Paying for Permanence: Public Preferences for Contaminated Site Cleanup

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Summary

We use conjoint choice questions to investigate people's preferences for income and reductions in mortality risks delivered by contaminated site remediation policies. Our survey is self-administered using the computer by residents of four cities in Italy with severely contaminated sites. We estimate the Value of a Statistical Life to be about €5.6 million for an immediate risk reduction. If the risk reduction takes place 20 years from now, however, the implied VSL is about €1.26 million. The discount rate implicit in the responses to the conjoint choice questions is about 7%. People *are* willing to pay for permanent risk reductions, but not just *any* amount. Risk reductions in the nearer future are valued more highly than risk reductions in the more distant future. We also find that the VSL is "individuated," in the sense that it depends on observable individual characteristics of the respondents, familiarity with contaminated sites, concern about the health effects of exposure to toxicants, having a family member with cancer, perceived usefulness of possible government actions, and the respondent's beliefs about the goals of government remediation programs. Additional questions suggest that respondents discount *lives*, and do so at a discount rate in the ballpark of that implicit in their risk v. money tradeoffs.

Keywords: Value of a Statistical Life, Latent Risk Reductions, Individual Discount Rates, Conjoint Choice Questions, Contaminated Sites, Remediation

JEL Classification: J17,I18, K32, Q51, Q53

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by

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1. Introduction and Motivation

Many environmental programs require the agency in charge to set emissions or ambient quality standards. In the case of programs addressing contaminated sites, key decisions involve (i) to what extent pollution must be removed from soil, the subsurface and groundwater in order to protect human health, and (ii) whether contaminants should be removed, as opposed to implementing remedies that simply prevent human exposure to contaminants and/or off-site migration of the polluting substances in the short term. These are serious challenges in the U.S. Superfund program and in similar programs in other countries.

Clearly, it would useful to compare the (monetized) value of more permanent reductions in the risks to human health with the costs of treating contaminated soil, groundwater and surface water. Doing so requires finding out how much the beneficiaries of these risk reductions are willing to pay to obtain them.

Because contaminated sites often entail exposure to carcinogens and other toxicants with long-term effects on health, the reductions in risks to human health delivered by remediation must be paid for now but are accrued in the future. It is thus of interest to find out if the willingness to pay for risk reductions is affected by such a delay ("lag"), and, if so by how much. In this paper, we focus on the risks of dying associated with exposure to contaminants at hazardous waste sites and use conjoint choice questions

(Hanley et al., 2001) to answer this question and to explore people's preferences for permanent remediation, and hence permanent risk reductions. We then illustrate the use of this approach with a sample selected to be representative of the residents of four cities in Italy with significant contaminated site problems.

We ask three related questions. First, how much are people willing to pay for each unit of mortality risk reduction? In other words, what is the public's Value of a Statistical Life (VSL) that should be used for computing the benefits of contaminated site policies that save lives? Second, do people favor permanent cleanup policies, and are they willing to pay more for longer-lasting risk reductions? Third, what is the effect on willingness to pay of delaying the beginning of the mortality risk reductions?

Although the concept of VSL is reasonably well accepted in academic and policy circles, and the VSL has been estimated using a variety of approaches,[1] there is surprisingly little empirical evidence about what VSL should be used in the context of contaminated site remediation. Gayer et al. apply the hedonic pricing approach to homes sold in the vicinity of Superfund sites in Grand Rapids, Michigan, and estimate the value of a statistical case of cancer is \$3.9-4.6 million (1996 dollars) (Gayer et al., 2000) or \$4.3-8.3 million (Gayer et al., 2002). These values rely on specific assumptions about people's subjectively assessed risks and about how they change in response to the release of information by the agency.

Recent research (e.g., Chilton et al., 2002; Tsuge et al., 2005; Vassanadumrongdee and Matsuoka, 2005) has examined the effects of risk perceptions—such as dread, degree of voluntariness, etc. (Fischoff et al., 1978; McDaniels et al.,

[1] See Ashenfelter (2006) for a recent discussion of the VSL and Viscusi (2003) for an overview of VSL figures estimated in compensating wage studies.

1992)—on the value of reducing these risks, but results are mixed, so it is unclear if, and by how much, existing VSL estimates from other contexts should be adjusted to cater to hazardous waste site risks.

For these reasons, we use a stated-preference approach to elicit the tradeoffs that people make between income and risk reductions in the hazardous waste site context. Specifically, we showed people pairs of hypothetical public programs described by five attributes—the annual risk reduction afforded by the program, the size of the population living in the area with the contaminated sites that would be addressed by the program, how soon such risk reductions would be observed, the number of years over which the risk reduction would be observed (and hence lives would be saved), and the cost to the taxpayer. We then asked them to indicate (i) which they would prefer out of these two programs, and (ii) which they would prefer, program A, program B, or neither.

Statistical modeling of the responses to (i) and (ii) allows us to estimate the VSL—the first of our research questions. In addition, it allows us to answer two related questions: In the context of contaminated site policies, is the VSL affected by the individual characteristics of the respondent? Are the responses to the choice questions and the implied WTP figures internally valid, in the sense that they depend in predictable ways on variables suggested by economic theory and confirm opinions expressed by the respondent elsewhere in the questionnaire?

Because the time it takes before lives are saved and the number of years over which lives would be saved are varied to the respondents, the responses to the conjoint choice questions can be used to estimate the rate at which people discount future risk reductions. Were such a rate found to be low, we would conclude that people care for permanent risk reductions, and that their WTP for risk reductions is little affected by the lag until the risk reductions are incurred. The opposite conclusions would be reached if the discount rate was found to be relatively high.

Earlier research has estimated the rates at which people discount lives saved in the future (Cropper et al., 1991, 1992) and the rates at which people trade off current income for future reductions in their own risk of dying (Horowitz and Carson, 1990; Moore and Viscusi, 1990; Hammitt and Liu, 2004; Alberini et al., 2006), but to our knowledge none of these studies are specific to or easily adapted to contaminated site cleanup policies. None of them asked how much more people are prepared to pay for permanent risk reductions.[2]

In this study, we pay special attention to the internal validity of the responses, so we inquire about people's preferences for permanence through direct attitude questions. We also compare the discount rate estimated from money v. risk tradeoffs with that at which people discount *lives*.

Finally, we note that by including among the attributes of the hypothetical programs the size of the population living in the areas with the targeted contaminated sites, we explore the question whether people care more for small risk reductions spread over a large population or for larger risk reductions that affected a smaller population. Here, attention is restricted to the hazardous waste site context, but this question is also of great interest when comparing, say, air pollution policies, where the risk reductions are small and cover a very large population, with other environmental policies targeted at very specific populations.

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[2] Viscusi and Huber (2006) estimate the rate at which people discount the future benefits of clean water policies in the US.

The remainder of the paper is organized as follows. In section 2, we describe key concepts, including the VSL, and our methodology, including the conjoint choice questions and the model of the responses to these questions. Section 3 describes the survey questionnaire and the administration of the survey. Section 4 presents the data and estimation results. Section 5 concludes.

2. Key Concepts, Methods and Models

A. What is the The Value of a Statistical Life?

The VSL is the marginal value of a reduction in the risk of dying, and is therefore defined as the rate at which people are prepared to trade off income for a risk reduction:

$$VSL = \frac{\partial WTP}{\partial R} \quad , \tag{1}$$

where WTP signifies the willingness to pay for a change in the risk of dying, and R is the risk of dying. The VSL can be equivalently described as the total WTP by a group of N people experiencing a uniform reduction of 1/N in their risk of dying. To illustrate, consider a group of 10,000 individuals, and assume that each of them is willing to pay €30 to reduce his or her own risk of dying by 1 in 10,000. The VSL implied by this WTP is €30/0.0001, or €300,000.

The concept of VSL is generally deemed as the appropriate construct for ex ante policy analyses, when the identities of the people whose lives are saved by the policy are not known yet. The mortality benefits of a policy that saves L lives are equal to (VSL×L).

B. Policy Relevance

Because hazardous waste site programs purport to eliminate or reduce threats to public health and to reduce mortality risks, the VSL is a relevant concept when one wants to estimate the benefits of one such program and compare them with its costs. In the US, the Superfund statute spells out cleanup criteria to be adopted at the most egregious contaminated sites in the nation, which are placed on the so-called National Priorities List and may qualify for publicly financed cleanup.[3]

Specifically, EPA managers are directed to select target risk reductions to protect human health and meet any “legally applicable” or “relevant and appropriate” standards (e.g., maximum contaminant limits in groundwater), regardless of cost (Revesz and Stewart, 1995). When selecting among alternative remedies that attain the selected target risk reduction, consideration must be given to cost-effectiveness, practicable technologies *and* permanent remediation—as opposed to simple containment to prevent migration of pollutant and to limit exposure. Permanent remedies are generally more expensive, but Gupta et al. (1996) find that the EPA has indeed heeded this preference for permanent cleanups in its remediation decisions.[4]

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[3] The Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, commonly dubbed “Superfund”) was passed in 1980 to address the problem of hazardous waste sites and the risks they pose to human health and ecological systems. The Superfund program provides for both emergency, short-term “removals” and remedial actions, which imply more or less permanent measures to reduce contamination. The statute also created an extensive and far-reaching liability system. The courts have interpreted the Superfund liability to be strict, retroactive, and joint-and-several. The liability system (and hence cleanup financing), cleanup processes and targets have been debated since the onset of the program. See, among others, Barnett (1994), Harper and Adams (1996), Hird (1994), Revesz and Stewart (1995), Viscusi and Hamilton (1999), Hamilton and Viscusi (1999), and Probst and Konisky (2001).

[4] Gupta et al. (1996) empirically examine the preferences for permanence implicit in EPA’s cleanup decisions at 110 wood preserving and PCB-contaminated Superfund sites. They focus on the choice of cleanup technology for contaminated soil, where the least permanent and expensive option is to simply cap the soil, and more permanent and more expensive options typically including excavating the soil and placing it in approved landfill or treating it. Gupta et al. find that the EPA does have a preference for more permanent cleanup options, but not at any cost, in the sense that the agency is less likely to choose a more permanent remedy as the cost of the remedy increases. Still, the agency values permanence, in that the premium it attaches to on-site incineration of waste (over and above the cost of capping it) is $12 million (1987 dollars) at relatively small sites, and up to $40 million at large sites.

Recent state programs, however, seem to be reversing this preference for permanence. State voluntary cleanup programs, for example, offer a variety of incentives in exchange for site cleanup (Meyer, 2000; US General Accounting Office [GAO], 1997), including simplified or variable cleanup standards linked to land use, engineering controls (e.g., caps, fences, or other physical means of preventing contact with pollution), and/or institutional controls, such as permanent land use restrictions at the site or monitoring of the contamination plume, in place of (more stringent) cleanups. The US GAO (1997) surveyed 17 state VCP programs and found that over 50% of the cleanups entailed non-permanent remedies and/or adopted industrial land use standards.

Several European countries face similar dilemmas. In Italy, for example, legislation addressing hazardous waste sites was first passed in 1997. The statute contains an explicit preference for permanent remediation and for on-site treatment of contaminated media, but recent analyses conducted by the Italian Environmental Protection Agency and environmental organizations (APAT, 2004; Legambiente, 2005) point out that the majority of actions at NPL and non-NPL contaminated sites have, thus far, been short-term and impermanent. For several reasons—because this outcome potentially conflicts with the European Union's sustainability goals, because the Italian law places the burden of remediation at orphan sites on municipalities,[5] because funding for cleanup is limited,[6] and because of a recent law that emphasizes the role of risk

[5] Unlike its US counterpart, the Italian Superfund statute is not retroactive. The law provides for "orphan" sites—sites where the party responsible for the contamination is insolvent or no longer in existence, placing the burden on these sites on the municipalities.

[6] The estimated cleanup costs for the sites on the Italian NPL are €3,149 million, but the available public funding tops off at €541 million.

assessment[7]—it is important to study people's preferences for more or less permanent risk reductions and to elicit the VSL in this context.

C. Our Conjoint Choice Questions

Conjoint choice questions (also termed "experiments") are a survey-based technique frequently used to place a value on a good or estimate the benefits of a public program. The approach is based on stated preferences, in the sense that it asks individuals what they would do under hypothetical circumstances, rather than observing actual behaviors on marketplaces.

In a conjoint choice survey, a good or public program is described in a stylized fashion by a vector of attributes. Respondents are shown K alternative variants of this good or program obtained by taking combinations of the possible values of the attributes, and are asked to choose the most preferred (Hanley et al., 2001). The alternatives differ from one another in the levels taken by two or more of the attributes. An advantage of this method is that it is flexible and that it can span goods/programs, levels of risk reductions and other aspects of environmental quality that do not currently exist.

Respondent choices are assumed to be motivated by a random utility model and to trade off the attributes of the alternatives. If one of the attributes of the alternatives is its cost, it is possible to calculate the marginal price of each attribute. If a "do nothing" or status quo option is included in the choice set, the choice experiments can be used to estimate the full value of—i.e., the WTP for—each alternative.

[7] The new law (Decree N. 152/06, which went into force on April 29, 2006) places a major emphasis on risk assessment, which is to be done when the level of contamination in soil or water exceeds the maximum limit set by the law.

In our conjoint choice questions, respondents are asked to consider hypothetical public programs that would clean up sites where the responsible parties are no longer in existence or do not have the means to pay for remediation. Respondents are also told that the government would be in charge of the remediation programs, and that the programs would be guaranteed to be effective.

The specifics of the programs are described using five attributes, namely (i) the risk reduction per year, (ii) the size of the population living in the areas with the contaminated sites targeted by the program, (iii) the delay until the risk reduction begins, (iv) the number of years over which the risk reduction would be observed, and (v) the cost of the program to the respondent, which would be incurred as an immediate, and one-time, tax. Clearly, attribute (iii) gets at the heart of the latency issue,[8] and attribute (iv) captures the degree of permanence of the risk reductions.[9]

The respondents are shown a total of four pairs of hypothetical programs constructed in this fashion. They are first asked to indicate which of the two programs—A or B—they prefer, and then indicate which they would choose out of program A, program B, or neither. This results in a total of 8 conjoint choice questions where the size of the choice set is 2 (when choosing between A and B) or 3 (when choosing between A, B, and the status quo).

[8] By latency, we refer to a future risk reduction. In this paper, the terms "lag" and "latency" are used interchangeably.

[9] DeShazo and Cameron (2005), Tsuge et al. (2005), and Itaoka et al. (2006) are other recent applications of the conjoint choice approach to value mortality risk reductions. DeShazo and Cameron ask respondents to choose between profiles defined by expected lifetime, risk, illness and recovery, and cost to the respondent. Tsuge et al. ask people to choose between two stylized government programs described by cost, size of the risk reduction, type of risk (accident, cancer, heart disease, or a generic type of risk), and latency, finding that the VSL is not sensitive to the type of risk, but does vary with latency and individual characteristics of the respondent. Itaoka et al. compare low probability/large loss events with higher probability/small loss events in the context of electric power generation in Japan.

An example of the conjoint choice questions is reported in Appendix A, and a summary of attributes and levels is reported in table 1. In earlier focus groups and one-on-one tests, people had generally deemed these attributes and attribute levels reasonable and acceptable. We emphasize that the risk reductions were presented to the respondents as the number of lives saved per million people (from the mortality rate due to contaminated site exposures in the absence of cleanup).

Table 1. Attributes and attribute levels in the conjoint choice questions.

Attribute	**Levels of the attribute**
Lives saved per million people (ΔR)	10, 20, 30
Population living in the areas with the contaminated sites covered by the program (N)	0.5 million, 1 million, 2 million
Delay (number of years until the risk reduction is incurred) (A)	2, 10
Duration of the health benefits (number of years) (T)	20, 30, 45
One-time tax payment for the respondent's household (C) (in euro)	50, 100, 300, 500, 950

That risk reductions will be realized no earlier than two years from now (attribute (ii) or "Delay" in table 1) is consistent with the notion that the pollutants at most contaminated sites are carcinogens or cause long-term health effects, and with the fact that it takes some time to complete even the most efficient government remediation program. It is also reasonable to assume that no remediation program can reduce risks forever: hence, we set the duration of the risk reductions at 20, 30 or 45 years. These may be interpreted as time to failure of the remedies. The delay and duration attributes provide variation in the timing of the mortality risk reductions across and within respondents, which we exploit for the purpose of estimating the rate at which people discount future risks.

We chose a one-time tax to be incurred immediately for two reasons. First, since risk reductions are incurred in the future, this allows us to estimate the rate at which people discount risks. Second, in focus groups and during the survey development work people voiced strong opinions against taxes and against committing to pay annual taxes over a long period of time. We certainly did not want people to dismiss our scenarios outright, and a one-time tax was the most appealing option.

We also vary the size of the population living in the areas with the contaminated sites that would be addressed by the program, and hence potentially affected by the risk reductions. We chose hypothetical populations of 0.5, 1 and 2 million because these levels were judged credible by focus groups participants, especially when compared with the total population living in areas with NPL sites (7 million; see section 3), and because we felt that respondents could easily form a sense of the size of these populations by comparing them with those of the cities they live in.

We created a total of 32 sets with four pairs of programs each. We began this task by creating all of the possible alternative programs (i.e., all possible combinations of the levels of the attributes). We then formed all of the possible pairs, but excluded pairs that contained dominated alternatives.[10] The 32 sets we used for the survey were obtained by selecting four pairs at random (without replacement) out of this universe of non-dominated pairs. Respondents were randomly assigned to one of the 32 sets.

[10] A pair has a dominated alternative if one of them is obviously better (e.g., saves more lives over a longer period of time) and no more expensive than the other.

D. The Model

We assume that in the conjoint choice questions our respondents choose the alternative with the highest indirect utility, and that the indirect utility depends on the discounted stream of risk reductions and on residual income. Formally,

(2) $$\overline{V}_{ij} = \alpha \cdot DR + \beta(y_i - C_{ij}),$$

where $\overline{V}_{ij}$ denotes the deterministic component of the indirect utility function, DR is the discounted flow of risk reductions delivered by program j, y is income and C is the cost of the program to the respondent. Coefficients α and β denote the marginal utility of the discounted flow of risk reductions and the marginal utility of income, respectively. We assume constant exponential discounting and define DR as

(3) $$DR = \exp(-\delta A) \cdot \int_0^T \Delta R \cdot \exp(-\delta t)dt = \Delta R \cdot e^{-\delta A}\left[\frac{1-e^{-\delta T}}{\delta}\right],$$

where ΔR is the annual risk reduction (which is varied to the respondents but constant over the years), δ is the discount rate, A is the number of years one must wait before the risk reductions are observed, and T is the number of years over which lives are saved. Expression (3) shows the effect of a delay in the beginning of the risk reduction (captured by the term $e^{-\delta A}$) and the effect of more or less permanent risk reductions (captured by term in brackets).

On appending an error term ε_{ij}, equation (2) becomes a random utility model, which in turn results in a conditional logit model if we further assume that the error terms ε_{ij} are independent across alternatives within the same respondent and follow the standard type I extreme value distribution. The probability that option k is selected out of K alternatives when answering a choice question is thus

$$\text{(4)} \qquad \Pr(k) = \frac{\exp(\overline{V}_{ik})}{\sum_{j=1}^{K} \exp(\overline{V}_{ij})},$$

and the log likelihood function of our sample is

$$\text{(5)} \qquad \log L = \sum_{i=1}^{n} \sum_{m=1}^{M} \sum_{k=1}^{K_m} y_{mik} \cdot \log \Pr(i \text{ chooses } k \text{ in choice question } m)$$

$$= \sum_{i=1}^{n} \sum_{m=1}^{M} \sum_{k=1}^{K_m} y_{mik} \cdot \log \frac{\exp(\overline{V}_{ikm})}{\sum_{j=1}^{K_m} \exp(\overline{V}_{ijm})},$$

where y_{imk} is a binary indicator that takes on a value of 1 if the respondent *i* selects alternative k in choice question m, and 0 otherwise, K_m denotes the number of the alternatives the respondent is faced with in choice question m, and M denotes the total number of choice questions asked of the respondent.[11] Equation (5) thus describes a non-linear conditional logit. It assumes that the choice responses are independent within and across respondents.

The maximum likelihood estimates of the coefficients can be used to compute the Willingness to Pay (WTP) for any given program:

$$\text{(6)} \qquad WTP = \frac{\hat{\alpha}}{\hat{\beta}} DR.$$

The VSL, i.e., the willingness to pay for a marginal risk reduction to be incurred in the current year, is equal to $(\hat{\alpha} / \hat{\beta})$.

[11] We remind the reader that individuals faced a total of four pairs of programs. For each pair of programs, the respondent was asked two choice questions: (i) which of the two programs—A or B—is judged more attractive, and (ii) which is the most preferred option—program A, program B, or neither (the status quo)? This results in a total of eight conjoint choice questions, hence M=8, K_m=2 for m=1, 3, 5, and 7, and K_m=3 for m=2, 4, 6, and 8.

E. Hypotheses

Clearly, model (2)-(3) assumes that the VSL is constant with respect to the size of the risk reduction and the size of the population that would benefit from the cleanup. In this paper, we wish to test if the VSL does indeed vary with the number of beneficiaries of the program. To do so, we amend equation (2) to obtain:

$$\overline{V}_{ij} = \alpha_1 \cdot DR_{0.5} + \alpha_2 \cdot DR_1 + \alpha_3 \cdot DR_2 + \beta(y_i - C_{ij}), \tag{7}$$

where $DR_{0.5}$=DR if the size of the population affected by the program is 0.5 million and 0 otherwise, DR_1=DR if the size of the population affected by the program is 1 million and 0 otherwise, and DR_2=DR if the size of the population affected by the program is 2 million and 0 otherwise. We then test the null hypothesis that $\alpha_1 = \alpha_2 = \alpha_3$. Failure to reject the null implies that equation (7) is simplified to equation (2), i.e., the marginal utility of a risk reduction is not affected by the size of the population of beneficiaries of the program, N.

Another interesting null hypothesis is that $\alpha_2 = 2\alpha_1$ and $\alpha_3 = 2\alpha_2$. This null hypothesis implies that what enters in the utility function is the discounted number of *lives* saved, rather than discounted *risk*. The indirect utility function would thus be

$$\overline{V}_{ij} = \gamma \cdot L + \beta(y_i - C_{ij}), \tag{8}$$

where L is discounted lives saved:

$$L = \exp(-\delta A) \cdot \int_0^T \Delta R \cdot N \cdot \exp(-\delta t)dt = \Delta R \cdot N \cdot e^{-\delta A} \frac{1 - e^{-\delta T}}{\delta}. \tag{9}$$

Equations (8) and (9) mean that the VSL is strictly proportional to N, the size of the population living in the areas targeted by the hypothetical program.

We are also interested in testing whether the marginal utility of risk reductions and the marginal utility of income depend on individual characteristics. To see if this is the case, we amend equation (1) (or (6)) to allow for heterogeneity among the respondents.[12] Specifically, we posit that the marginal utility of risk reduction for respondent *i* is $\alpha_i = \alpha_1 + \mathbf{x}_i \boldsymbol{\alpha}_2$ and that the marginal utility of income is $\beta_i = \beta_1 + \beta_2 P_i$, where $\mathbf{x}_i$ is a vector of individual characteristics such as age, gender, education, own health, familiarity with contaminated sites and remediation, acceptance of government policies addressing hazardous waste sites, etc., and *P* is a low-income dummy. In other words, we form interaction terms between the arguments of equation (2)—DR and residual income—and $\mathbf{x}_i$ and *P*, respectively, and add these interactions in the right-hand side of the indirect utility function:

(10) $$\overline{V}_{ij} = \alpha_1 \cdot DR_{ij} + (DR_{ij} \times \mathbf{x}_i)\boldsymbol{\alpha}_2 + \beta_1 \cdot (y_i - C_{ij}) + \beta_2[(y_i - C_{ij})P_i].$$

Finally, it is possible to replace δ with a function of individual characteristics $\mathbf{z}_i$ of the respondent, such as age, whether he or she is married and has young children, etc.: $\delta_i = \mathbf{z}_i \pi$.

3. Structure of the Questionnaire and Survey Administration

Our conjoint choice questions are at the heart of our questionnaire and are accordingly placed roughly in the middle of the survey instrument. They are preceded by many other questions that *first* find out what people already know about specific problems or concepts (e.g., contaminated sites, health risks from exposure to

[12] As shown below, although we find that the marginal utility of risk reduction is different for different population sizes, in practice the VSL is constant with respect to population size. For this reason, we incorporate covariates only in the simpler specification of the indirect utility function, allowing α and β to vary across respondents but not across the size of population in the conjoint choice questions.

contaminants, remediation) or feel about policy options, and *then* educate them about risks, remediation techniques, etc.

The questionnaire is comprised of 5 sections. Section 1 begins with asking people whether and how they are acquainted with contaminated sites. Since a respondent's notion of contaminated site may be different from our own, we then provide the following definition: "A contaminated site is a parcel or an area with hazardous substances that pose risks to human health or the environment, now or in the future. These hazardous substances are the result of human activities. Electromagnetic fields/pollution and air pollution are not considered contaminated sites in this questionnaire." In section 2, we briefly describe the problem of contaminated sites in Italy and provide succint information about the total population living in areas with sites on the National Priorities List—the most egregious contaminated sites—and thus potentially exposed to contaminants, current legislation and government policies.

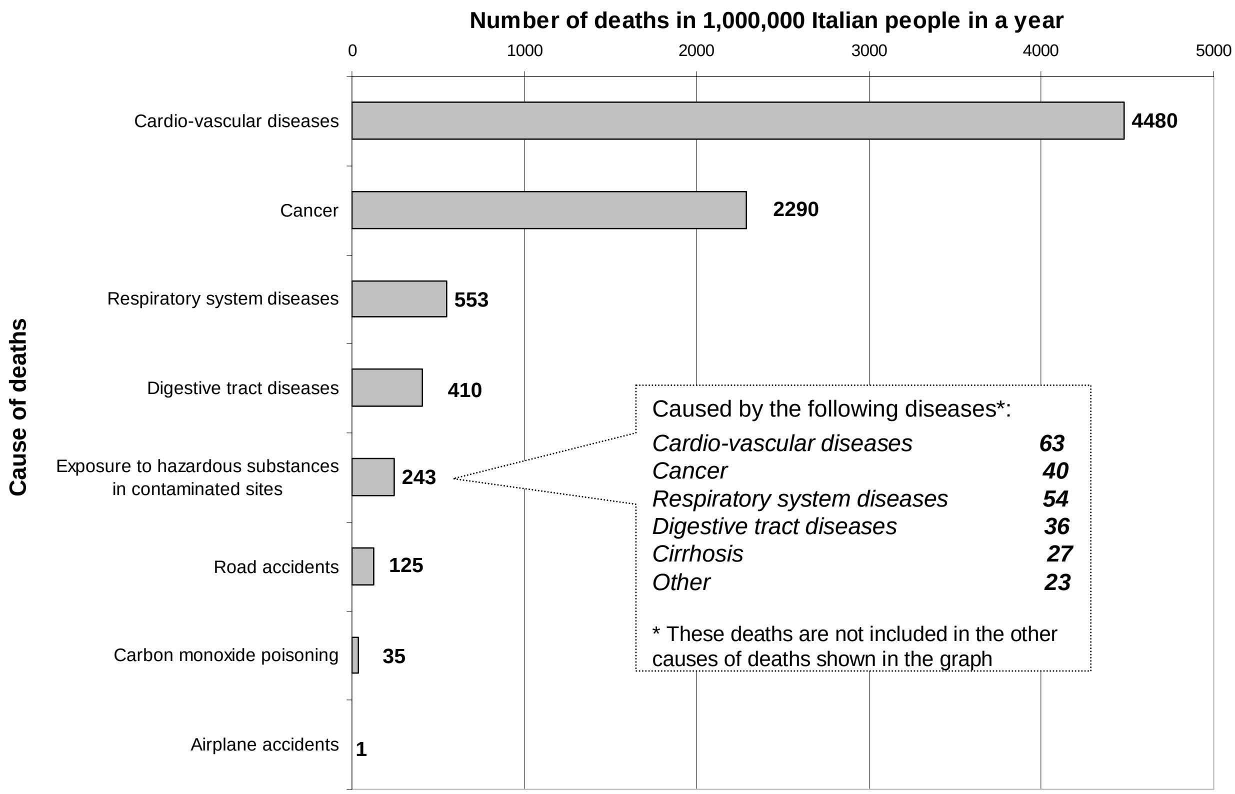
In section 3 we inquire about the health risks people perceive to be associated with contaminated sites, and then explain, using animation, how people are typically exposed to contaminants. A list of the possible short- and long-term health effects of exposure to certain substances follows. For example, respondents are told that heavy metals have been linked with kidney damage, adverse effects on the neurological and immune systems, and may cause cancer.

At this point, we focus on mortality endpoints and provide an estimate of the baseline mortality risks associated with exposure to pollutants found at contaminated sites. Specifically, respondents are told that exposures to pollutants at contaminated sites results in 243 deaths per million people a year and that a total of about 7 million people live in the areas with National Priorities List sites, resulting in an estimated 1700 deaths per year linked to contaminated site exposures.[13]

When asking people to value risk reductions for a specific cause, it is important that respondents be told how this risk compares with mortality rates for other causes. This is exactly what we do in the next screen, which displays a bar chart with the most important causes of death in Italy (i.e., cardiovascular causes, which account for 4480 deaths per million people every year; cancer, which accounts for 2290 deaths per million people every year), and, for comparison, less frequent but familiar causes of death, such as road-traffic accident (125 in a million per year) or carbon monoxide poisoning (35 in million a year) (see Figure 1). Respondents are subsequently tested for risk comprehension.

[13] We were not able to find estimates of the risks and population at risk for the sites on the Italian National Priorities List. We calculated an estimate of the baseline risks before cleanup by transferring estimates of risks in other contaminated areas in Italy. Specifically, we relied on a World Health Organization study which identifies highly industrialized and polluted areas in Italy, computes mortality rates for men and women in these areas in 1990-94, and compares them with those of the surrounding regions. This study concludes that in those years the highly industrialized areas experienced about 800 excess deaths per year (Martuzzi et al., 2002; Mitis et al., 2005). When this figure is divided by the exposed population (3,295,380 people), we obtain an excess risk of about 243 per million, which we posit to be our baseline risk.

Figure 1. Baseline risks.



Since our conjoint choice questions are concerned with public programs, we next inquire about how important it is for the respondent to reduce the health risks posed by contaminated sites, and how much confidence they place in public policies such as economic incentives for firms, dissemination of information, more stringent inspections, institutional controls, and remediation undertaken directly by the government at orphan sites.

In section 4 we present the concept of remediation and provide examples of possible remediation technologies, pointing out that they vary in terms of cost and completion time, and that different sites and pollutants require different remedies. For example, pump-and-treat options are appropriate for contaminated groundwater, while bioremediation may be used at petroleum sites.

This is followed by the conjoint choice experiment portion of the questionnaire. A reminder of the baseline risks is shown at the top of each screen with the pairs of programs and the associated choice questions.

We use additional questions to gather further evidence about preferences for saving lives and about the rate of time preference. For example, we ask our respondents which option they would prefer, a program that saves 100 lives now, or one that saves (100+X) in Y years, where the respondents are told to assume equal costs, and both X and Y are varied to the respondents. The discount rate for lives saved implicit in the responses to these questions can be compared to the one implicit in the money v. future risk reductions tradeoffs in the conjoint choice questions.

We also ask people to express their agreement or disagrement with statements spelling out possible priorities for cleanup and risk reductions. Section 5 concludes the questionnaire with the usual sociodemographic questions and with questions about the respondent's own health.

The survey was self-administered using the computer by respondents recruited from the general population in four cities in Italy (Venice, Milan, Bari and Naples[14]) in May 2005, for a total of 804 completed questionnaires. The sample was stratified by age, with an equal number of respondents in each of three broad age groups (25-44, 45-54, 55-65), and was comprised of a roughly equal number of men and women. We did not expect all respondents to be familiar with computers, so we made sure that two interviewers were present at the survey facilities at all times to welcome the respondents, introduce the survey to them and provide assistance if requested.

4. Results

A. The Sample

Descriptive statistics of the respondents are displayed in table 2. Our sample is well-balanced in terms of gender, and its distribution by age is consistent with the sampling plan. The average age is 47. The average annual household income is approximately €27,000, which is close to, but slightly lower than, the national average (€29,483, Banca d'Italia, 2006).

[14] These cities were selected to ensure geographic representativeness and because each has one or more sites on the National Priorities List. The chemical and oil refining complex of Porto Marghera in the Venice hinterland is probably the most egregious contaminated site on the NPL, with soils, groundwater and Lagoon sediments contaminated by polycyclic aromatic hydrocarbons (PAHs), heavy metals and many other pollutants. The former Fibronit complex, an asbestos-processing facility, is located in downtown Bari, while the NPL site in Naples is a closed steel mill. Milan, as the center of a large industrial area, has several NPL sites.

Almost 50% of our sample has a high school diploma and 13.43% has a college degree or higher education. Comparison with population statistics reveals that our sample has a larger share of persons with high school diploma than the population, but is similar to the population in terms of share of persons with college degree or post-graduate education. (The population statistics are 32% and 11%, respectively.) Table 1B in Appendix B displays other descriptive statistics for education in the sample and in the populations of the four cities.

Table 2: Descriptive statistics of the respondents (N=804)

Variable	Description	Mean	Stand. Devn.	Min	Max
Male	Dummy equal to 1 if the respondent is a male	0.51	0.50	0	1
Age	Respondent age	47.02	11.25	25	65
Married	Dummy equal to 1 if married	0.73	0.44	0	1
age2534	Respondent is aged 25-34	0.19	0.39	0	1
age3544	Respondent is aged 35-34	0.18	0.38	0	1
age4554	Respondent is aged 45-54	0.29	0.46	0	1
age55plus	Respondent is aged 55 or older	0.34	0.47	0	1
Collegedegree	Dummy equal to 1 if respondent has a college degree or post-graduate education	0.13	0.34	0	1
Household size	Number of household members	3.26	1.17	1	8
Children5	Dummy equal to 1 if respondent has children of ages ≤15	0.28	0.45	0	1
Household income (€/year)	Take-home household income	26,955	16,872	5,000	100,000

Regarding their familiarity with contaminated sites, as shown in table 3, 90% of the respondents stated that they had heard about contaminated sites before. Most of these persons reported that they learned about contaminated sites by watching television.

Forty-three percent of the sample indicated that they are aware of contaminated sites near their homes or workplaces. Fully 80% of the respondents were acquainted with the concept of cleanup, and 37% stated that they were personally aware of previously contaminated sites that had been subsequently cleaned up.

Table 3: Knowledge of contaminated sites. N=804.

Variable	**Description**	**Percent of the sample**
HEARD	Respondent has heard about contaminated sites before	90.04
KNOWSITE	Respondent is aware of a contaminated site near home or the workplace	43.16
HEARBONI	Respondent has heard about cleanup of contaminated sites before	79.98
KNOWBONI	Respondent is aware of a contaminated site that has been cleaned up	36.70

In table 4 we report the respondents' views of possible priorities for contaminated site policies, answers to debriefing questions, and concern about mortality risks, which we use to examine the internal validity of the responses to the conjoint choice questions. As show in table 4, almost 89% of the respondent stated that it is "very important" to them personally to reduce the human health risks posed by contaminated sites. Only 7% of the respondents indicated that they only thought of future generations when answering the conjoint choice questions. Indeed, the majority (76%) of the respondents thought about their own exposure, that of their family members, of other people and of future generations, with only 2.86% focusing exclusively on themselves and 2.99% focusing exclusively on other people's exposure.

Fully 40% of the sample strongly agreed that cleanups should take place, even if their benefits are experienced only 30 years from now, and 80% expressed strong agreement with the statement that cleanups should be as permanent as possible, even if they cost more.[15] At the same time, 69% of the sample deemed policies based on fencing off and prohibiting access to contaminated sites “very helpful.” Taken together with table 3, these statistics suggest that most people have at least some rudimentary information about contaminated sites and cleanup programs, that the latter should be meaningful to them, and that they should accept our hypothetical scenarios, which depict public remediation programs.[16]

Finally, about 30% of the sample reported that a family member has had or has cancer, and 45% claimed that they do use seatbelt when riding in the backseat of a car. We interpret familiarity with cancer as a proxy for concern over this illness, and use of seatbelt as concern for, and willingness to undertake action against, mortality risks (albeit of a different nature than cancers and other illnesses associated with exposures to contaminants).

[15] To further elaborate on this matter, when asked to express agreement or disagreement with the statement that “Priority should be given to permanent and effective cleanups even if they are more expensive,” 79.60% of the respondents “strongly” agreed, 12.31% was in agreement with the statement, 5.85% was neutral, and only 1.5% disagreed or strongly disagreed (see Turvani et al., 2006).

[16] These conclusions are further corroborated by the responses to other Likert-scale questions, which suggest that respondents expect the government to take an active role in the management of contaminated site situations. Specifically, two-thirds of the sample state that it would be “very useful” to offer tax credits and other economic incentives to firms to encourage cleanups, and over 80% ascribe the same degree of usefulness to direct government cleanup of orphan sites. Almost 90% find stringent inspections and regulatory approaches to pollution control “very useful” (see Turvani et al., 2006).

Table 4. Opinions on contaminated sites policies and concern about mortality risks. N=804.

Variable	**Description**	**Percent of the sample**
Impexpos	Respondent deems it very important to reduce the adverse effects on human health of hazardous wastes	88.93
Solofut	Respondent thought only of future generations when answered conjoint choice questions	7.21
Futben	Favorable to cleanup even if its benefits are experienced 30 or more years from now	40.55
Durat	Respondent strongly agrees that remediation should be as permanent as possible even it costs more	79.60
Cartelli	Respondents deems policies based on fencing off contaminated sites and preventing access very helpful	68.53
Famcancer	Respondent's family members have had cancer	29.98
Seatbelt	Respondent uses seatbelts when travelling in the back seat of a car	45.02

B. Responses to the Choice Questions

Following Viscusi et al. (1991), we checked how many people always pick plan A in all of the eight choice questions (87 people, or 10.82% of the sample), plan B in all eight choice questions (60 people, for 7.46% of the sample), and exhibited preference "reversals"[17] in one or more choice questions (65 people, or 8.31% of the sample). Always choosing the plan on the left or the plan on the right (or exhibiting a "reversal") does not necessarily imply that people are violating the basic tenets of the random utility model, but at any rate these behaviors account for very small fractions of the sample.

In table 5 we examine the choice frequencies observed when people were given the option to choose between program A, program B, and the status quo. The frequency of "neither program" responses is less than 20%, suggesting that people were not

[17] A preference reversal would be observed if, for example, when asked to choose between A and B, the respondent states that B is the more preferred program, and then, when asked which he prefers among A, B, and the status quo, he chooses A.

dismissing the public programs being shown to them without giving them due consideration. The remainder are rather even split between program A and B, suggesting that there were no obvious choices between the hypothetical programs.

Table 5. Frequencies of observed responses to the question "Which would you prefer between A, B, and neither program?"

Pairs of program	*Percent choose A*	*Percent choose B*	*Percent choose "neither"*
1	42.41	37.69	19.9
2	43.66	37.81	18.53
3	42.16	40.67	17.16
4	42.79	39.05	18.16

C. VSL Estimates

The results of the non-linear conditional logit models of the responses to the conjoint choice questions are reported in table 6. The indirect utility function underlying the two logits is equation (7), and the two regressions differ solely for the criteria we used to clean the sample. Model I uses the full sample, which consists of 782 usable observations.[18] For good measure, in model II we further discard those subjects who failed all of the four probability comprehension quizzes (N=58) and/or exhibited preference reversals (N=65). The estimation results are very similar to those of model I.

Briefly, table 6 shows clearly that risk reductions are positively and significantly valued by the respondents. Within a model, the estimated α_j coefficients (where j denote

[18] A total of 804 respondents completed the questionnaire, but we discarded the choice responses of the 22 individuals who were shown a conjoint choice question screen with a typographical error in the risk reduction.

the population size, ranging from half a million to 2 million) are within 10 to 20% of one another. The marginal utility of income is positive and significant, and the discount rate is pegged at 6.9%.

Wald test statistics of 66.69 (for the full sample; p-value < 0.0001) and 51.09 (for the "cleaned" sample; p-value < 0.0001) reject soundly the null hypothesis that $\alpha_2 = 2\alpha_1$ and $\alpha_3 = 2\alpha_2$, providing evidence against indirect utility (9).[19] Wald test statistics of 10.02 and 12.45 for the full and "cleaned" samples, respectively, also reject the null that the marginal utility of discounted risk reductions is the same regardless of the size of the population.[20]

Table 6. Conjoint choice questions: conditional logit models.

	Model I all data		Model II Cleaned data (no preference reversals, no allwrong=1)	
	coefficient	t stat.	Coefficient	t stat.
ALPHA1	0.0049	8.19	0.0045	7.104
ALPHA2	0.0053	8.187	0.0051	7.228
ALPHA3	0.0044	7.85	0.0041	6.838
BETA	0.0009	11.595	0.0009	11.29
DELTA	0.0689	9.542	0.0685	8.284
log L	-5370.13		-4558.36	
N obs	6256		5296	
N respondents	782		662	

[19] We also estimated a conditional logit equation (shown in Appendix C) that assumes that the deterministic component of the indirect utility is a linear combination of the attributes of the alternatives. This model must be estimated separately for the subsample with Delay=2 and the subsample with Delay=10. The logit coefficients indicate that the likelihood of selecting a program increases with the size of the risk reduction and decreases with its cost, and does not depend on the size of the population living in the areas with the contaminated sites to be targeted by the hypothetical programs for Delay=2, whereas it is negatively related to it for Delay=10. The effect of duration is consistent with our expectations for Delay=2 but is insignificant for Delay=10.

[20] The respective P-values are 0.001 and 0.00047, respectively.

The VSL for a risk reduction to be incurred in the current year implied by the coefficients of model I in table 6 is €5.547 million (standard error around the VSL €0.806 million) when the affected population is 0.5 million, €5.996 million (s.e. €0.929 million) when the population is 1 million, and €5.056 million (s.e. €0.840 million) when the affected population is 2 million.[21, 22]

Even more importantly, these three VSL figures are *not* statistically different from one another, so in what follows we estimate (non-linear) conditional logit models that restrict the marginal utility of the risk reductions—the αs—to be the same for all population sizes used in the questionnaire. We argue that doing so should bring only negligible biases upon the estimated VSL. The results of such a restricted model are reported in table 7 for the full sample. All coefficients are close to their counterparts in table 6, and the implied VSL for a risk reduction to be incurred in the current year is €5.58 million (s.e. €0.771 million). This figure is in the ballpark of the values of a statistical case of cancer derived by Gayer et al. (2000, 2002) under alternate assumptions about how individuals form and update their priors about risks.[23]

It is also very close to the VSL figure ($6.1 million, 1999 dollars) used by the US EPA in its policy analyses (US EPA, 2000) and higher than that used by the European Commission (whether or not a 40% cancer premium is added).[24] Our 5.6 million lies on

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[21] We remind the reader that the VSL is what people are willing to pay in the current year for a marginal change in risk to be incurred entirely in the current year, and that here it is estimated as α divided by β, multiplied by one million. (The multiplication by one million is necessary because in our dataset for estimation purposes the risk reduction was coded as 10, 20, or 30, instead of 10, 20, or 30×10^{-6}.)

[22] The standard errors were computed using the delta method (described in Appendix D).

[23] Gayer et al. (2000) find that a reduction of individual cancer risk by 1.81E-06 after the Remedial Investigation results in a implied value of statistical case of cancer between $3.9 and 4.6 million. If we assume that the conditional mortality for cancer is 70% (see below) and adjust to 2005 dollars (see http://www1.jsc.nasa.gov/bu2/inflateCPI.html), the resulting VSL is $6.7-7.9 million.

[24] See http://europa.eu.int/comm/environment/enveco/others/recommended_interim_values.pdf.

the high end of the range of VSL found by Alberini and Chiabai (forthcoming) in a previous CV study of Italians, where attention was restricted to the risk of dying for cardiovascular and respiratory causes, the risk reduction was private and there was no mention of environmental circumstances.

Table 7. Non-linear conditional logit model. Full sample (Nobs=6256, Number of respondents=782).

	coefficient	t stat.
ALPHA	0.0050	8.38
BETA	0.0009	12.36
DELTA	0.0741	9.82
Log L	-5369.20	

D. Implications for Latency and Permanence

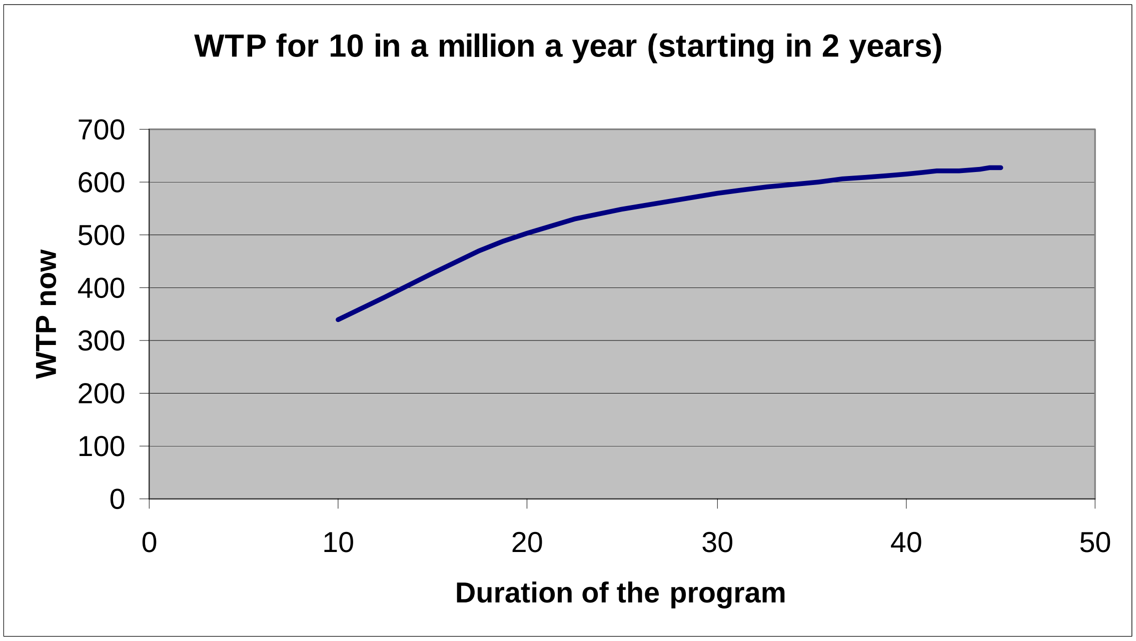
As shown in table 7, the discount rate in the simplified model is 7.41%. This figure is significantly different from zero, suggesting that our respondents do indeed discount risk reductions that occur in the future. This estimate of the discount rate is reasonable, but not too low, confirming that a unit of risk reduction is valued less if it occurs in the future, and suggesting that people care about permanence, but not at *any* cost. Our respondents discount future risk reductions at a rate that is well within the range estimated in earlier studies (typically 1-14%; see Alberini et al., 2006).

The implications of a discount rate of this magnitude can be illustrated in several ways. For example, for a risk reduction of 1 in a million in the current year, the VSL is €5.6 million, but if this risk reduction were to be incurred in 10 years, the applicable VSL would be €2.66 million (s.e. around the VSL €0.296 million), and if it were to be incurred 20 years from now—the lag used in analyses of arsenic maximum contaminant limits in drinking water[25]—the applicable VSL would fall to only €1.26 million (s.e. €0.158 million). (This is because a one-time risk reduction of 1 in a million a year occurring 10 years from now is equivalent to an immediate, one-time risk reduction of 0.4766 in a million. The same 1-in-a-million risk reduction occurring 20 years from now is equivalent to an immediate, one-time risk reduction of 0.2272 in a million.)

As a second example, consider a program that delivers an annual risk reduction of 10 in a million, and begins in two years. If the risk reduction were to continue for 10 years, the typical respondent's one-time WTP would be €340. This would increase to €502 if the duration of the program doubled, €579 if it lasted 30 years, €616 if it lasted 40 years, and €626 if it lasted 45 years. Clearly, the WTP is less than proportional to the duration of the program (and to total nominal—undiscounted—risk reduction), as shown in Figure 2.

[25] A 20-year lag between now and the time of the risk reduction is, for example, that considered by the EPA Science Advisory Board when examining the maximum contaminant limit allowable for arsenic in drinking water. See www.house.gov/science/ets/oct04/ets_charter_100401.htm (accessed 22 January, 2006).

Figure 2. WTP for a program with $\Delta R = 10$ per million per year starting two years from now.



Consider now two programs that save the same number of (undiscounted) lives and affect the same population (1 million people), except that in one the risk reduction is 10 in a million a year and the duration of the program is 20 years, while in the other the risk reduction is 20 in a million a year and the duration of the program is 10 years. Both programs would realize the risk reductions starting two years from now. The one-time WTPs for these programs are €502 and €680, respectively, confirming that our respondents value more highly programs that saves lives sooner, even if those programs are shorter-lived. Finally, consider the former of these two programs, but imagine that it began saving lives 10 years from now: WTP would fall from €502 to €277.

E. The Effect of Individual Characteristics

The results from the model with individual-specific marginal utilities of risk reduction, income and discount rates are displayed in table 8. We remind the reader that these results refer to equation (10), which posits that the VSL is "individuated" (Sunstein, 2004), but constant with respect to the size of the population living in the areas with the sites that would be affected by the hypothetical policy.

Table 8 (top right portion) displays the estimates of the marginal utilities of income. In this specification of the model, our low-income dummy takes on a value of 1 if the respondent's income is below the sample average, and zero otherwise. Clearly, people with income below the sample average have a higher marginal utility of income than the remainder of the sample, which is consistent with prescriptions from economic theory.[26]

Turning to the marginal utility of risk reductions, Table 8 shows that males value risk reductions more highly, all else the same, but that having a college degree does not imply a statistically different marginal utility of risk reductions. Likewise, the α coefficients on age group dummies are insignificant.

Surprisingly, persons who told us they knew about contaminated sites in their neighborhood or near their workplace (KNOW), and persons who care about the health effects of exposure to contaminants (IMPX) appear to value risk reductions *less* than the other respondents. Perhaps the former effect is due to the fact that familiarity with contaminated sites reduces the perceived severity of risk. Alternatively, it is possible that people may have self-selected into areas with contaminated sites, so that the negative sign captures the fact that people living close to such sites are less bothered by their presence.

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[26] We experimented with different ways of constructing the low income dummies (for example, a low-income person is one with annual household income less than €15,000, which corresponds to about a quarter of the sample), and found that the results are qualitatively robust to these changes.

We do not have a good explanation for why people who worry about the health risks of contaminants should value less highly risk reductions.[27] At any rate, both effects are sizeable: They lower the VSL by €0.850 million and €1.860 million for a respondent with relatively low income.

We conjectured that acceptance of government contaminated site remediation programs should affect the marginal utility of risk reductions, and ultimately the WTP for the program, and indeed these expectations are borne out in the data. Respondents who believe that the government should take care of orphan sites (ORFAN) value the risk reductions and the program more highly than the other respondents, whereas people who deem it "very useful" to fence and prohibit access to contaminated sites (CART) are willing to pay less, all else the same. Perhaps doing so is judged sufficient to reduce risks, so that no additional long-term remediation is deemed necessary. For a lower-income person, holding such an opinion lowers the VSL by €0.950 million.

Finally, respondents whose family members have had cancer (FAMCAN) and respondents who profess to use seatbelts (SEATB) when they travel in the back seat of a car—which we interpret as indicating concern about mortality risks—value risk reductions more highly. The corresponding increases in WTP for a less wealthy person are €2.76 million and €2.09 million, respectively.

Regarding the determinants of the personal discount rates, we find that, all else the same, discount rates are 1 percentage point lower for persons with young children, 1 percentage point higher for married persons, and almost 3 percentage points lower among people of ages 45-54. They are also 1.8 percentage point higher for males, but this effect

[27] We conjectured that such a negative coefficient might reflect the negative correlation between IMPX and the educational attainment of the respondent, but found that the correlation coefficient between IMPX and COLLEGEDEGREE is very low (-0.07). We conclude that this is an unlikely explanation.

is statistically significant only at the 10% significance level, whereas the abovelisted associations are all significant at the 5% level or better.

Table 8. Non-linear conditional logit with individual-specific marginal utility of risk reduction, income and discount rate.

marginal utility of ΔR				**marginal utility of income**		
variable	coefficient	t stat.		variable	coefficient	t stat.
ALPHA1	0.003704	3.168		BETA	0.00063	6.122
A_KNOW	-0.00092	-2.271		BETAPOOR	0.00044	3.865
A_IMPX	-0.00199	-2.559				
A_COLLEG	-0.00038	-0.764		**discount rate**		
A_BONI	0.000433	1.206		variable	coefficient	t stat.
A_AGE55P	-0.00137	-1.194		DELTA	0.091449	5.326
A_AGE45	-0.00111	-0.976		D_KIDS	-0.00988	-1.988
A_AGE35	-0.00178	-1.469		D_MARRIE	0.010502	1.972
A_MALE	0.002868	3.314		D_DURAT	-0.0351	-4.130
A_CART	-0.00102	-2.485		D_FUTBEN	0.005837	1.253
A_ORFAN	0.001959	3.704		D_SOLFUT	-0.0066	-0.834
A_FAMCAN	0.002955	2.800		D_MALE	0.017756	1.672
A_SEATB	0.002242	5.221		D_AGE55P	-0.01859	-1.282
				D_AGE455	-0.02879	-2.003
				D_AGE354	-0.02214	-1.399
				D_FCANC	0.025818	2.164

That people are internally consistent is confirmed by the fact the discount rate is 3.5 percentage points lower for those persons who strongly agree with the statement that remediation should be as permanent as possible, even if it costs more (dummy DURAT). By contrast, the coefficient on a dummy capturing whether the respondent favors remediation even if its benefits are experienced 30 or more years from now—FUTBEN—and that on a dummy—SOLFUT—capturing sole concern for future generations as a driver of the responses to the conjoint choice questions are not statistically significant. Finally, people whose family members have had cancer tend to have significantly higher discount rates (by about 2.6 percentage points).

F. Additional Tests of Internal Validity

In our questionnaire, we also ask the following question: "Suppose there were two public programs for cleaning up contaminated sites. These two programs differ for technology and completion time. Program A saves 100 lives now. Program B saves X lives in Y years. If the cost of the two program were the same, which would you choose, A or B?" X and Y were varied to the respondents (X= 150, 200, 300, 400; Y = 10, 20, 30, 40, 45).[28]

Let D* be the discount rate that makes the two programs have equal discounted lives saved.[29] In our survey, D* ranged from less than 1 percent to about 14%. The respondent should choose program A if his or her own discount rate, D_i, is greater than D*, B if D_i is less than D*, and should be indifferent between the two programs if D_i is equal to D*.

We assume that D_i is i.i.d. normal with mean μ_D and variance σ_D^2. Our sample is thus a mix of binary and continuous observations, and the log likelihood function is

$$(11) \qquad \log L = \sum_{i \in \text{choose A}} \ln \Phi\left(\frac{\mu_D}{\sigma_D} - \frac{D_i^*}{\sigma_D}\right) + \sum_{i \in \text{choose B}} \ln\left[1 - \Phi\left(\frac{\mu_D}{\sigma_D} - \frac{D_i^*}{\sigma_D}\right)\right] + \sum_{i \in \text{indifferent}} \ln \phi\left(\frac{\mu_D}{\sigma_D} - \frac{D_i^*}{\sigma_D}\right)$$

where $\Phi(\cdot)$ and $\phi(\cdot)$ are the cdf and pdf of the standard normal distribution, respectively.

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[28] For comparison, Cropper et al. (1991, 1992) ask a sample of Maryland residents, a sample of residents of the Washington, DC, area, and a national sample the following question: "Without new programs, 100 people will die this year from pollution and 200 people will die 50 years from now. The government has to choose between two programs that cost the same, but there is only enough money for one. Program A will save 100 lives now. Program B will save 100 lives 50 years from now. Which program would you choose?" The number of lives saved by program B and the number of years from now when lives are saved were varied to the respondents.

[29] In other words, assuming constant exponential discounting, D*=(-1/Y)*(ln(100/X)).

The responses to the latter question indicate that most people (80%, or 626 individuals) prefer the program that saves lives now, 14.7% (115 people) prefer the one that saves lives in the future, and 5.2% (41 people) are indifferent between the two.[30] We estimate μ_D to be equal to 12.36%, while σ_D is pegged at 0.0870 (see table 9, panel (A)). The former figure suggests that the mean discount rate is larger than, but within the ballpark of, the discount rate inferred from the conjoint choice tradeoffs. The latter indicates that there is substantial heterogeneity among people's individual discount rates.

Such heterogeneity is consistent with the fact that, when asked to rate their agreement with the statement "We should avoid spending money on cleanup programs that will save lives only 30 years from now" on a scale from 1 to 5 (where 1=strongly disagree and 5=strongly agree), 40.55% of the sample chose response category 1, 10.07% chose 2, 14.43% chose 3, 7.46% chose 4, and 23.76% chose 5.

Equation (11) can be amended to allow the expected value of D_i to depend on individual characteristics of the respondents (such as age, gender, knowledge of the problem of contaminated sites, education, etc.). As shown in table 9, panel (B), we find only modest evidence that D_i depends systematically on individual characteristics of the respondents. Whatever evidence there is, however, it is broadly consistent with that from the earlier conjoint choice question exercise: The discount rate for lives is about 2 percentage points lower for those respondents who are at least somewhat favorable to remediation even when its benefits are incurred many years into the future (dummy FUTBEN), and 2 percentage points lower among the 45-54 year-olds.

[30] Cropper et al. (1991) report that in their combined Maryland and Washington, DC area samples, fully 40% of the respondent chose the program that saves lives now, even when the number of lives to be saved in the future was very large.

Table 9. Continuous-Discrete model of discount rates for lives saved. N=782.

	(A) Model without covariates		(B) Model with covariates	
Variable	Coefficient	T Stat.	Coefficient	T Stat.
Intercept	0.1236	14.21	0.1385	8.05
kids15			0.0029	0.25
married			0.0000	0.00
durat			0.0026	0.23
futben			-0.0222	-2.34
solofuture			-0.0111	-0.66
male			-0.0052	-0.58
age55plus			0.0011	0.07
age4554			-0.0241	-1.64
age3544			-0.0047	-0.30
famcancer			0.0066	0.65
σ_D	0.0870	10.23	0.0854	10.29
Log L	-285.83		-279.59	

5. Discussion and Conclusions

We have deployed conjoint choice questions to investigate the tradeoffs people are prepared to make between income and mortality risk reductions delivered by contaminated site remediation programs. Our survey questionnaire was designed to investigate the value that people place on permanent risk reductions, and to assess the effect of lag (or latency), i.e., people pay now, but the risk reduction is incurred in the future. The questionnaire was self-administered using the computer by a sample of residents of four Italian cities with serious contaminated site problems.

We find that people *are* willing to pay for permanence, but not just *any* price. We estimate the VSL for an immediate risk reduction over the current year to be about €5.6 million. The VSL does not vary significantly with the size of the population that would be affected by the policy. However, the VSL is lower if the risk reduction occurs in the future. For a risk reduction occuring exactly 20 years from now, for example, we estimate our respondents' VSL to be only €1.27 million. People discount future risk reductions at a rate of 7.41%, which means that each respondent is willing to pay €340 now for a risk reduction of 10 in a million per year that begins in two years and continues over 10 years. For a more permanent risk reduction, such as one that continues over 20 years, each respondent would be willing to pay €502. For one that continues over 30 years, the WTP would be €579, and for one that lasts 45 years, €626. Clearly, risk reductions that take place in the more distant future are valued less highly than more immediate risk reductions.

We find evidence that the VSL *is* individuated, in that it depends on observable individual characteristics (e.g., age, gender and income), familiarity with contaminated sites, concern about the health effects of exposure to contaminants, and direct experience with cancer. The VSL also depends on what the respondent thinks the goals of a remediation program should be, and on which government actions he or she deems appropriate. (However, policymakers may not be able to use all of this information in policy analyses, because attitudes, beliefs and confidence in specific government actions are usually *not* known for the entire population of beneficiaries of the policy.)

Additional questions indicate that the rate at which people discount future risk reductions in money versus risk tradeoffs is within the ballpark of the rate at which they discount future lives. We interpret this as further evidence of good internal validity of the data, and of the fact that people were paying attention to the attributes of the program we wanted to focus on, including the futurity of risk reductions.

The results of this study could be used in benefit-cost analyses of Superfund-like programs. Unfortunately, information about current risks associated with contaminated site exposures before and after cleanup of sites on the Italian National Priorities List are not publicly available. Absent these data, we perform an illustrative benefit-cost analysis for a 43-hectare operating unit within the broader NPL site at Marghera, near Venice, Italy. In this operating unit—a former industrial waste dump owned by the City of Venice—soil and groundwater are heavily contaminated with PAHs, heavy metals, and many other toxicants.

Following Patassini et al. (2003, 2005), we focus on soil, for which remediation options include soil washing, thermal desorption, capping, and excavation with subsequent shipment of the contaminated soil to an approved hazardous waste disposal facility. We restrict attention to capping—the least permanent of remedies—and to excavation and removal of soil—the most permanent and the most expensive, and assume reuse for residential purposes. Based on their estimate of excess lifetime cancer risks (4.78E-03) and a conservative assumption of 70% conditional mortality,[31] the annual mortality risk for residents is 4.54E-05. Assuming that risk reductions would begin 10 years from now, and an exposed population of 30,000—as estimated in the Master Plan of the City of Venice (Regione Veneto and Comune di Venezia, 2004)— a permanent remedy like excavation and removal of the contaminated soil would require at least an 87% risk reduction for the mortality benefits to exceed the cost of remediation (€45,589 million).[32] By contrast, the least permanent of remedies, capping, which is estimated to

[31] This rate is for the 1980s, the most recent period for which estimates are available (see http://www.istitutotumori.mi.it/menuistituto/diparclinici/epidemiologia, and Verdecchia et al., 2001).

[32] These calculations assume that the risk reductions would last 45 years. Patassini et al. suggest that excavation and removal of the contaminated soil affords a 95% risk reduction. This would imply benefits for €49 million, whereas the costs of the remedy is €45 million.

cost about €5 million, results in positive net benefits even for 20% reductions from the baseline risk, and even if we assume that the lifetime of the cap is only 10 years.[33]

Caution should be used in interpreting our results, however, because they are based on one operating unit, and the Marghera NPL site is comprised of many operating units. In addition, our estimates do not include other benefits of cleanup, such as benefits to ecological system, other economic benefits from the redevelopment of the area, etc.

The results from our study can also be used to cast some light on the issue of re-use of contaminated sites, which is an important goal of current policies and programs (US GAO, 1995, 1997b). For industrial and commercial use, cleanup targets are often allowed to be less stringent than for residential use. This may in turn imply that cleanup is completed earlier. The discount rate estimated in this study suggests that to get the risk reduction sooner, people would be willing to settle for a smaller risk reduction. Suppose cleanup delivers an annual risk reduction of 10 in a million for 10 years beginning 10 years from now. To bring these risk reductions forward to 2 years from now, people would be willing to settle for an annual risk reduction of 5.53 in a million.

Likewise, to get the risk reduction sooner, people would be willing to accept less permanence. Consider for example an annual risk reduction of 10 in a million to begin in 10 years and continue for 30 years. To bring the risk reductions forward to 2 years from now, people would be willing to settle for a remedy that lasts 9.25 years. These are intriguing implications of the preferences elicited through our approach, which we hope to explore more explicitly in future research.

[33] These calculations sound a common theme with those in Gayer et al (2000), who report that their upper bound measure of welfare benefits of $10.1 million for reducing cancer risks is smaller than the EPA's estimated total costs of remediation for the areas of investigation ($56.8 million). By contrast, less permanent measures such as fencing and deed restrictions cost about $5.4 million and result in positive net benefits.

References

Agenzia per la Protezione dell'Ambiente e per i Servizi Tecnici (2004), "Metodologie, Tecniche e Procedure per il Supporto degli Interventi di Valorizzazione dei Siti Inquinati", Rome, June.

Alberini, Anna and Aline Chiabai (forthcoming), "Urban Environmental Health and Sensitive Populations: How Much are the Italians Willing to Pay to Reduce their Risks?" *Regional Science and Urban Economics*, 2006.

Alberini, Anna, Maureen Cropper, Alan Krupnick and Nathalie Simon (2006), "Willingness to Pay for Risk Reduction: Does Latency Matter?" *Journal of Risk and Uncertainty*, 32, 231-245.

Ashenfelter, Orley (2006), "Measuring The Value Of A Statistical Life: Problems and Prospects," NBER working paper 11916, Cambridge, MA, January.

Banca d'Italia (2006), *I bilanci delle famiglie italiane nell'anno 2004*, Supplementi al Bollettino statistico anno XVI n. 7, Rome, January.

Barnett, Harold (1994), *Toxic Debts and the Superfund Dilemma.* Chapel Hill: The University of North Carolina Press.

Chilton, Susan, Judith Covey, Lorraine Hopkins, Michael Jones-Lee, Graham Loomes, Nick Pidgeon, Anne Spencer (2002), "Public Perceptions of Risk and Preference-based Values of Safety," *Journal of Risk and Uncertainty*, 25(3), 211-232.

Cropper, Maureen L., Sema K. Aydede and Paul R. Portney (1991), "Discounting Human Lives," *American Journal of Agricultural Economics*, 73(5), 1410-1415.

Cropper, Maureen L., Sema K. Aydede and Paul R. Portney (1992), "Rates of Time Preference for Saving Lives," *American Journal of Agricultural Economics*, 82(2), 469-472.

DeShazo J.R., and Trudy A. Cameron (2005), The Effect of Health Status on Willingness to Pay for Morbidity and Mortality Risk Reductions, *California Center for Population Research On-Line Working Paper Series*, CCPR-050-05.

Fischoff, Baruch, Paul Slovic, Sarah Lichtenstein, Stephen Read and Barbara Combs (1978), "How Safe is Safe Enough? A Psychometric Study of Attitudes towards Technological Risks and Benefits," *Policy Sciences*, 9, 127-152.

Gayer, Ted, James T. Hamilton and W. Kip Viscusi (2000), "Private Values of Ris Tradeoffs at Superfund Sites: Housing Market Evidence on Learning About Risks," *Review of Economics and Statistics*, 82(3), 439-451.

Gayer, Ted, James T. Hamilton, and W. Kip Viscusi (2002), "The Market Value of Reducing Cancer Risk: Hedonic Housing Prices with Changing Information", *Southern Economic Journal*, 69(2), pp 266-289

Gupta, Shreekant, George van Houtven, and Maureen Cropper (1996), "Paying for Permanence: An Economic Analysis of EPA's Cleanup Decisions at Superfund Sites," *RAND Journal of Economics*, 27(3), 563-582.

Hamilton, James and W. Kip Viscusi (1999), *Calculating Risks? The Spatial And Political Dimensions Of Hazardous Waste Policy*, Cambridge and London: MIT Press.

Hammitt, James K. and Jin-Tan Liu (2004), "Effects of Disease Type and Latency on the Value of Mortality Risk", *The Journal of Risk and Uncertainty*, 28(1), 73-95.

Hanley, Nick, Susana Mourato, and Robert E. Wright (2001), "Choice Modelling Approaches: A Superior Alternative for Environmental Valuation?" *Journal of Economic Surveys*, 15(3), 435-462.

Hird, John A. (1994), *Superfund: The Political Economy Of Environmental Risk*, Baltimore: Johns Hopkins University Press

Horowitz, John K. and Richard T. Carson (1990), "Discounting Statistical Lives," *Journal of Risk and Uncertainty*, 3, 403-413.

Itaoka, Kenshi, Aya Saito, Alan Krupnick, Wiktor Adamowicz and Taketoshi Taniguchi (2006), "The Effect of Risk Characteristics on the Willingness to Pay for Mortality Risk Reductions from Electric Power Generation," *Environmental and Resource Economics*, 33(3), 371-398.

Legambiente (2005), "La chimera delle bonifiche", http://www.legambiente.com/documenti/2005/0510_dossier_bonifiche/La_chimera_delle_bonifiche.pdf (accessed January 31, 2006)

Martuzzi, Marco, Francesco Mitis, Aannibale Biggeri, Benedetto Terracini, Roberto Bertollini (2002), "Ambiente e stato di salute nella popolazione delle aree ad alto rischio di crisi ambientale in Italia," *Epidemiologia e Prevenzione*, 26(6), 1-56.

McDaniels, Timothy L., Mark S. Kamlet, and Gregory W. Fischer (1992), "Risk Perception and the Value of Safety," *Risk Analysis*, 12. 495-503.

Meyer, Peter B. (2000), "Looking at State Voluntary Cleanup Programs in Perspective: Liability Relief, Flexible Cleanup Standards and Institutional Controls as Forms of Economic Development Subsidies," Working Paper, Center for Environmental Policy and Management, University of Louisville.

Mitis, Francesco, Marco Martuzzi, Annibale Biggeri, Roberto Bertollini, Benedetto Terracini (2005), "Industrial Activities in Sites at High Environmental Risk and Their impact on the Health of the Population," *International Journal of Occupational and Environmental Health*, 11, 88-95.

Moore, Michael J. and W. Kip Viscusi (1990), "Models for Estimating Discount Rates for Long-Term Health Risks Using Labor Market Data," *Journal of Risk and Uncertainty*, 3, 381-401.

Patassini, Domenico, Paola Cossettini, Enrico De Polignol, Markus Hedorfer, and Enrico Rinaldi (2003), "El.Gi.R.A. Una procedura di aiuto alla conoscenza nelle aree di bonifica di Porto Marghera (Venezia)," paper presented at a FEEM seminar, http://www.iuav.it/Didattica1/pagine-web/facolt--di2/Domenico-P/ricerca/Bonifiche-/slide_ELGIRA.pdf (accessed July 31, 2006)

Patassini, Domenico, Paola Cossettini, Enrico De Polignol, Markus Hedorfer, and Enrico Rinaldi (2005), "ELGIRA: Support System for Knowledge Building and Evaluation in Brownfield Redevelopment", in CORILA (ed.), *Scientific Research and Safeguarding of Venice, Research Programme 2001-2003*, Volume III, CORILA, Venice, 5-20.

Probst, Katherine and David Konisky (2001), *Superfund's Future: What Will it Cost?* Washington, DC: Resources for the Future.

Regione del Veneto and Comune di Venezia (2004), "Master Plan per la bonifica dei siti inquinati di Porto Marghera," http://www.regione.veneto.it/NR/rdonlyres/408958E0-542A-4227-9CF9-46025D51DBDF/0/134.pdf (accessed August 2, 2006).

Revesz, Richard L. and Richard B. Stewart (1995), "The Superfund Debate," in Revesz, Richard L. and Richard B. Stewart (eds.), *Analyzing Superfund: Economics, Science, and Law*, Washington, DC: Resources for the Future.

Sunstein, Cass R. (2004), "Are Poor People Worth Less than Rich People? Disaggregating the Value of a Statistical Life," AEI-Brookings Joint Center for Regulatory Studies Working paper 04-05, Washington, DC, January.

Tsuge, Takahiro, Atsuo Kishimoto, Kenji Tekeuchi (2005), "A Choice Experiment to the Valuation of Mortality," *Journal of Risk and Uncertainty*, 31(1), 73-95.

Turvani, Margherita, Aline Chiabai, Anna Alberini, and Stefania Tonin (2006), "Public Support for Policies Addressing Contaminated Sites: Evidence from a Survey of the Italian Public," paper presented at the 3rd World Congress of Environmental and Resource Economists, Kyoto, Japan, July.

US Environmental Protection Agency (2000), *Guidelines for Preparing Economic Analyses*, EPA 240-R-00-003, Washington, DC, September.

US General Accounting Office (1995), *Community Development: Reuse of Urban Industrial Sites*, GAO/RCED 95-172, Washington, DC, June.

US General Accounting Office (1997a), *Superfund: State Voluntary Programs Provide Incentives to Encourage Cleanups*, GAO/RCED-97-66, Washington, DC, April.

US General Accounting Office (1997b), "Superfund. Proposals to Remove Barriers to Brownfield Redevelopment", GAO/T-RCED-97-87, March.

Vassanadumrongdee, Sujitra and Shunji Matsuoka (2005), "Risk Perceptions and Value of a Statistical Life for Air Pollution and Traffic Accidents: Evidence from Bangkok, Thailand", *Journal of Risk and Uncertainty*, 30(3), pp 261-287.

Verdecchia, Arduino, Angela Mariotto, Riccardo Capocaccia, Gemma Gatta, Andrea Micheli, Milena Sant, Franco Berrino (2001), "Incidence and prevalence of all cancerous diseases in Italy: trends and implications", *European Journal of Cancer*, 37, 1149-1157.

Viscusi, W. Kip (2003), "The Value of a Statistical Life: A Critical Review of Market Estimates," NBER Working Paper 9847, Cambridge, MA.

Viscusi, W. Kip, and James T. Hamilton (1999), "Are Risk Regulators Rational? Evidence from Hazardous Waste Cleanup Decisions," *American Economic Review,* 89(4), 1010-27.

Viscusi, W. Kip and Joel Huber (2006), "Hyperbolic Discounting of Environmental Quality," NBER Working Paper No. W11935, Cambridge, MA.

Appendix A. Example of a conjoint choice question.

Public Programs

Recall, every year
243 persone su 1.000.000 di abitanti

$$\left(\frac{243}{1.000.000}\right)$$

die in Italy for causes due to exposure to contaminants at contaminated sites

The table below shows two government programs, A e B, addressing contaminated sites. These programs are guaranteed to be effective and to save lives.

As you can see, each program has different effects and saves a different number of lives. Please choose the one you prefer.

Program features	**Program A**	**Program B**
Number of lives saved every year in 1,000,000 people	10 in 1.000.000 $\left(\frac{10}{1.000.000}\right)$	10 in 1.000.000 $\left(\frac{10}{1.000.000}\right)$
Population: the number of people living in the areas with the targeted contaminated sites	1,000,000	2,000,000
Delay: the number of years before the risk reduction begins	2 years	2 years
One-time tax payment: amount of tax household will have to pay for the remediation program	50 euro	100 euro
Duration: number of years over which lives are saved	20 years	20 years

16. Which program would you choose between A e B?

A ❑ **B ❑**

17. If you could choose between A, B e neither program, which would you choose?

A ❑ B ❑ NEITHER ❑

Appendix B. Comparison between the sample and the population.

Table B.1 Education

	Bari		**Milan**		**Naples**		**Venice**		**total sample**	**total Italian population**
	sample	population	sample	population	sample	population	sample	population		
Elementary school	5,00	19,68	1,49	10,46	9,50	21,79	6,90	18,00	5,72	19,60
Completed middle school/junior high	42,00	27,43	26,37	27,08	36,50	29,50	20,69	31,87	31,34	34,31
High school diploma	47,00	31,98	60,69	37,50	42,50	28,77	47,70	34,10	49,51	32,08
College or higher	11,00	16,88	11,45	23,34	11,50	15,28	24,63	14,74	13,43	10,95

Table B.2 Average after-tax household income (€/yr)

	Population (2004)	**Sample**
Northern Italy	33,376	31,905
Southern Italy	21,463	21,612
Italy	29,483	26,784
males	32,200	28,088
females	23,204	25,442
up to 30 years	29,821	24,860
31-40	30,213	24,053
41-50	33,810	29,372
51-65	35,187	26,760

Appendix C. Simple conditional logit model of the responses.

Delay=2 years. Log likelihood = -2600

	coefficient	t statistic
deltarisk	37559	8.96
popul	4.48E-08	0.85
duration	0.006795	2.54
costperyear	-0.0262	-8.49

Delay=10 years. Log likelihood = -2769

	coefficient	t statistic
deltarisk	37327	9.2
popul	-1.42E-07	-2.75
duration	0.000373	0.15
costperyear	-0.0174	-5.76

Appendix D. Delta method.

For large samples and assuming that the model is correctly specified, the maximum likelihood estimates from the conditional logit are normally distributed around the true vector of parameters, and the asymptotic variance-covariance matrix, Ω, is the inverse of the Fisher information matrix. If we assume for simplicity that the indirect utility is that of equation (2), the VSL is computed as:

(A.1) $$VSL = \frac{\hat{\alpha}}{\hat{\beta}} \ .$$

We use the delta method to produce the variance around the VSL (equation (A.1)):

(A.2) $$Var(WTP) = \mathbf{\Delta g' \Omega \Delta g}\,,$$

where Ω is the variance-covariance matrix of the logit coefficients, and $\mathbf{\Delta g}$ is equal to $\begin{bmatrix} 1/\beta \\ -\alpha/\beta^2 \end{bmatrix}$.

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