters the municipal drinking water supply; however, it is relatively easy to avoid the carcinogen by buying bottled water. In the case of smoking, smokers are certainly to blame for their habit, yet, due to the addictive nature of nicotine, it may be difficult for them to control it.

usually viewed as difficult to avoid. Health and safety risks such auto accidents and smoking were viewed as easier to avoid. *Ease of avoidance* is the second of the risk characteristics on which we focus.

Two other characteristics that have been found important in explaining people's preferences for risk regulation are the *Seriousness of the risk* (Vlek and Stallen 1981) and whether the respondent feels himself to be personally at risk (*Personal risk*) (Slovic, Fischhoff and Lichtenstein 1985).

Seriousness of Risk

In the psychometric literature and in this survey, *Seriousness of risk* is not defined for the respondent, but left to individual interpretation. Perceived seriousness of risk could, therefore, reflect the severity of health consequences due to the risk, or the potential number of fatalities based on the number of people exposed to the risk.

Personal Risk

Studies by Carson and Horowitz (1991a, 1991b, 1992), Beggs (1984) and Mendeloff and Kaplan (1989) have found *Personal risk* to be very significant in explaining people's preference for risk reduction. Our focus group participants often reacted to risks such as smoking or cancer on the basis of personal experience and the potential the risk had for affecting them or their family members.

B. Program Characteristics Studied

While psychometric studies have carefully examined the ***risk*** characteristics discussed above, they have not looked at risk reduction in the context of specific programs. The literature related to life-saving programs also has paid little attention to ***program-specific*** characteristics (Horowitz and Carson 1991a, 1991b, 1992; Mendeloff and Kaplan 1989; Beggs 1984). Factors such as people's perception of whether a program is effective, whether the method of funding the program is fair, and how appropriate it is for the government to provide the service have not been examined for their effects on program choice.

Participants in the focus groups we conducted suggested that people attach as much importance to the manner in which a risk is regulated as they do to which risk is reduced. In explaining choices we asked them to make between environmental and other health and safety programs, respondents often mentioned the first three program characteristics described below:

Efficacy of the program

People often expressed skepticism about the effectiveness of public health or safety programs, especially those that require cooperation from members of the target population, or that seek to change behavior. For example, most people were skeptical that a tax on cigarettes would discourage smoking. By contrast, environmental programs were not viewed as requiring cooperation from beneficiaries to be effective--everyone benefits *ipso facto* from breathing cleaner air or drinking cleaner water.

Appropriateness of government intervention

Focus group participants sometimes resented government interference in behavior modification or on issues that involved personal choice, such as the right to smoke or to choose not to wear a helmet on a motorbike. Safety programs such as mandatory airbags in automobiles were criticized as infringing on people's right to choose. Similarly, government provision of public health services such as vaccinations were viewed as "socialized medicine."

Regulations to control pollution, by contrast, were more likely to be viewed as within the appropriate scope of government activity.

Fairness of the funding mechanism

In focus groups, public health programs were sometimes viewed as inequitable because the costs of these programs are usually distributed across the population while the benefits are not. 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, were viewed as being paid 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 for by user fees).

Time at which the program begins to save lives

The last program characteristic, the *Time before the program saves lives*, was included to see if people's tendency to discount future lives saved (Cropper, Aydede and Portney 1991, 1992, 1994) was robust to the inclusion of other characteristics in the description of life-saving programs.

C. Choice of Program Pairs

In selecting health and safety programs with which to confront respondents, we wanted to assure that the programs in each pair differed in the above characteristics. It was, therefore, natural to select pairs consisting of one environmental and one public health program.[2] To

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[2]We classify programs that clean up air or water pollution or toxic substances as environmental health programs. Our public health programs either directly provide health services

make the choice between programs more meaningful, we sought programs that targeted the same health endpoint--for example, respiratory illness or cancer. We also sought programs whose primary benefit was life-saving, rather than reduction in illness or environmental (ecosystem) benefits, due to difficulties in measuring (and hence controlling for) the latter.

Subject to these constraints, the environmental programs chosen also possessed the following features: (a) they addressed problems that pose the greatest risk to human health according to the EPA (USEPA 1987, 1990); (b) they included regulations that have been cited as objectionable because of the high cost-per-life saved (OMB 1993); and (c) they included regulations that entail high total costs and thus may result in a significant misallocation of resources. The public health programs were chosen to target the same health endpoint as the environmental ones--cancer, respiratory illness and heart disease.

The six program pairs used in the survey and the diseases they target are presented in Table 1. The environmental programs include control of air pollution by factories and autos, drinking water treatment and restricting pesticide residues on food. The public health programs include colon cancer screening, smoking education and pneumonia vaccinations.

An exception to the rule that both programs in a pair target the same disease is pair 3. The Dual Airbags and the Auto Emissions Reduction programs address deaths related to

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(cancer screening, vaccinations) or safety (airbags in cars), or health education (smoking education). We realize that some of the programs that we classify as environmental health, such as drinking water treatment, have traditionally been classified as public health programs. All of our public health programs, however, have the property that they serve people "one at a time." 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.

automobiles. Though the link here is rather tenuous, the combination provides for some rich variation in characteristics, such as appropriateness of government role in risk reduction (mandatory installation of airbags is sometimes seen as intruding on individual rights) and timing of benefits (the airbags program begins to save lives right away compared to the auto emissions program).

To see whether respondents perceived the programs in each pair as differing in the eight characteristics of interest, Table 3 gives the ratio of the mean scale ratings that respondents assigned the two programs in each pair for each characteristic. To illustrate, the ratio 0.95 under "Efficacy of Program" for Pair 1 implies that the mean efficacy score assigned to the smoking education program was 95% of the mean score assigned to the industrial pollution prevention program.

Two conclusions stand out: For the program pairs studied, people perceived greater differences in the last four characteristics in Table 3 than in the first four. Three of these are risk characteristics that have been studied extensively in the psychometric literature (Ease of Avoiding Risk, Blame, Personal Risk), the fourth is the Timing of Lives Saved. 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.

As will be seen below, however, large differences in perceived characteristics do not necessarily imply that these characteristics are important in predicting choices. Indeed, it is the first four of the characteristics in Table 3 that turn out to be the most important qualitative factors explaining program choices.

We turn now to the formal model that is used to explain choices made between life-saving programs.

III. CONCEPTUAL FRAMEWORK

A. Utility Received from a Life-Saving Program

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**. The wording of our questionnaire implicitly assumes that utility is multiplicatively separable in X and **C**,

$$U = f(\mathbf{C})X, \tag{1}$$

implying that the choice between any two life-saving programs will depend on the *ratio* of lives saved by the two programs.[3]

In our empirical work we assume that the utility function of person i takes the form,

$$U_i = (C_{1i})^{\beta 1} (C_{2i})^{\beta 2} (C_{3i})^{\beta 3} \ldots (C_{ni})^{\beta n} X_i \tag{2}$$

where X_i = Number of lives saved by the program (as presented to respondent i)

C_{ki} = Characteristic k describing the program (as perceived by respondent i)

k=1,2,..n.[4]

[3]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 was given to the respondents as a ratio.

[4]This is the actual form of the utility function used in our empirical work. It has the advantage that it does not impose curvature restrictions on the utility function--characteristics may alter utility at an increasing or at a decreasing rate. It also fit the data better than the semi-log form of the utility function.

The utility that an individual derives from the lives saved by a program (X_i) is thus modified by the qualitative characteristics of the program (C_i), as the individual perceives them.

The parameters of the utility function, $\{\beta_k\}$, determine the ease with which the individual is willing to trade qualitative characteristics for lives saved. Formally, β_k represents the elasticity of lives saved with respect to characteristic k--the percentage change in lives saved corresponding to a percentage change in the characteristic that keeps the individual equally satisfied. If β_k exceeds one in absolute value, then the individual's indifference curve between characteristic k and lives saved is elastic (as is curve A in Figure 1) implying, as in Figure 1, that if the *Seriousness of the risk* a program targets increases by 10% the number of lives the program saves can decrease by more than 10% and keep utility constant.[5] The lower is β_k, the less willing the individual is to trade lives saved for qualitative characteristics (as is the case for curve B in Figure 1) and, according to some policy analysts (Viscusi 1992), the more "rational" the individual is.

B. A Model of Choice Between Life-Saving Programs

Consider now the respondent's choice between two life-saving programs. Using subscripts A and B to denote the two programs, the individual will prefer program A iff $U_A > U_B$. In practice, all of the program characteristics that are relevant to the individual's choice will not be observable. Let us denote by e_{Ai} and e_{Bi} the unmeasured characteristics of the programs as perceived by respondent i, and assume that

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[5]The more elastic the indifference curve the more steeply sloped it is, since the slope of the indifference curve varies inversely with β, e.g., $dC_1/dX = -(1/\beta_1)(C_1/X)$.

$$U_{Ai} = (C_{A1i})^{\beta 1} \ (C_{A2i})^{\beta 2} (C_{A3i})^{\beta 3} \ldots. (C_{Ani})^{\beta n} \ X_{Ai} \, e_{Ai} \quad (3)$$

$$U_{Bi} = (C_{B1i})^{\beta 1} \ (C_{B2i})^{\beta 2} (C_{B3i})^{\beta 3} \ldots. (C_{Bni})^{\beta n} \ X_{Bi} \, e_{Bi}. \quad (4)$$

Under the assumption that e_{Ai} and e_{Bi} are independently and identically distributed for all i, the individual's choice between the two programs is described by a random utility model. Assuming that $\ln(e_{Ai} / e_{Bi})$ is normally distributed with mean zero and variance σ^2, the probability of choosing Program A is given by a probit model,

$$\Phi[(1/\sigma) \ln(X_{Ai}/X_{Bi}) + \Sigma(\beta_k/\sigma) \ln(C_{Aki}/C_{Bki})]. \quad (5)$$

The econometric model that we estimate is more complicated than this. This is because after an individual has chosen 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.[6] Each individual's contribution to the likelihood function is the probability that he made the choice he was observed to make (AA, AB, BA or BB) at the X_{Ai}/X_{Bi} ratios with which he was confronted (see the Appendix for a more complete description of the model).

Estimation of this model enables us to compute the elasticities β_k, and hence to infer which of the program characteristics described in section II are most important in explaining choices among life-saving programs. The model allows us to answer other policy questions as well. For example, once the utility function parameters have been estimated, we can ask for

[6]It is well known 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).

any arbitrary pair of programs (**C** vectors) how many more lives one program must save than the other to make the median respondent indifferent between the two programs. The question of policy interest is whether this ratio is as large as disparities in cost-per-life saved would suggest.

IV. SURVEY METHODOLOGY

A. Description of the Survey

We asked people to choose between hypothetical (though realistic) life-saving programs in a telephone survey conducted by the Survey Research Center at the University of Maryland 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.

Though the socioeconomic profile of our sample compares fairly well with the corresponding national statistics,[8] it is important to point out the differences. Our sample has a smaller representation of blacks (9.7% compared to a national figure of 12.4%), and a higher

[7]In order to develop the questionnaire, we held eight focus groups, followed by a series of pretests. 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.

[8]The national statistics were obtained from the 1993 Statistical Abstract of the U.S.

representation of college-educated people than the national average (27.9% versus 18.4%). We also have fewer younger people (7.6% of the group was between 18-24 years old as compared to a national figure of 14.1%) and a smaller percentage of households earning below $50,000 than the national figure (69.7% instead of 74.2%).

B. Structure of the Questionnaire

The survey, which took an average of 23 minutes, began with a set of warmup questions that introduced the respondent to the environmental and public health theme of the study and to the idea of choosing between alternatives. Respondents were explicitly told that the setting for the questions was in a hypothetical state, other than the one in which he or she lived. The purpose of this was to control for the respondent's preconceived knowledge of programs already in existence in his own state.[9]

The main section of the survey confronted each respondent with two randomly selected program pairs. The structure of this part of the survey can be explained using program pair 1 for illustration. For pair 1, the first program in the pair, the Smoking Education program, was briefly described and the specific objective that the program was expected to achieve was

[9]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 about 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.

explicitly stated.[10] The respondent's belief about the program's effectiveness in realizing the objective was then elicited.

If the individual thought that the program was ineffective in achieving the stated objective--if he gave it a rating of 3 or less on the 10-point scale--he was given a different pair of programs.[11] The reason for branching respondents away from programs perceived as ineffective was that they would be unlikely to believe claims about lives saved by these programs.[12]

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.

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[10]The exact wording of the questions for Pair 1 appears in the Appendix. The complete questionnaire is available upon request from the authors.

[11]In branching respondents to alternate program pairs, care was taken to ensure that no respondent got the same program in two pairs. For instance, since both pairs 1 and 5 have an Industrial Air Pollution program, an individual could get only one of the two pairs.

[12]The percentage of respondents who gave programs an efficacy rating of 3 or below was less than 12% for all programs except the radon programs. Contrary to our expectations, public health programs were judged no less efficacious than environmental programs.

Following the approach of Hanemann, Loomis and Kanninen (1991), 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 given in the Appendix. Respondents who initially chose the Industrial Air Pollution control program were given a similar followup question with the new ratio of lives saved selected randomly from one of four values.

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 served two purposes. They enabled us to verify that respondents understood the questions and reacted thoughtfully in choosing programs. Secondly, they elicited spontaneous factors that influenced respondent choices.

Immediately after these 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 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 2. (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 standard questions about the respondent's age, race, marital status, income and education. Also included were questions exploring his attitude to a national health insurance plan, asking the respondent whether he was a smoker, and also whether he had lost a friend or relative to cancer or lung disease.

V. SURVEY RESULTS

A. Choices Among Life-Saving Programs with Lives Saved Held Constant

We shall begin by examining people's choices between the programs in each pair, first when both programs save the same number of lives and then when the number of lives saved is varied. Two results stand out :

(1) When both programs in a pair saved the same number of lives, a majority of

respondents favored the environmental program rather than the public health program.

(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.

Table 4 presents the percentage of respondents favoring Program A over Program B for each program pair when respondents were told that both programs in the pair saved the same number of lives for the same cost. Analysis of the respondents' choices indicates that there is, indeed, a greater preference for environmental health programs in the first four pairs, which have an environmental program paired with a public health or safety program. If we consider the smoking ban program and the pesticide regulation program in pairs 5 and 6 as environmental programs and the radon eradication program as a public health/safety program, we see that respondents have a greater preference for environmental programs relative to public health programs in the last two pairs also.

B. The Effect of Lives Saved on Program Choice

When the ratio of the number of lives saved by both programs was varied, the majority of respondents switched to the program that saved more lives. This is apparent from Figures 2-7 which show, for each program pair, the percentage of respondents choosing program A as X_A/ X_B varies. The graphs of these distributions display a fairly uniform pattern across all program pairs. For all pairs, the percentage of respondents choosing program A increases as the ratio of lives saved by that program to lives saved by program B increases. However, as is evident from the graphs, the percentage of respondents choosing the program that saves more lives does not increase monotonically with the ratio of lives saved. The lack of monotonicity implies that people appear to be reacting to whether one program saves more lives than the other, but not to the magnitude of the change.

Another interesting finding concerns the percent of respondents who stayed with the program they had originally chosen, even when the alternate program saved 50 to 100 times more lives. This number, which is 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 Figure 2, for example, approximately 20 percent of people continue to favor the Industrial Pollution Control program when the Smoking Education program is alleged to save 100 times more lives. By contrast, 13 percent of people who originally favored the Smoking Education program continue to favor it even when the pollution control program is alleged to save 50 times more lives. (The corresponding percentages for all programs pairs appear in Table 5.)

A possible explanation for these findings is that people did not believe the extreme ratios of lives saved that appear in Table 5. We do, however, have evidence, based on open ended comments, that people were willing to go along with the assumptions stated in the survey. The hypothesis that people did not accept our assumptions, furthermore, cannot explain why the ratio of people with (possibly) lexicographic preferences varies across programs. A striking finding in Table 5 is that between 20 and 30 percent of respondents continue to choose the pollution control program in pairs 1 through 3, even when the public health program saves 100 times more lives. Indeed, Table 5 strongly suggests that people are less sensitive to the number of lives saved for environmental programs than for public health programs.

C. 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. For instance, the belief that the environmental health program would cost more could have driven some people to choose the public health program even though they really preferred the environmental program for other reasons.

In order to control for people's beliefs about program costs, people 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 6, most respondents did not believe that both programs would cost the same. Respondents perceived the environmental health program to have a higher cost for 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 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, as soon as respondents had made their choices, they were asked what other benefits they had associated with each program. Environmental programs were seen as generating global environmental 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 the surroundings. From Table 7 we see that over half of the respondents who considered an air pollution control program mentioned environmental 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").

When asked explicitly what other benefits were associated with public health programs, the most frequently mentioned benefits were reductions in illness or injury, savings of health care costs and increased awareness about health risks.

VI. ECONOMETRIC ANALYSIS OF PROGRAM CHOICES

To analyze the contributions to program choice of the 8 qualitative factors, other program benefits, cost considerations and lives saved, it is necessary to estimate the random utility model described in section III. This can be done for each program pair, or by combining data from all six pairs. The advantage of modeling each pair separately is that one can see whether the factors affecting choice are consistent across program pairs. It is also easier to interpret the effect of socio-economic factors on choice for specific pairs. For example, whether the respondent is a smoker may affect the probability that he chooses the

Smoking Education program (Program A) in pair 1, but is unlikely to affect the probability that he chooses Program A in general.

Because of the larger number of observations obtained when data from all six pairs are combined, we focus on the pooled model. 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 (*Pair I*;, where I=1,2...6), for each of the program pairs, to capture attributes of the programs in each pair that are not reflected in the 8 measured qualitative characteristics or the number of lives saved.

A. Significance of Qualitative Characteristics in Explaining Program Choices

When the pooled model is estimated (see Table 8), seven of eight qualitative characteristics (as rated by respondents) are significant at conventional levels and all have the expected sign.[13] All the program attributes--*Efficacy of the program* in achieving stated objectives, ***Appropriateness of government intervention*** , ***Fairness of the funding mechanism***, ***Time before the program begins to save lives***--are statistically significant in explaining the probability of choosing a program. Among the risk characteristics, ***Seriousness of risk***,

[13]If Program A is perceived as more efficacious than Program B or log ($efficacy_A$/ $efficacy_B$) >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 log (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 *Time lag* of benefits would be negative. The signs for the other qualitative variables given in the third column of Table 8 can be interpreted in a similar manner.

***Personal** risk*, and ***Ease of avoiding** risk* are statistically significant. The only variable among the qualitative risk characteristics that emerges as insignificant is the extent to which people are to ***Blame** for exposure to the risk.*

One possible explanation for the insignificance of the ***Blame*** variable may be due to its collinearity with ***Ease of avoiding** risk*. In the case of smoking, people often blame the smoker for voluntarily exposing himself to a risk; by the same argument, they also believe that the smoker could easily avoid the risk (by stopping smoking). Simple correlation tests indicated that *Blame* and *Ease of avoiding risk* are indeed significantly correlated. However, when *Ease of avoiding risk* is excluded from the model there is no notable change in the estimated coefficient or standard error of *Blame*. A possible explanation for our results is that, although people rate the programs differently in terms of how much people are to blame for needing them, our respondents don't consider people who are exposed to pollution or even people who are at risk of cancer because of a poor diet to be very much to blame for their situation. We are dealing with a class of risks where there are, to some extent, factors that mitigate personal responsibility for being exposed to the risk.

Both of the "other benefit" variables, *Other Benefits from Program A* and *Other Benefits from Program B* are also significant. If respondents believed that there were other 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 other benefits from Program B other than life saving benefits, then the probability of choosing Program A declined.

Dummy variables for pairs 3, 4, 5 and 6 were also statistically significant in explaining program choice. Each of the pair dummies represents the unmeasured properties of the programs in a pair. The negative sign of the coefficient of *Pair 3*, for instance, implies that the unmeasured positive characteristics of the auto emissions program outweigh the unmeasured benefits of the air bag program, thus lowering the probability that the airbag program is selected. Similarly, the unmeasured qualities of the Industrial Air Pollution program enhance the probability that it is chosen in Pair 4. The coefficients of the pair dummies for pairs 5 and 6 are both statistically significant but opposite in sign. In pair 6, the Pesticide Ban program's desirable unmeasured attributes exceed those of the Radon program. In pair 5, on the other hand, the unmeasured attributes of the Radon program are, on balance, more positive than the unmeasured attributes of the Workplace Smoking Ban. 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.

Examining the coefficients of the pair dummies sheds light on the question "Do people have an inherent preference for environmental programs, when all factors, including other benefits from programs, are held constant?" From the results in Table 8, there appears some evidence of an inherent preference for environmental health programs in pairs 3, 4 and 6. It is, however, difficult to be sure that we have captured all other benefits from environmental programs; hence, it is possible that the dummy variables for pairs 3, 4 and 6 are actually capturing ecological benefits. One test of this is to look at the interaction between these dummy variables and the Other Benefit dummies. To examine this interaction, the model was estimated with only the qualitative characteristics, the number of lives saved and the six pair dummies, **excluding** the *Other benefits* variables. When the *Other Benefit* variables are omitted, the coefficients of the *Pair 3* and *Pair 4* dummies are slightly higher, with smaller standard errors, than in Table 8 and the coefficient value and standard error for the *Pair 5* dummy are slightly lower. Hence we cannot rule out interactions between the *Other benefits* variables and the pair dummies. It is, therefore, difficult to infer from Table 8 that respondents have an inherent preference for environmental health programs.

B. Significance of Lives Saved and Program Costs in Explaining Program Choices

While qualitative factors are significant in explaining program choices so, clearly, were lives saved. The coefficient of Lives Saved is estimated with great precision, both in the pooled model (Table 8) and in the models for each individual program pair (presented in the Appendix).

To determine how readily people were willing to substitute qualitative attributes for lives saved, one must divide each of the coefficients in Table 8 by the coefficient of lives saved, in order to estimate the elasticity of substitution between characteristic k and lives saved, β_k.

Before doing this, however, we must consider the role of perceptions about programs costs in explaining program choices. As noted above, most people did not believe that both programs in a pair would cost the same if they saved the same number of lives. Dummy variables for the perception that *Program A costs more* and the perception that *Program B* *costs more* were included in the model to measure the impact of perceived cost on the probability of choosing a program.

The results from estimating the model with perceived cost variables are presented in Table 9. Comparing the coefficient estimates with those in Table 8, it is apparent that including the perceived cost variables does not change the coefficients of any of the explanatory variables very much, except for the coefficients of the pair dummies. Just as in the model without the cost variables, all qualitative attributes (excepting *Blame*) including *Other Benefits* from programs A and B are statistically significant and have the expected sign. Of the two perceived cost variables, *Program A costs more* has the expected negative sign but is statistically insignificant in explaining choice. The variable *Program B costs more* is statistically significant, but has an unexpected negative sign[14].

One explanation for this anomaly could be that the variable *Program B costs more* is correlated with dummies for *Pair 3* or *Pair 1,* whose coefficients show the greatest change when the cost variables are introduced. Simple correlation tests between a dummy representing *Pair 3* and/or *Pair 1* and *Program B costs more* suggest that *Program B costs more* indeed captures the unmeasured desirable aspects of the environmental programs in Pair 1 and Pair 3.[15]

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[14]Including perceived cost variables in the models for the individual program pairs also produced the same aberration in the coefficient estimates for *Program B costs more*. The coefficients were either insignificant or had the wrong sign. The Appendix contains estimates of models for the individual program pairs.

[15]A dummy was created to have a value of 1 if respondents were confronted with pair 1 or pair 3, and a value of 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.

C. The Role of Demographic Variables

Until now we have ignored the influence of respondent characteristics in explaining choices. For example, one might expect smokers to be less likely to favor a smoking education program and more likely to favor a program to control industrial air pollution.[16]

When the models for individual program pairs are estimated including respondent characteristics, the results indicate that none of the standard socio-economic variables--race, income, education, age, gender, marital status--are statistically significant in explaining program choice for any of the program pairs. The lack of importance of demographic variables in explaining preference may be due to the fact that the qualitative characteristics are capturing the effects of the socio-economic factors. Regressions of the characteristics for each program on demographic and economic variables revealed that, indeed, some of the demographic variables (e.g., *Race*) were significant in explaining variations in qualitative characteristics such as *Seriousness of Risk, Fairness of Funding*, and *Appropriateness of Government intervention*. For instance, blacks consider smoking and pneumonia to pose significantly greater health risks than do whites, and they consider it more appropriate for the government to provide smoking education and pneumonia vaccinations than do whites. Blacks also consider themselves to be at greater personal risk from smoking-related diseases than to whites.

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[16]It is more meaningful to analyze effects of socio-economic variables for individual pairs rather than for the aggregate model because environmental and public health programs in each of the six pairs are not arranged in any particular order.

D. The Relative Importance of Qualitative Characteristics versus Lives Saved

As explained before, the β vector represents the elasticity of lives saved by a program with respect to each risk and program characteristic. Table 10 presents the β coefficients and the corresponding standard errors for each of the qualitative characteristics. For example, the elasticity of lives saved by a program to the *Seriousness of the risk* it addresses is -1.52. This implies that if there is a 100% increase in the *Seriousness of the risk*, people would be willing to accept a 152% reduction in the number of lives saved by the program.[17]

A striking feature of the table is that the point estimate of the elasticity of substitution between lives saved and the qualitative characteristics examined is greater than one only for *Seriousness of the risk* and *Program efficacy*. If one tests the null hypothesis that each elasticity is less than or equal to one against the alternative that it is greater than one, the null hypothesis is rejected only for *Seriousness of the risk*. The coefficient on *Efficacy of the program* is not significantly different from one, implying that respondents scale down the ratio of lives saved presented to them by the ratio of efficacy scores for the two programs. All of the remaining elasticities are significantly below one and, indeed, lives saved has a zero elasticity with respect to the *Extent of blame*. Table 10 certainly fails to suggest that people are extremely sensitive to the characteristics studied in choosing among life saving programs.

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[17]The interpretation of the coefficient on *Efficacy of the program* is somewhat different from the interpretation of the other β'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_A/X_B, the <u>effective</u> ratio of lives saved is $(E_A/E_B)^{\beta}(X_A/X_B)$, where E_i = Efficacy rating given by the respondent to program I. Table 10 implies that one cannot reject the hypothesis that $\beta = 1$.

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 incorporates such factors in the dummy variables for each program pair, to predict people's choices among life saving programs. Specifically, we use the estimated model to calculate the ratio of lives saved that will make the median respondent indifferent between both the programs in each pair, assuming that his perceptions of program characteristics (the C_i's) satisfy mean values.

Table 11 presents the ratio of lives that must be saved by the two programs in a pair to make the median respondent equally likely to choose either program. 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 clean 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.

While it is true that the median respondent is indifferent between public and environmental health programs only if the public health program saves more lives, 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 widely accepted estimates of the ratio of the cost per life saved of the environmental program to the cost per life saved of the public health program.

VII. CONCLUSIONS

The purpose of this survey was to see what choices people would make when asked to decide 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.

For the median respondent, however, qualitative characteristics do not matter much. The elasticity of substitution between lives saved and qualitative characteristics is significantly greater than one only for one characteristic--*Seriousness of the 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, for the median respondent 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 11, 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 pesticide in question.[18] 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 Table 5 indicates, 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 the corresponding public health program saved 100 times as many lives. 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 trade-offs are made across environmental and public health programs. The two are approved and funded in distinct ways: Public health programs generally are 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 level of implementation is decided.

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[18]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 each home for radon 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, Evans et al. 1992).

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, generally, less apparent than the tax burden associated with public health programs. We believe these facts may help to explain the apparent discrepancies between the findings of this study and program implementation.

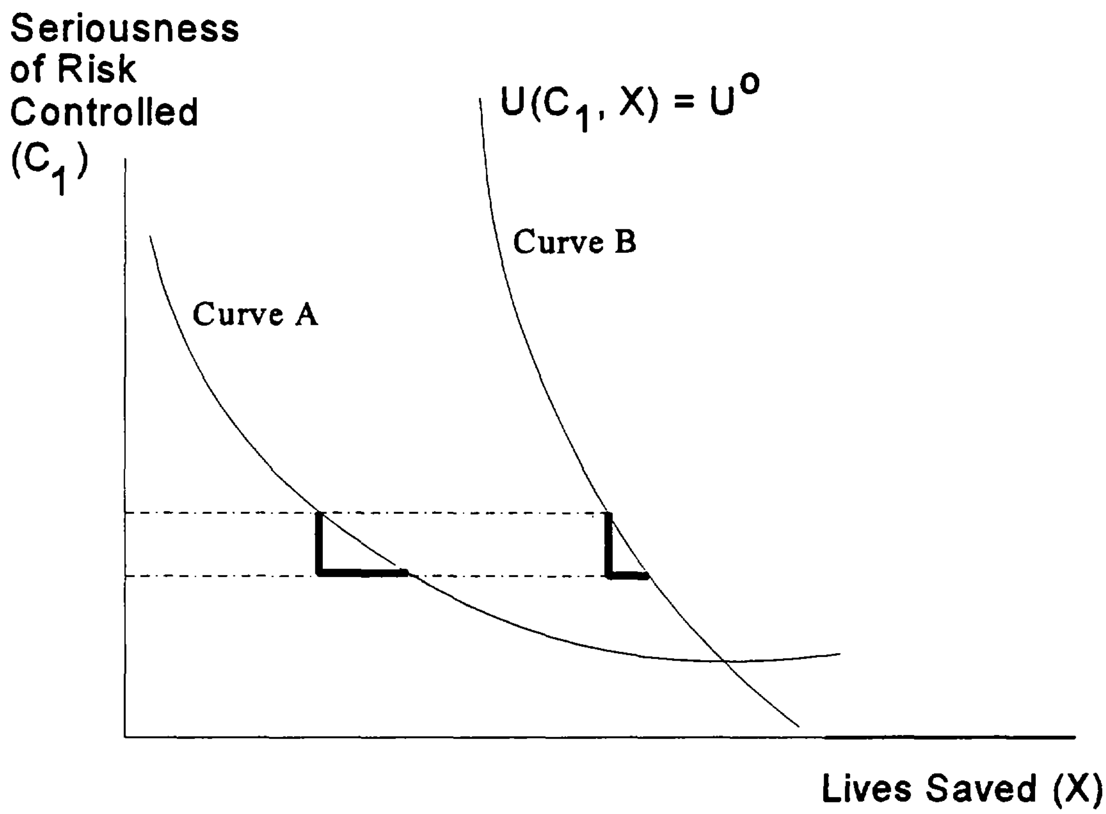
Seriousness
of Risk
Controlled
(C_1)
$U(C_1, X) = U^o$
Curve B
Curve A
Lives Saved (X)

Figure 1

Figure 2

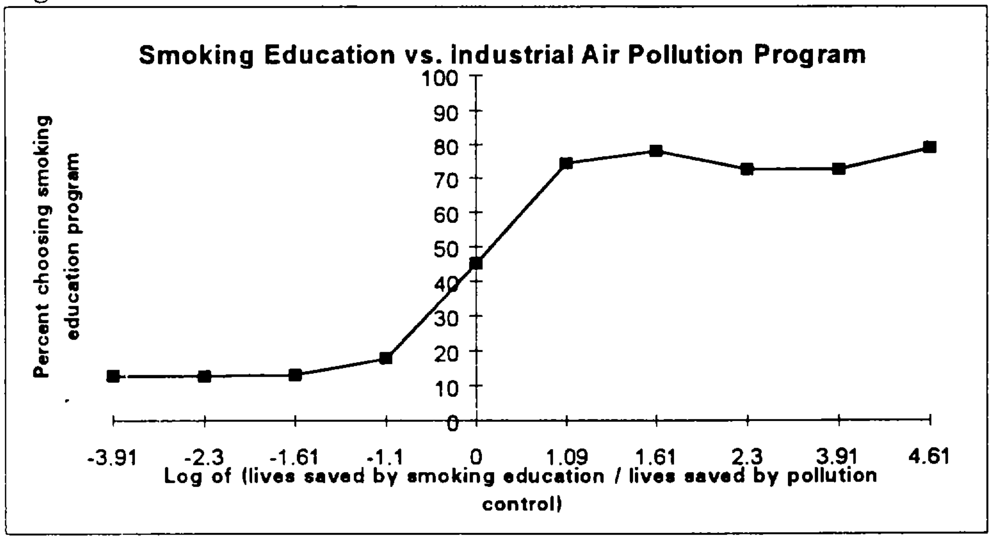

Figure 3

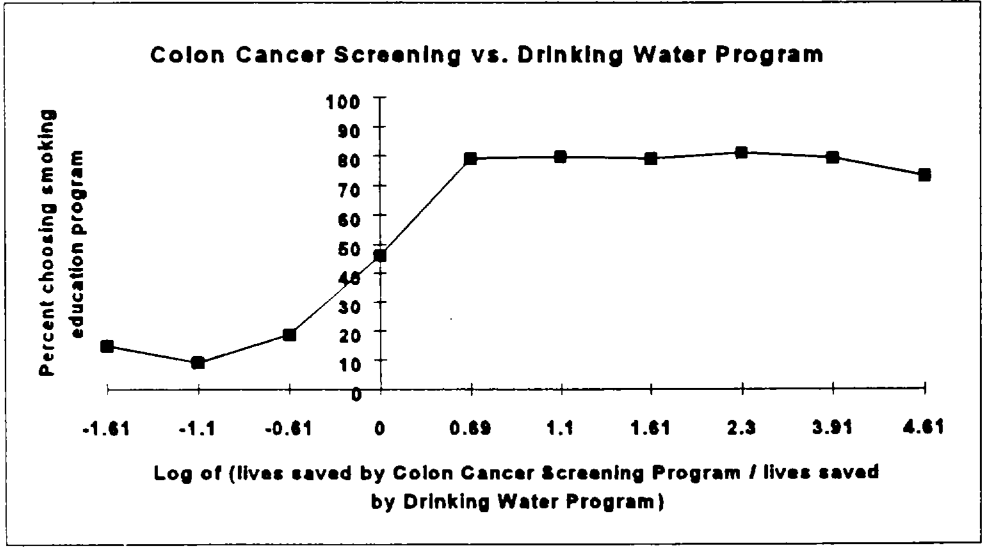

Figure 4

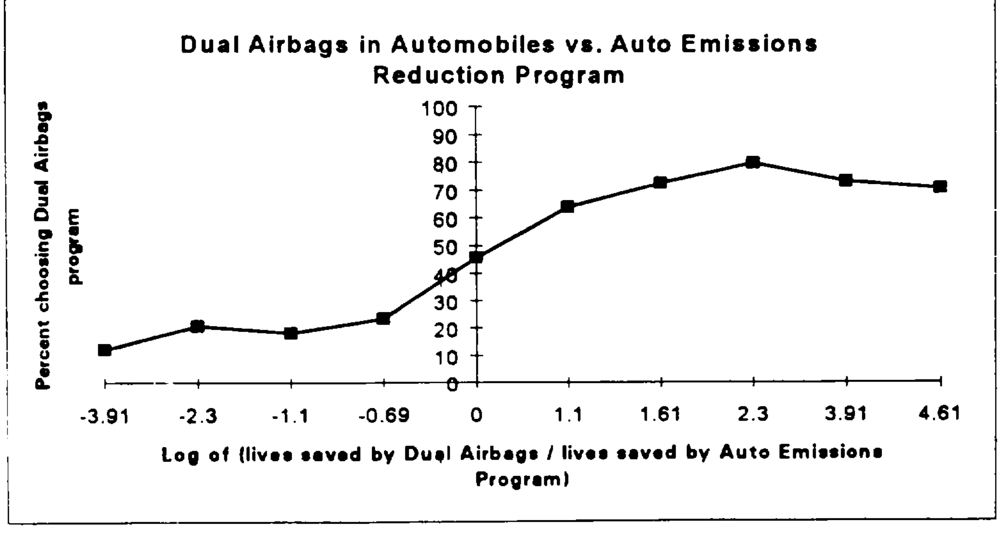

Figure 5

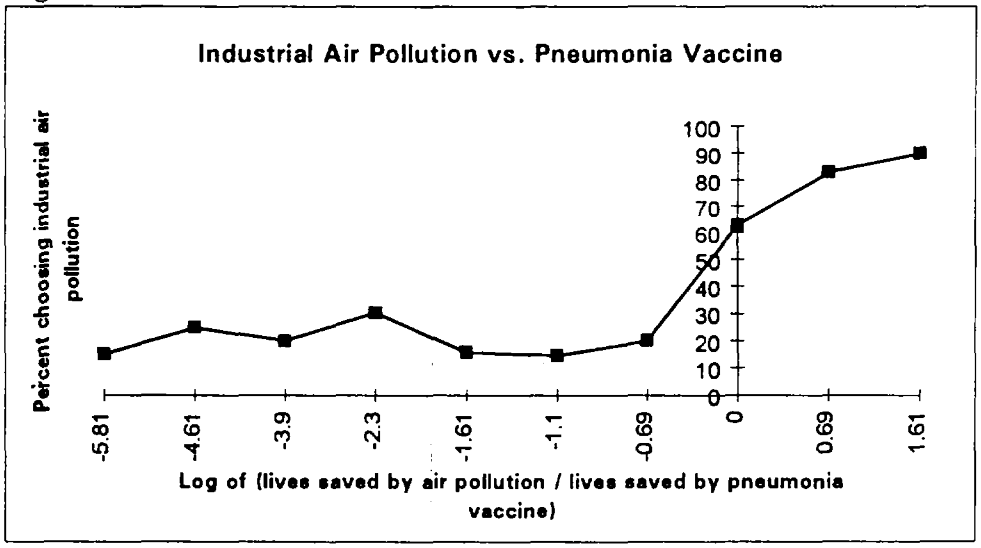

Figure 6

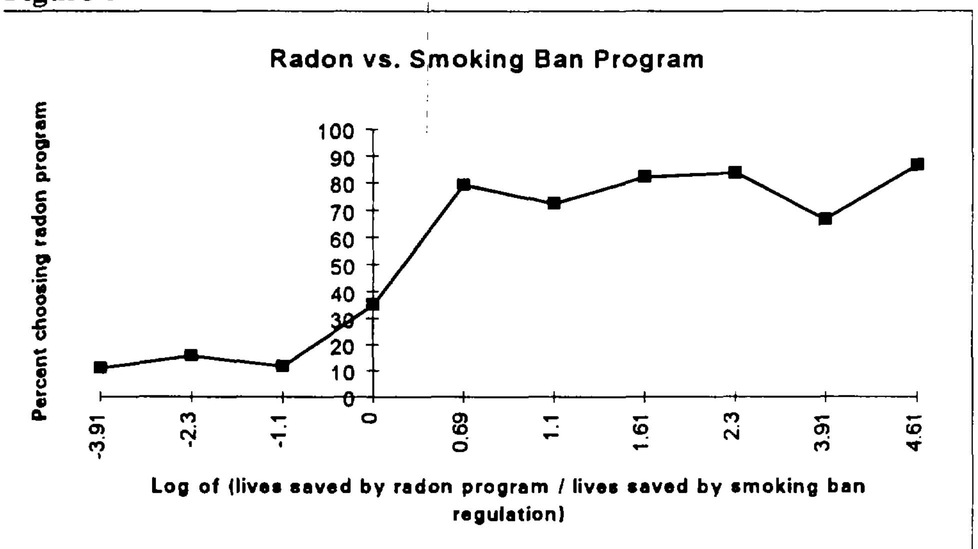

Figure 7

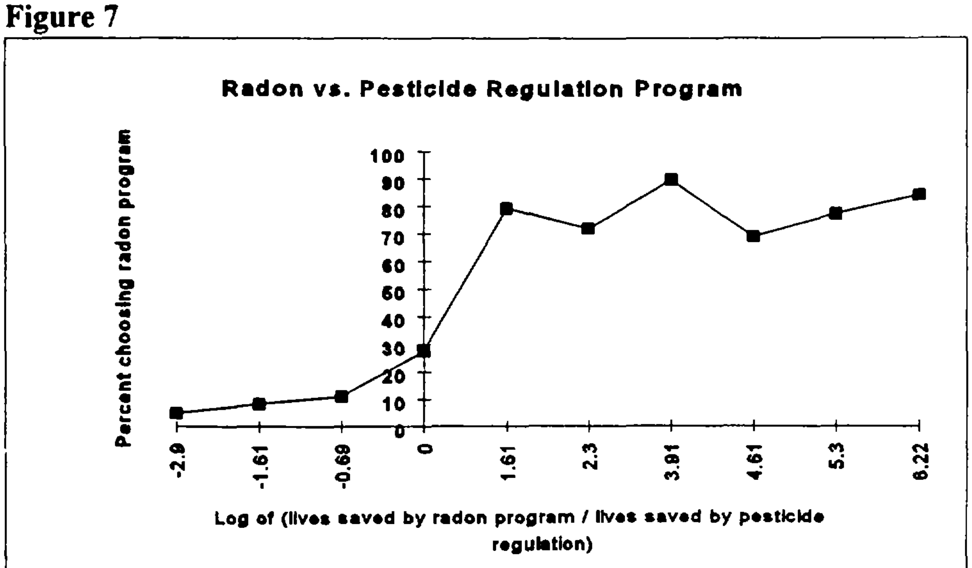

Table 1
PAIRS OF PREVENTIVE HEALTH PROGRAMS

Program Pair	Disease Targeted
Smoking Education Industrial Air Pollution Control	Heart and lung disease
Colon Cancer Screening Drinking Water Treatment	Colon Cancer
Dual Airbags Automobile Emissions Control	Auto deaths
Pneumonia Vaccinations Industrial Air Pollution Control	Lung disease
Radon Control Workplace Smoking Ban	Lung cancer
Radon Control Pesticides Ban	Cancer (unspecified)

Table 2
RISK AND PROGRAM CHARACTERISTICS STUDIED

Risk Characteristics Studied

Extent to which population served is to Blame for risk
(Voluntariness of Risk)

Ease of Avoiding Risk (Controllability of Risk)

Seriousness of risk targeted

Whether Risk Affects Respondent Personally

Program Characteristics Studied

Efficacy of the Program

Appropriateness of Government Intervention

Fairness of the Funding Mechanism

Time Before Program Begins to Save Lives

TABLE 3
PERCEIVED DIFFERENCES IN PROGRAM CHARACTERISTICS
Mean Ratio (Characteristic A/Characteristic 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	Industrial air pollution control v. Pneumonia vaccine program	Radon control in homes v. Smoking ban in the work place	Radon control in homes v. Pesticide ban on fruit
Efficacy of program	0.95	1.04	1.13	0.95	0.87	0.95
Seriousness of risk controlled	1.03	1.01	1.09	1.27	0.79	0.81
Appropriateness of govt. intervention	0.89	0.86	0.96	1.15	0.94	0.78
Fairness of program funding	0.83	1.12	1.05	0.93	0.88	1.07
Ease with which risk can be avoided	2.55	1.31	1.96	0.57	1.06	1.31
Time lag before program begins to save lives	0.95	0.85	0.53	1.77	1.36	1.28
Extent to which program beneficiary is to blame	1.73	1.20	1.92	1.02	0.78	0.87
Respondent at risk	0.87	1.11	1.22	1.23	0.70	0.60

TABLE 4

PERCENTAGE OF RESPONDENTS CHOOSING EACH PROGRAM WHEN BOTH SAVE THE SAME NUMBER OF LIVES

	Percentage of respondents	Total number of respondents
1. Smoking education	45	259
Industrial air pollution	55	
2. Colon cancer screening	46	359
Drinking water pollution	54	
3. Dual airbags in automobiles	46	402
Auto emissions program	54	
4. Industrial air pollution	63	251
Pneumonia vaccine program	37	
5. Radon in homes	35	250
Smoking ban in the work place	65	
6. Radon in homes	28	178
Pesticide ban on fruit	72	

Table 5

Percentage of Respondents Who Did Not Switch Preferences
at Extreme Ratios of Lives Saved

Program Pairs	Lives Saved Ratio X_A/X_B	Percentage of respondents	Choice in second round
Pair 1	0.02	12.9	AA
	100.0	21.1	BB
Pair 2	0.2	14.8	AA
	100.0	26.9	BB
Pair 3	0.02	12.3	AA
	100.0	29.7	BB
Pair 4	0.003	15.0	AA
	5.0	10.0	BB
Pair 5	0.02	10.9	AA
	100.0	13.4	BB
Pair 6	0.05	4.75	AA
	500.0	16.0	BB

Table 6
RESPONDENTS' BELIEFS ABOUT PROGRAM COSTS
(Percent)

		Program A Costs More	Program B Cost More	Programs Cost Same
1.	Smoking education Industrial air pollution	5	73	22
2.	Colon cancer screening Drinking water pollution control	44	22	34
3.	Dual airbags in automobiles Auto emission control program	16	53	31
4.	Industrial air pollution control Pneumonia vaccine program	66	13	21
5.	Radon control in homes Smoking ban in the work place	58	17	25
6.	Radon control in homes Pesticide ban on fruit	30	31	39

Table 7
Program Benefits Other than Lives Saved

Programs	Percentage that cited benefits other than lives saved	Percentage that mentioned environmental benefits	Percentage that mentioned other health benefits
Smoking Education[1]	56	6	23
Industrial-air Pollution	60	43	11
Colon Cancer Screening	42	0	35
Drinking Water[2]	51	3	15
Dual Airbags	26	0	19
Auto Emissions	59	41	10
Industrial Air Pollution	61	39	12
Pneumonia Vaccine[3]	37	0	27
Radon	25	4	11
Smoking Ban[4]	54	9	16
Radon	25	5	10
Pesticide Ban	43	14	10

[1] Helps nonsmokers (3.5%); more pleasant homes (2%); saves smokers money (5.4%) prevent tobacco companies from making money (1.8%).

[2] Better tasting water (5.6%); purer/cleaner drinking water (12%).

[3] Helps elderly (1.6); helps kids (2.4%).

[4] Helps nonsmokers (6.4%); more pleasant workplace/homes (7.2%).

TABLE 8
Probability that Program A is Preferred

Program Characteristic	Utility function coefficients (β/σ)**	t-statistics	Expected sign of coefficient
EFFICACY OF PROGRAM*	0.5259	6.07	Positive
SERIOUSNESS OF RISK CONTROLLED*	0.6304	10.39	Positive
APPROPRIATENESS OF GOVERNMENT. INTERVENTION*	0.3239	6.16	Positive
FAIRNESS OF PROGRAM FUNDING*	0.1258	3.36	Positive
EASE WITH WHICH RISK CAN BE AVOIDED*	-0.1154	-4.2	Negative
TIME LAG BEFORE PROGRAM SAVES LIVES*	-0.0644	-2.06	Negative
EXTENT TO WHICH PROGRAM BENEFICIARY IS TO BLAME	-0.0182	-0.65	Negative
RESPONDENT AT RISK	0.0646	2.06	Positive
LIVES SAVED	0.4144	45.46	Positive
OTHER BENEFITS FROM PROGRAM A	0.2458	3.92	Positive
OTHER BENEFITS FROM PROGRAM B	-0.2711	-4.7	Negative
PAIR 1 DUMMY	0.0287	0.41	Favored Pgm.
PAIR 2 DUMMY	-0.093	-1.47	
PAIR 3 DUMMY	-0.1224	-2.01	Auto emissions
PAIR 4 DUMMY	0.2804	3.52	Industrial air pollution
PAIR 5 DUMMY	0.1523	2.23	Radon
PAIR 6 DUMMY	-0.3093	-4.15	Pesticide ban

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

TABLE 9
Probability that Program A is Preferred

Program Characteristic	Utility function coefficients $(\beta/\sigma)^{**}$	t-statistics	Expected sign of coefficient
EFFICACY OF PROGRAM*	0.5327	6.13	Positive
SERIOUSNESS OF RISK CONTROLLED*	0.6301	10.39	Positive
APPROPRIATENESS OF GOVERNMENT. INTERVENTION*	0.3219	6.11	Positive
FAIRNESS OF PROGRAM FUNDING*	0.1269	3.38	Positive
EASE WITH WHICH RISK CAN BE AVOIDED*	-0.1135	-4.15	Negative
TIME LAG BEFORE PROGRAM BEGINS TO SAVE LIVES*	-0.0635	-1.99	Negative
EXTENT TO WHICH PROGRAM BENEFICIARY IS TO BLAME	-0.0214	-0.77	Negative
RESPONDENT AT RISK	0.0646	2.05	Positive
LIVES SAVED	0.4154	45.44	Positive
OTHER BENEFITS FROM PROGRAM A	0.2538	4.03	Positive
OTHER BENEFITS FROM PROGRAM B	-0.2603	-4.48	Negative
PROGRAM A COSTS MORE	-0.1054	-1.52	Negative
PROGRAM B COSTS MORE	-0.1596	-2.34	Positive
PAIR 1 DUMMY	0.1041	1.33	
PAIR 2 DUMMY	-0.063	-0.95	
PAIR 3 DUMMY	-0.0683	-1.05	
PAIR 4 DUMMY	0.3246	3.91	
PAIR 5 DUMMY	0.1958	2.67	
PAIR 6 DUMMY	-0.2861	-3.78	

* LN(Characteristic of Program A/Characteristic of Program.

TABLE 10
ELASTICITIES OF LIVES SAVED
WITH RESPECT TO QUALITATIVE CHARACTERISTICS

Program Characteristic	-(Elasticity of lives saved with respect to qualitative characteristic)	Standard error
EFFICACY OF PROGRAM	1.2692	0.2055
SERIOUSNESS OF RISK CONTROLLED	1.5213	0.1457
APPROPRIATENESS OF GOVERNMENT. INTERVENTION	0.7812	0.1266
FAIRNESS OF PROGRAM FUNDING	0.3036	0.0902
EASE WITH WHICH RISK CAN BE AVOIDED	-0.2785	0.066
TIME LAG BEFORE PROGRAM BEGINS TO SAVE LIVES	-0.1553	0.0764
EXTENT TO WHICH PROGRAM BENEFICIARY IS TO BLAME	-0.0439	0.0671
RESPONDENT AT RISK	0.1559	0.0756

TABLE 11

NUMBER OF LIVES SAVED BY EACH PROGRAM THAT MAKES MEDIAN RESPONDENT INDIFFERENT BETWEEN THEM

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. Industrial air pollution control	100
Pneumonia vaccine program	162
5. Radon control in homes	206
Smoking ban in the work place	100
6. Radon control in homes	213
Pesticide ban on fruit	100

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List of Appendices

APPENDIX A

Sampling Procedures and Respondent Characteristics in the National Survey

A random digit dialing procedure using a standard two stage Waksberg-Mitofsky[1] design generated a national sample of 2,487 telephone numbers. Of these telephone numbers 1,011 were found to belong to non-households or were of unknown status and were therefore eliminated from the pool of numbers from which survey respondents would be drawn. The target population for this survey were adults (age 18 years or older) residing in the 1,476 households.

The target respondent from each household was selected at random by asking for the adult (age 18 or older) who would have the next birthday. This is a standard method used in surveys to ensure that respondents are not concentrated in certain demographic groups, without having to ask intrusive questions about household composition.

Of the 1,476 households selected, 8% could not be contacted and 4.3% had miscellaneous problems, such as language difficulties and illnesses. Of the 1,294 households that were contacted 21.7% respondents refused to participate in the survey.[2] This study is based on the 1,013 interviews that were completed.

A demographic profile of these 1,013 respondents and that of the U.S. population for 1993 is presented in Table A.1. Comparing the two columns in Table A.1, there were fewer blacks in our sample (9.7%) than the national average (12.4%). The respondents in the survey were more educated (27.9% were college educated compared to a U.S. average of 18.4%). The sample also had a smaller representation of households with incomes below $50,000 than the national figure of 74.2%.

With respect to the age groups included in the sample, the percentage of young people between 18 and 24 years was half that in the population (7.6% instead of 14.1%). However, the percentage of 35-54 year olds in the sample exceeded their share in the population (42.4% in the sample versus 34.8% in the population). Finally, a larger percentage of women (57%) were among the respondents compared to the U.S. population (51.2%).

Sample weights. Sample weights were assigned to each respondent:

- To correct for the number of telephone numbers in a household.
- To correct for the number of adults in a household.
- To correct for under-representation of males.
- To correct for under-representation of people with less than high school education.

Estimation of the model with the weighted data produced results that were not notably different from the results from the unweighted data. (See Table A.2 for results using weighted data).

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[1] The Waksberg-Mitofsky two-stage cluster sampling design gives all residential telephone number an equal probability.

[2] All telephone numbers in the sample were tried up to 20 times. Respondents who initially refused were recontacted by a specialist in refusal conversion. As a result, the initial refusal rate of 31.9% declined to 21.7%.

Table A.1
Demographic Characteristics of the Sample Compared with National Data

	SAMPLE PROFILE (%)	NATIONAL STATISTICS (%)
RACE		
White	81.8	83.6
Black	9.7	12.4
Asian	2.2	3.2
Other	5.4	0.8
Refused	0.9	
GENDER		
Male	43	48.8
Female	57	51.2
INCOME		
Below $ 20,000	18.9	Below 25,000 41.7
$20,000-30,000	18.0	25-35,000 15.2
$30,000-50,000	32.8	35-50,000 17.3
$50,000-75,000	16.7	50-75,000 15.4
Above $75,000	13.6	Above 75,000 10.4
EDUCATION		
Elementary School	11.3	20.8
High School Graduate	37.2	35.7
Some College	23.0	25.1
College Graduate	16.5	12.5
Graduate or Professional degree	11.4	5.9
Refused	0.7	

AGE		
18-24 years	7.6	14.1
25-34 years	21.0	22.9
35-44 years	26.8	21.0
45-54 years	15.6	13.8
55-64 years	11.6	11.2
Over 65 years	16.5	17.0
Refused	0.9	
MARITAL STATUS		(1992 figures)
Married	60.5	61.2
Separated	2.6	
Divorced	12.2	8.8
Widowed	7.7	7.3
Never been Married	16.3	22.7
Refused	0.7	

* From the Statistical Abstract of the United States, 1993, The National Data Book, Bureau of the Census.

TableA.2
Probability that Program A is Preferred (Weighted Data)

Program Characteristic	Utility function coefficients**	t-statistics	Expected sign of coefficient
EFFICACY OF PROGRAM*	0.5076	6.07	Positive
SERIOUSNESS OF RISK CONTROLLED*	0.6558	13.25	Positive
APPROPRIATENESS OF GOVT. INTERVENTION*	0.2850	5.97	Positive
FAIRNESS OF PROGRAM FUNDING*	0.1797	5.51	Positive
EASE WITH WHICH RISK CAN BE AVOIDED*	-0.1151	-4.83	Negative
TIME LAG BEFORE PROGRAM SAVES LIVES*	-0.0552	-1.98	Negative
EXTENT TO WHICH PROGRAM BENEFICIARY IS TO BLAME*	-0.0155	-0.62	Negative
RESPONDENT AT RISK**	0.0755	2.63	Positive
LIVES SAVED	0.4041	50.37	Positive
OTHER BENEFITS FROM PROGRAM A	0.2571	4.83	Positive
OTHER BENEFITS FROM PROGRAM B	-0.2509	-4.98	Negative
PAIR 1 DUMMY	-0.0049	-0.08	
PAIR 2 DUMMY	-0.1346	-2.65	
PAIR 3 DUMMY	-0.0845	-1.72	
PAIR 4 DUMMY	0.2727	3.73	
PAIR 5 DUMMY	0.1396	2.33	
PAIR 6 DUMMY	-0.3168	-4.66	

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

APPENDIX B

Survey Questions for Program Pair 1
(Smoking Education and Industrial Pollution Programs)

Now 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 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.

>P1A<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?

<1-10>RECORD ACTUAL NUMBER FROM 1 TO 10
<88> DK

Why did you choose that rating?

[If P1A ge 4 goto P1B]
[If P1A <4 go to another program pair]

>P1B<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?

<1-10> RECORD ACTUAL NUMBER FROM 1 TO 10
<88> DK

>P1C<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?

<1-10>RECORD ACTUAL NUMBER FROM 1 TO 10
<88> DK

Why did you choose that rating?

[If P1C ge 4 goto P1D]
[If P1C <4 go to another program pair]

>P1D<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?

<1-10>RECORD ACTUAL NUMBER FROM 1 TO 10
<88> DK

>P1E< 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 P1E1]
<2> CONTROL OF INDUSTRIAL POLLUTION [go to p1e1]
<8> DK [goto P1I]

>P1E1< Why is that? [go to P1F]
>p1e1< Why is that? [go to P1G]

>P1F< 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 [go to P1F1]
<2> CHANGE MIND [goto p1f1]
<3> OTHER (SPECIFY) [specify] [goto P1I]
<8> DK[goto P1I]

>P1F1< Why is that?
>p1f1< Why is that?

>P1G<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 [P1G1]
<2> CHANGE MIND[goto p1g1]
<3> OTHER (SPECIFY) [specify] [goto P1I]
<8> DK [goto P1I]

>P1G1< Why is that?
>p1g1< Why is that?

>P1I< 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

>P1J< (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

>P1L< In choosing between the two programs, did you think that the cost of the programs would be the same?

<0> NO [goto P1M]
<1> YES
<8> DK

>P1M< Which program did you think would cost more?

<1> SMOKING EDUCATION PROGRAM
<2> AIR POLLUTION CONTROL PROGRAM
<8> DK

[FOLLOWING THE SECOND PROGRAM PAIR:]

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.

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

How serious a health problem do you think industrial air pollution 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 industrial air pollution is?)

<1-10> RECORD ACTUAL NUMBER FROM 1 TO 10
<88> DK

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

How appropriate do you think it is for the government to impose pollution controls on industry? (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 impose pollution controls on industry?)

<1-10> RECORD ACTUAL NUMBER FROM 1 TO 10
<88> DK

How fair do you think it is to fund the smoking education program 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

How fair do you think it is for the cost of pollution controls on industry to be paid for by the industries' stockholders, employees and consumers of the industries' products? (If 1 means not at all fair and 10 means very fair), (What number from 1 to 10 best describes how fair it is for the cost of pollution controls to be paid for by the industries' stockholders, employees, and consumers of the industries' products?)

<1-10> RECORD ACTUAL NUMBER FROM 1 TO 10
<88> DK

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

How easy do you think it is for people to avoid exposure to air pollution from industry? (If 1 means not at all easy and 10 means very easy), (What number from 1 to 10 best describes how easy it is for people to avoid exposure to air pollution from industry?)

<1-10> RECORD ACTUAL NUMBER FROM 1 TO 10
<88> DK

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 FROM 1 TO 10
<88> DK

How long do you think it would be before the program to reduce industrial air pollution 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 reduce industrial air pollution would begin to save lives?)

<1-10> RECORD ACTUAL NUMBER FROM 1 TO 10
<88> DK

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

How much do you think people are to blame for being exposed to industrial air pollution? (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 people are to blame for being exposed to industrial air pollution?)

<1-10> RECORD ACTUAL NUMBER FROM 1 TO 10
<88> DK

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

How likely do you think it is that industrial air pollution 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 industrial air pollution will cause a health problem for you or for someone in your family?)

<1-10> RECORD ACTUAL NUMBER FROM 1 TO 10
<88> DK

APPENDIX C

Survey Design

Branching pattern of program pairs. Each respondent was faced with two pairs of programs. In order to avoid presenting the respondent with the same program in both pairs, a computerized procedure matched program pairs so that no two pairs had a program in common. For instance, no respondent would face Pair 1(Smoking Education - Industrial Air Pollution programs) and Pair 4 (Industrial Air Pollution Pneumonia Vaccine Programs.)
More specifically, no respondent could be faced with :

Pairs 1 and 4: Smoking Education and Industrial Pollution Programs
Industrial Pollution and Pneumonia Vaccine Programs;
Pairs 5 and 6: Radon Eradication and Smoking Ban Programs
Radon Eradication and Pesticide Ban Programs;
Pairs 1 and 5: Smoking Education and Industrial Pollution Programs
Radon Eradication and Smoking Ban Programs

Design Values. Respondents were given program pairs where, initially, both programs in a pair saved the same number of lives for the same cost. After the respondent had made his choice, the alternate program was presented as saving more lives than the one he chose initially. If the respondent chose Program A in any pair, then Program B was alleged to save [x] times as many lives as Program A. Similarly, for a respondent who initially chose B, Program A was presented as saving [y] times as many lives as Program B. For each program pair, **nine** x and y values were selected to which respondents were randomly assigned. Analysis of a pretest of 200 respondents helped in selecting the design values for each pair. The design values and the lives saved ratios (X_A / X_B) are given in Table C.1 below.

TABLE C.1

CHOICE OF DESIGN VALUES AND THE RATIO OF LIVES SAVED (X_A/X_B)

Pair 1 Smoking Education Versus Industrial Air Pollution

	x values				y values				
Design values	50	10	5	3	3	5	10	50	100
X_A/X_B	0.02	0.1	0.2	0.33	3	5	10	50	100

Pair 2 Colon Cancer Screening Versus Drinking Water Pollution

	x values			y values					
Design Values	5	3	2	2	3	5	10	50	100
X_A/X_B	0.2	0.33	0.5	2	3	5	10	50	100

Pair 3 Dual Airbags Versus Automobile Emissions

	x values				y values				
Design Values	50	10	3	2	3	5	10	50	100
X_A/X_B	0.02	0.1	0.33	0.5	3	5	10	50	100

Note: X_A = Number of lives saved by Program A
X_B = Number of lives saved by Program B

Pair 4 Industrial Air Pollution Versus Pneumonia Vaccine

	x values							y values	
Design Values	300	100	50	10	5	3	2	50	100
X_A / X_B	.003	0.01	0.02	0.1	0.2	5	10	50	100

Pair 5 Radon Versus Smoking Ban In The Workplace

	x values			y values					
Design Values	50	10	3	2	3	5	10	50	100
X_A / X_B	0.02	0.1	0.33	2	3	5	10	50	100

Pair 6 Radon versus Pesticide Ban

	x values			y values					
Design Values	20	5	2	5	10	50	100	200	500
X_A / X_B	0.05	0.2	0.5	5	10	50	100	200	500

Note: X_A = Number of lives saved by Program A
X_B = Number of lives saved by Program B

APPENDIX D

Statistical Methods Used to Analyze Double-Sampled Data

Dichotomous choice questions that ask the respondent to make a choice between two programs have the advantage that they are relatively easy to answer. But, the amount of information obtained by this approach is limited. One obtains only an upper or lower bound to willingness to pay (WTP). Hanemann et al. (1991) show that it is possible to increase the statistical efficiency of the estimates of the parameters by using a double-sampling strategy. That is, individuals are faced with two rounds of bidding. Respondents are faced with a first dollar amount. Then, depending on their answer to this bid, the dollar amount is raised or lowered and presented to the respondent again, thereby tightening the bounds on the individual's WTP.

In this survey the individual is first asked to choose between Programs A and B, given that both programs save the same number of lives, or that the ratio of lives saved by both programs equals 1,

$$X_{Ai}^{1}/X_{Bi}^{1} = 1 = \frac{\text{Number of lives saved by Program A in first round}}{\text{Number of lives saved by Program B in first round}}$$

Suppose the individual chooses Program A. Then a second question is asked where the ratio of lives saved is changed so that Program A saves fewer lives,

$$X_{Ai}^{2}/X_{Bi}^{1} < 1.$$

Similarly if the person chooses Program B then in the second question the number of lives saved by Program B is lowered so that the new ratio of lives saved by Programs A and B--

$$X_{Ai}^{1}/X_{Bi}^{2} > 1$$

With this approach four possible outcomes are possible:

Option 1. Program A - Program A
Option 2. Program A - Program B
Option 3. Program B - Program B
Option 4. Program B - Program A

Let π_{AA}, π_{AB}, π_{BB} and π_{BA} be the likelihood of these outcomes respectively. If the respondent chooses Option 1--i.e. program A in both the questions--

$$\pi_{AA} = \Pr\{\, \varepsilon/\sigma < 1/\sigma \ln(X_{Ai}^{1}/X_{Bi}^{1}) + \beta'/\sigma \ln(C^{Ai}/C^{Bi}) \text{ and } \varepsilon/\sigma < 1/\sigma \ln(X_{Ai}^{2}/X_{Bi}^{1}) + \beta'/\sigma \ln(C^{Ai}/C^{Bi}) \,\}$$

$$=F[\ 1/\sigma \ln(X_{Ai}^{2}/X_{Bi}^{1}) + \beta'/\sigma\ (\ln (C^{Ai}/C^{Bi})]$$

Expressions for π_{AB}, π_{BB}, and π_{BA} can be derived similarly,

$$\pi_{AB} = F[\ \beta'/\sigma\ (\ \ln (C^{Ai}/C^{Bi})] - F[1/\sigma \ln(X_{Ai}^{2}/X_{Bi}^{1}) + \beta'/\sigma\ (\ln (C^{Ai}/C^{Bi})]$$
$$\pi_{BB} = F[1/\sigma \ln(X_{Ai}^{1}/X_{Bi}^{2}) + \beta'/\sigma\ (\ln(C^{Ai}/C^{Bi})] - F\ [\beta'/\sigma\ (\ln (C^{Ai}/C^{Bi})]$$
$$\pi_{BA} = 1 - F[\ 1/\sigma \ln(X_{Ai}^{1}/X_{Bi}^{2}) + \beta'/\sigma\ (\ \ln (C^{Ai}/C^{Bi})]$$

Given a sample of N respondents, the log likelihood function takes the form:

$$\ln L_D = \sum_{i=1}^{N} \{r_{AA}^{i} \ln\pi_{AA} + r_{AB}^{i} \ln\pi_{AB} + r_{BB}^{i} \ln\pi_{BB} + r_{BA}^{i} \ln\pi_{BA}\}$$

Where

r_{AA}^{i} = 1 if the respondent i chooses Program A in both the questions
= 0 otherwise

r_{AB}^{i} = 1 if the respondent i chooses Program A in the first round and then switches in the second question
= 0 otherwise

r_{BB}^{i} = 1 if the respondent i chooses Program B in both the questions
= 0 otherwise

r_{BA}^{i} = 1 if the respondent i chooses Program B in the first round and then switches in the second question
= 0 otherwise

The parameters of this function can be estimated using maximum likelihood estimation techniques.

APPENDIX E
Estimates for Individual Program Pairs (t-statistics in parentheses)
Table E.1

	Smoking Education vs. Industrial Air Poll.	Colon Cancer Screening vs. Drinkg water	Airbags vs. Auto Emissions	Industrial Air Pollution vs. Pneum. Vaccine	Radon vs. Smoking Ban	Radon vs. Pesticide Ban	Expected Sign
Intercept	-0.0801 (-0.29)	-0.155 (-0.74)	0.218 (0.89)	0.146 (0.50)	-0.025 (-0.092)	**-0.824** **(-2.11)**	
Efficacy of Program	**0.765** **(3.21)**	0.303 (1.48)	**0.621** **(3.32)**	0.252 (1.08)	**0.873** **(3.75)**	0.181 (0.56)	Positive
Seriousness of Risk	**0.864** **(3.12)**	**0.89** **(7.53)**	**0.662** **(5.31)**	**0.504** **(2.87)**	**0.351** **(1.85)**	**0.754** **(3.16)**	Positive
Appropriateness of Government Intervention	**0.406** **(2.04)**	**0.239** **(2.11)**	**0.367** **(3.32)**	**0.365** **(2.38)**	**0.282** **(2.44)**	0.265 (1.02)	Positive
Fairness of Program Funding	0.141 (1.09)	0.052 (0.74)	0.157 (1.57)	**0.182** **(1.71)**	0.026 (0.28)	0.177 (1.5)	Positive
Ease with which Risk can be Avoided	0.005 (0.061)	-0.011 (-0.17)	**-0.243** **(-4.08)**	**-0.179** **(-2.23)**	-0.096 (-1.38)	-0.084 (-0.89)	Negative
Time Lag Before Program save lives	-0.111 (-1.18)	-0.042 (-0.59)	-0.005 (-0.07)	-0.113 (-1.4)	-0.053 (-0.61)	-0.049 (-0.35)	Negative
Extent to Which Program Beneficiary is to Blame	-0.062 (-0.91)	0.065 (1.13)	-0.047 (-0.72)	-0.047 (-0.6)	-0.027 (-0.43)	0.074 (0.66)	Negative
Respondent at Risk	0.038 (0.49)	-0.105 (-1.39)	**0.136** **(1.94)**	0.071 (0.9)	**0.238** **(2.55)**	0.135 (1.22)	Positive
Other Benefits from A	**0.273** **(1.71)**	0.197 (1.43)	0.091 (0.688)	**0.374** **(2.37)**	0.181 (1.02)	0.415 (1.28)	Positive
Other Benefits from B	**-0.317** **(-1.87)**	**-0.272** **(-2.01)**	**-0.321** **(-2.62)**	**-0.327** **(-2.09)**	-0.131 (-0.87)	-0.029 (-0.13)	Negative
Lives Saved Ratio	**0.392** **(16.57)**	**0.553** **(23.1)**	**0.358** **(20.12)**	**0.477** **(16.77)**	**0.429** **(17.03)**	**0.375** **(13.83)**	Positive

Table E.2
Estimates for Individual Program Pairs

	Smoking Education vs. Industrial Air Poll	Colon Cancer Screening vs. Drinkg water	Airbags vs. Auto Emissions	Industrial Air Pollution vs. Pneum Vaccine	Radon vs. Smoking Ban	Radon vs. Pesticide Ban
Intercept	0.84 (1.27)	**0.696** **(1.93)**	0.112 (0.29)	0.129 (0.26)	-0.338 (-0.69)	0.136 (0.25)
Efficacy of Program	**0.759** **(3.17)**	0.356 (1.71)	**0.618** **(3.3)**	0.242 (1.01)	**0.867** **(3.69)**	0.127 (0.38)
Seriousness of Risk	**0.859** **(3.15)**	**0.879** **(7.37)**	**0.662** **(5.21)**	**0.51** **(2.87)**	0.353 (1.82)	**0.728** **(2.83)**
Appropriateness of Government Intervention	**0.379** **(1.92)**	**0.219** **(1.93)**	**0.366** **(3.27)**	**0.366** **(2.32)**	**0.282** **(2.39)**	0.246 (0.84)
Fairness of Program Funding	0.176 (0.13)	0.064 (0.92)	0.157 (1.58)	0.165 (1.49)	0.019 (0.21)	0.158 (1.3)
Ease with which Risk can be Avoided	0.019 (0.25)	-0.004 (-0.06)	**-0.245** **(-4.02)**	**-0.183** **(-2.29)**	-0.097 (-1.37)	-0.108 (-1.13)
Time Lag Before Program Saves Lives	-0.119 (-1.27)	-0.058 (-0.8)	-0.005 (-0.07)	-0.099 (-1.2)	-0.055 (-0.63)	-0.038 (0.27)
Extent to which program beneficiary is to blame	-0.073 (-1.03)	0.053 (0.9)	-0.047 (-0.71)	-0.047 (-0.6)	-0.022 (-0.35)	0.059 (0.52)
Respondent at Risk	0.042 (0.53)	-0.106 (-1.39)	**0.138** **(1.95)**	0.077 (0.93)	**0.234** **(2.5)**	0.148 (1.24)
Other Benefits from A	0.286 (1.8)	0.22 (1.55)	0.092 (0.69)	**0.406** **(2.56)**	0.156 (0.87)	0.385 (1.21)
Other Benefits from B	-0.316 (-1.88)	-0.244 (-1.75)	**-0.323** **(-2.6)**	**-0.337** **(-2.09)**	-0.142 (-0.94)	0.035 (0.14)
Program A costs more	-0.416 (-1.05)	-0.179 (-1.3)	0.037 (0.19)	-0.15 (-0.95)	0.127 (0.78)	-0.45 (-1.84)
Program B costs more	**-0.311** **(-1.91)**	**-0.602** **(-3.65)**	0.046 (0.37)	0.183 (0.66)	0.146 (0.59)	-0.393 (-1.53)
Lives Saved Ratio	**0.396** **(15.87)**	**0.567** **(22.73)**	**0.358** **(19.83)**	**0.479** **(16.83)**	**0.429** **(16.99)**	**0.379** **(13.86)**

APPENDIX F

Model Predictability

The matrices on the following page compare actual and predicted program choices for respondents based on two models. In Table F.1 respondents' choices are predicted using the pooled model described in the text, including all measured program characteristics. In Table F.2, respondents' choices are predicted using only the ration of lives saved.

The sum of the elements of along the diagonal of each of the matrices indicates the number of times the model's predictions are correct. When all the eight qualitative variables are included along with the *Lives Saved Ratio* and the *Other Benefit* variables, the model predicts correctly 36.6% of the time. With all the qualitative characteristics **excluded**, when the *Lives Saved Ratio* is included as the **only** explanatory variable, the predictive power of the model drops to 29.7%, implying that including the qualitative characteristics improves the ability of the econometric model to predict correctly.

Several other points about Table F.1 and F.2 are worth noting:

There is a tendency to overpredict program B rather than program A in the first question. The model predicts 1,111 persons as choosing B when in reality only 937 respondents chose program B. Also, the number of times the model incorrectly predicts a respondent as choosing B, in the first question, is more frequent than the number of times it wrongly predicts a person as choosing program A.

The model also tends to under-predict the number of switches in the second choice question for both programs A and B. That is, respondents are divided almost evenly between AA and AB by the model prediction. Similarly, BA and BB are predicted to be almost even. But in reality, 66% of those who chose A initially and 60% of those who chose B in the first question switched preference when the second choice question was asked.

When all qualitative variables are excluded and only the *Lives Saved Ratio* is included in the model, the tendency to over predict program B is aggravated. The number predicted as choosing program B (BB + BA) is 1,477 instead of the actual 937 persons. Again, the number of times the model falsely predicts the choice of Program B exceeds the number of times the model falsely predicts the choice of program A.

Table F.1

ACTUAL v. PREDICTED CHOICES
ALL QUALITATIVE VARIABLES INCLUDED IN THE MODEL

Predicted

		AA	AB	BA	BB
	AA	94	69	57	39
Actual	AB	137	116	145	105
	BA	63	58	233	205
	BB	21	30	148	179

Table F.2

ACTUAL v. PREDICTED CHOICE
LIVES SAVED RATIO IS THE ONLY EXPLANATORY VARIABLE

Predicted

		AA	AB	BA	BB
	AA	12	28	100	119
Actual	AB	14	64	202	223
	BA	14	50	265	230
	BB	9	31	174	164

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