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The Value of Reducing Cancer Risks at Contaminated Sites: Are More Heavily Exposed People Willing to Pay More?

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Summary

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Keywords: Value of a Statistical Case of Cancer, Conjoint Choice Experiments, Contaminated Sites, Abandoned Sites, Reuse, Remediation

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

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Abstract

We use conjoint choice questions to investigate people's tastes for cancer risk reductions and income in the context of public programs that would provide for remediation at abandoned industrial contaminated sites. Our survey was self-administered using the computer by persons living in the vicinity of an important contaminated site on the Italian National Priority List. The value of a prevented case of cancer is €2.6 million, but this figure does vary with income, perceived exposure to contaminants, and opinions about priorities that should be pursued by cleanup programs.

JEL Classification: J17 (Value of Life), I18 (Health: Government policy, Regulation, Public Health), K32 (Environmental, Health and Safety Law); Q51 (Valuation of Environmental Effects); Q53 (Air Pollution; Water Pollution; Noise; Hazardous Waste; Solid Waste; Recycling).

Keywords: Value of a Statistical Case of Cancer, conjoint choice experiments, contaminated sites, abandoned sites, reuse, remediation.

The Value of Reuse and Reducing Cancer Risks at Contaminated Sites

by

Stefania Tonin, Anna Alberini and Margherita Turvani

1. Introduction and Motivation

Protection of human health is the main driver of many environmental statutes and programs in the US and in other countries. While environmental exposures can trigger or exacerbate many adverse health effects, in the US regulators have traditionally expressed a strong interest in avoiding cancer when seeking to improve air quality (US EPA, 1999; US GAO, 2006[1]), allowing or disallowing the application of certain pesticides on crops (Cropper et al., 1992), specifying the maximum concentrations of arsenic and disinfection by-products in drinking water (US EPA Science Advisory Board, 2006), and requiring remediation of contaminated sites (Superfund and related programs, which were passed in 1980 and 1986).

When attention is restricted to the avoided cancer outcomes, the (monetized) benefits of a proposed regulation are correctly calculated as the (expected) reduction in the cases of cancer attributed to the regulation, times the Value of a Statistical Case of Cancer (VSCC), an ex ante measure that summarizes the willingness to pay for a marginal reduction in the risk of contracting cancer. Estimates of the VSCC, which can be thought of as the value of a prevented case of cancer, are, however, in short supply.

Earlier research has estimated the VSCC by observing how housing prices adjust to the discovery of circumstances that create cancer risks to residents (Gayer et al., 2000, 2002; Davis, 2004) or to the abatement of such risks (Gayer et al., 2000, 2002). Cropper et al. (1992) use the US Environmental Protection Agency's decisions to continue or disallow the

[1] See Hurley et al. (2005) for the benefits of the Clean Air For Europe program.

registration of pesticides on crops, and conclude that the EPA held implicit VSCC of $35 million for pesticide applicators, and of $60,000 for consumers of fruits and vegetables (who would ingest pesticide residue through their normal consumption of fruits and vegetables).

Alternatively, it is possible to conduct surveys and ask people how much they would be willing to pay to reduce their risk of cancer in hypothetical circumstances (e.g., Hammitt and Liu, 2004), or to choose among hypothetical plans for reducing cancer risks. This paper reports on the findings from one such survey.

In December 2007, we surveyed members of the general public living near the industrial complex and contaminated site of Marghera, Italy, for the purpose of estimating the VSCC in the context of contaminated site remediation programs. We used conjoint choice experiments, a stated preference method that allows the analyst to infer the tradeoffs that people make between different attributes of hypothetical programs (see Bateman et al., 2002). The hypothetical programs are described by (i) initial contamination status, (ii) cancer risk reductions delivered by remediation, (iii) proposed land use of the targeted sites, and (iv) one-time cost to the respondent's household.

It is the presence of the cost that allows us to estimate the marginal WTP for a cancer risk reduction, i.e., the VSCC, which is the appropriate construct for estimating the benefits associated with cleanup, since risk assessments typically contain evaluations of lifetime excess cancer risks. Attribute (iii) is included because in recent years many contaminated site remediation programs have sought to encourage the reuse of contaminated properties (see Alberini, 2007, and Guignet and Alberini, 2009, for a discussion of voluntary cleanup programs and an empirical analysis of two such programs) or have touted land revitalization as one of the benefits of traditional enforcement-based remediation programs (see http://epa.gov/superfund/programs/recycle/index.html).

We opted for a stated preference method because the workings of the Italian property tax assessment and escrow system do not allow us to obtain reliable information about property prices at many locales affected by contaminated sites.[2] Revealed stated preference studies of government agencies are likewise impossible: at least for the most egregious sites, information about the cost of cleanup is available, but risk assessment outcome are either incomplete or not publicly disclosed. While it is, in principle, possible to observe individual actions that people undertake to reduce cancer risks, it is problematic to infer values from such behaviors (e.g., healthy diet, exercise, etc.) because of joint outputs (see Bartik, 1988).

Stated preference methods allow us to circumvent some of these problems. Getting people to grasp, and subsequently put a monetary value on, risks, is, however, no easy task. Cognitive difficulties (cancer risks associated with contaminated site exposures are very small) are further complicated by risk perceptions and the fact that cancer is generally a highly dreaded health outcome (see, for example, Chilton et al., 2006 and Hammitt and Liu (2004). Moreover, economic theory does not offer any specific guidance as to whether the VSCC should depend on the context (e.g., air quality v. drinking water or contaminated site programs; occupational exposures v. others) above and beyond the notion that opportunities for self-protection may matter (Shogren and Crocker, 1991).

Common sense and recent non-market valuation research (Bateman et al., 2008) suggest that, when asking people to report the value they place on reductions in cancer risks

[2] Maddison and Bigano (2003) use summary statistics at the provincial level, which they link with information about climate, to estimate how climate is capitalized into housing prices, net of wage rates, in Italy. This approach is not possible with contaminated sites, because of the very localized nature of their effects on property prices.

associated with contaminated sites, attention should be restricted to persons that are educated about and familiar with such risks. This is the reason why we selected our survey sample from the residents of the area immediately adjacent to a high-profile contaminated site on the Italian National Priority List, namely the Marghera site, an extensive and high-profile contaminated site with an estimated cleanup cost of over €750 million.[3]

The Marghera site is a chemical complex that is comprised of both shuttered plants/abandoned areas and active plants. We knew from earlier research projects (Alberini et al., 2007) and the early development work on the questionnaire of the present research project that local residents are well aware of the contamination risks at the Marghera site. Our respondents should, therefore, be well acquainted with contaminated sites, exposure to carcinogens, possible exposure pathways, and remediation.

However, the circumstances surrounding the Marghera sites and related cleanup activities are contentious, and to avoid querying people about an issue that is too emotionally charged, we elected to ask people to report their preference for risk reductions at *other*, less severely contaminated sites—not at the Marghera complex. The Regional Government would be in charge of such less heavily contaminated sites, ensuring, among other things, no "crowding out" between the budget allocated to the Marghera site by the central national government, and the budget available to the Region, and hence no conflict of interest between taking care of the local contamination problem (the Marghera site) and addressing that on a broader Regional scale.

In this paper, we ask three main research questions. First, what *is* the value of a statistical case of cancer for these persons? Second, does the VSCC depend on the sub-

[3] For both magnitude and cost of cleanup, the Marghera industrial complex is thus a "mega site" in the parlance of the US Environmental Protection Agency (see Probst et al., 2001).

populations that would experience the hypothetical risk reduction, such as workers (if the sites were kept for industrial uses), residents (if the site were slated for residential redevelopment), etc.? Third, do familiarity with risks, beliefs about cancer, and opinions about remediation priorities influence the VSCC?

Briefly, we find that our respondents place a value of €2.6 million on a prevented case of cancer. We find that this value does vary with beliefs about cancer and about the appropriateness of long-term, permanent cleanup. There is no evidence, however, that the VSCC depends on the likely beneficiaries of the proposed risk reductions. Wealthier respondents hold higher VSCC values, and there is no evidence of an association between the VSCC and the age of the respondent. The estimates of the VSCC are stable with respect to changes in the specification of the econometric model. Importantly, the responses to the conjoint choice questions satisfy the "scope" requirement, i.e., WTP increases with the size of the risk reduction (Carson, 2000).

To our knowledge, they are the first estimates of the VSCC in Italy. Their magnitude is roughly comparable to those obtained by Gayer et al. (2000, 2002), and Davis (2004) using hedonic housing price approaches to obtain estimates of the VSCC in the context of hazardous waste sites and children's leukemia, respectively. They are also consistent with our own earlier estimates of the Value of a Statistical Life (i.e., the marginal WTP to reduce the risk of *dying*; see Viscusi, 1993) in the context of public programs addressing contaminated sites, which is about €5.6 million (2007 euro) (Alberini et al., 2007).

Caution should be used, however, when applying these figures to benefit-cost analyses of proposed programs or remediation actions at other contamination sites. Our respondents were selected from the residents in the area closest to the contaminated sites of

Marghera, a high-profile site on the Italian NPL. This population is highly sensitive to the issue of contaminated sites and to the adverse health effects of exposure to contaminants from these sites, and it is unclear that other populations would exhibit similar tradeoffs between money and cancer risks. More research is also needed to establish if preferences for risk and money are similar when the cancer risks arise from other contexts (e.g., air pollution) subject to environmental regulation.

The remainder of the paper is organized as follows. Section 2 presents the earlier literature on the Value of a Statistical Case of Cancer. Section 3 describes our study design and section 4 the survey questionnaire. Section 5 presents the econometric model of the responses to the conjoint choice questions. Section 6 describes the data and section 7 the results of the econometric model. Section 8 concludes.

2. Key Concepts and Previous Literature

A. What is the Value of A Statistical Case of Cancer?

Consider a simple static, one-period model. Let U(w) be the (state-dependent) utility of income if the individual is alive and healthy (i.e., cancer-free), and V(w) the utility of income if the individual gets cancer but survives it. We assume that the latter situation occurs with probability q, where $q=p*(1-p_{d|c})$, where p is the probability of getting cancer, and $p_{d|c}$ is the probability of dying of cancer, conditional on getting it in the first place. The probability of being alive and remaining healthy is thus (1-q).

If we further assume that the utility of income when dead is zero (i.e., no bequest utility), expected utility $E(U)$ is defined as $E(U) = (1-q)\cdot U(w) + q \cdot V(w)$. The Value of a Statistical Case of Cancer (VSCC) is defined as the income that the individual would be prepared to give up to obtain a small reduction in the risk of cancer, holding utility constant. Formally, this is $\partial w/\partial p$, which in turn is equal to $(1-p_{d|c})\cdot[U(w)-V(w)]/[(1-q)\cdot U'(w)+q\cdot V'(w)]$. Clearly, $\partial w/\partial p$ is positive, as long as the utility of income when healthy is greater than the utility of income when alive but with cancer. In other words, people should be willing to pay to reduce cancer risks, and should demand compensation for an increase in their risk of getting cancer.

B. Existing Estimates of the Value of a Statistical Case of Cancer

The VSCC is the appropriate construct for computing the ex ante benefits of contaminated site remediation, since risk assessments at contaminated sites typically produce estimates of lifetime excess cancer risks. To our knowledge, there are only few studies in the economics and non-market valuation literature that have estimated the VSCC. Revealed preference studies have inferred the VSCC by observing changes in property values when cancer risks are discovered or abated in the neighborhood where a home is located, or by examining the decisions made by government agencies wishing to protect specific groups of persons potentially exposed to carcinogens.

Gayer et al (2000; 2002) adopt the hedonic housing price method to estimate the value people place on cancer risk reduction in the context of contaminated sites in the US. Using an explicit measure of lifetime cancer risks near specific Superfund sites, they obtain a value of a statistical cancer of $4.3 million to $8.3 million (US$2000) by examining how the real estate market in the Grand Rapids, Michigan, area responds to information about Superfund sites in 1988-93. These figures rest on the assumptions that (i) the risk levels are based on EPA information, (ii) residents would be exposed to the risk for 30 years, (iii) future risks are not discounted, and (iv) there is no latency period before the onset of cancer.

Davis (2004) interprets new cases of child leukemia in Churchill County, Nevada, as a shock to the local real estate market, and documents a 15.6% decline in property values of as new cases of child leukemia were discovered in the neighborhood. The value of a statistical case of child leukemia implicit in the observed declines in property values range between \$3 million and \$9.2 million, depending on assumptions and models. The figures from the Gayer et al. and Davis studies are the VSCCs most closely related to our work.

In addition to examining property value adjustments to changes in cancer risks, it is possible to estimate the value of a prevented case of cancer by examining government agencies' safety and environmental regulation decisions. Cropper et al. (1992) estimate the VSCC implicit in the US EPA's actual pesticide registration or cancellation decisions, finding that this agency implicitly valued a prevented case of cancer among pesticide applicators to be worth \$35 million (1986 US\$). But for consumers, who would ingest pesticide residue in fruits and produce, the value of a statistical cancer avoided is only \$60,000.

Earlier research has also deployed stated preference methods to infer the value of a prevented case of cancer. Fu et al. (1999) use contingent valuation to estimate the willingness to pay for a statistical case of cancer avoided by reducing pesticide residue in food in Taiwan to be \$0.6-1.3 million (1995US\$). Magat et al. (1996) survey 727 respondents in Greensboro, North Carolina, to value reductions in a particular type of cancer risk (lymphoma cancer) using paired choice questions. They estimate a value of preventing a case of curable cancer of \$2.5 million, and a value of avoiding a case of terminal cancer of \$4 million.

Hammitt and Liu (2004) use contingent valuation to estimate the WTP to protect every member of a household in Taiwan from four health risks caused by environmental pollution. The risks vary among the 1200 respondents and differ with respect to whether the disease is latent or immediate, whether it is cancer or another illness, and whether if affects lung or liver. They find that the WTP to reduce the risk of cancer is about one-third larger than the WTP to reduce the risk of another illness. The value of preventing a statistical case of cancer is $0.7-2.2 million (US dollars).

A related issue is whether the value of a prevented *fatality*, also known as the value of a statistical life, is higher when the cause of death is cancer. This "cancer premium" would be due to the dread, fear and pain typically associated with cancer. For example, Jones-Lee et al. (1985) indicate that preventing 100 cancer deaths is valued at about three times the value of preventing accidental deaths. Based on this and other evidence, Tolley et al., (1994) argue that the appropriate VSL for lung cancer mortality may be twice as large as the VSL appropriate for mortality due to accidental, instant death. Other researchers do not support such a premium. For example, Magat et al (1996) conclude that no cancer premium is warranted because people seem indifferent between reducing the risk of cancer and reducing automobile accident.

These arguments have had mixed influence on policy circles. In its interim recommendations intended for the air pollution context in the European Union, the European Commission applies a 40% cancer premium to its base VSL.[4] The US EPA, by contrast, uses a VSL figure that draws heavily from labor market studies and is not adjusted for cancer. Given the lack of unambiguous conclusion about the existence of a cancer premium, the

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[4] These recommendations can be found at http://europa.eu.int/comm/environment/enveco/others/recommended_interim_values.pdf.

Environmental Economics Advisory Committee of the US EPA Science Advisory Board (SAB) came to the conclusion that it is best not to apply the premium, until empirical work clearly establishes the value of it (EPA SAB, 2000). Recent research in this area include Tsuge et al. (2005).

C. Institutional Context

As mentioned, we use stated preference methods to estimate the VSCC in the context of hazardous waste site remediation programs. We conducted our survey in Italy. In Italy, the first piece of legislation addressing hazardous waste sites—the Waste Act—was passed in 1997 (Gazzetta Ufficiale, 1997). The statute requires cleanup if the concentrations of certain pollutants exceed the maximum contaminants limits set by the law for soil and water. A subsequent law (Legislative Decree 152/2006) required that risk assessments be conducted at sites where pollutants exceed the maximum concentration limit, and that remedial plans be based on such risk assessments. Remediation is recommended when excess lifetime cancer risk exceeds 10^{-5} (Gazzetta Ufficiale, 2006).

The Waste Act provides for only limited funding for cleanup,[5] places the burden of remediating orphan sites on the municipalities, and contains an explicit preference for permanent remediation and for on-site treatment of contaminated media. Clearly, it would be useful to be able to place a value on the reduction of such lifetime cancer risks, so that the cancer benefits of remediation can be compared with the costs of the program. At present, the Italian National Priority List (the most egregious contaminated sites, where cleanup is

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[5] 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.

supervised and financed by the central national government) is comprised of about 54 sites, and cleanup costs are expected to total several billion euro (Bottarelli, 2008).

3. Study Design

In this section, we first describe conjoint choice experiments and then provide details on the design and structure of the conjoint choice experiment questions used in our study.

A. Conjoint Choice Experiments

Conjoint choice experiments are a survey-based technique used to investigate the tradeoffs that people are prepared to make between different goods or policies (see Bateman et al., 2002). It is a stated-preference technique, in that it relies on individuals saying what they would do under hypothetical circumstances, rather than observing actual behaviors in marketplaces (Alkrisson and Öberg, 2008).

In a typical conjoint choice experiment survey, respondents are shown alternative variants of a good or a policy described by a set of attributes, and are asked to choose their most preferred (Hanley et al., 2001). The alternatives differ from one another in the levels taken by two or more of the attributes. As long as the price of the good or the cost of the policy to the respondent is one of the attributes of the alternatives, conjoint choice experiments can be used to find the monetary value that people ascribe to the good or the monetized benefits of the policy.

The choice responses are assumed to be driven by an underlying random utility model (see section 4.C).[6] Alberini et al. (2007) review basic econometric models used with conjoint

[6] Most applications to date have adopted indirect utility functions that are linear in the attributes and in residual income. Lusk and Norwood (2005) study the effects of experiment designs and models in the presence of

choice experiments, and Swait (2007) presents more elaborate models that allow for preference heterogeneity (e.g., mixed logit and latent class models).[7]

Since a variety of policies, situations, or goods can potentially be described in a stylized fashion using a set of attributes, conjoint choice experiments have been applied in transportation economics (see Hensher and Rose, 2007, for a recent application), to study the demand for recreation (e.g., Garrod and Willis, 1998; Hanley et al., 2002), to estimate the losses in property values attributed to pollution (Chattopadhyay et al., 2005) or the increase in property values from open space and biodiversity (Earnhart, 2001), to elicit experts' preferences about climate change and its impacts on human health (Alberini et al., 2006), and to estimate the social benefits of soil conservation (Colombo et al., 2006) and the social costs from landfill siting (Sasao, 2004).[8]

One advantage of conjoint choice experiments (and of stated-preference methods in general) is that they allow the analyst to study people's responsiveness to goods, levels of environmental quality, or policy offerings that do not currently exist. Another major advantage is that the attributes can be manipulated independently of one another, allowing the analyst to disentangle their effects separately. This is a great advantage when in real life attributes tend to be bundled together.

Conjoint choice experiments are, of course, not exempt from criticism. Concerns have been raised about the sensitivity of results to the specific design and hypothetical alternatives

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interactions between attributes, and Alberini et al. (2007) adopt an indirect utility function that is non-linear in the coefficients and in the attributes.

[7] See Scarpa and Rose (2008) for an overview and discussion of statistical experiment design concepts—namely, the choice of attribute levels, creation of synthetic alternatives to be examined by the respondents, creation of choice sets for each choice question, and assignment of the respondents to the variant of the questionnaire.

[8] These are selected examples from the environment and planning literature. Additional examples were discussed in Section 3. In the interest of brevity we omit marketing and health applications from this brief review. See Alriksson and Öberg (2008) for numerous references in the environmental area.

adopted by the researcher (see Spash, 2007), dependence of responses on previous responses (Holmes and Boyle, 2005), and perceived complexity of the choice task (Swait and Adamowicz, 2001; Scarpa et al., 2007).

Even more important, there is considerable disagreement among economists as to whether hypothetical responses to hypothetical questions should be trusted (see, for example, Diamond and Hausman, 1994). Lusk and Norwood (2005) document that conjoint choice experiments correctly estimate *actual* marginal willingness to pay for specific attributes exhibited by individuals when purchasing meat. Bateman et al. (2008) document the stability of hypothetical (contingent) valuations when familiarity with the good being valued increases. These arguments suggest that when analyzing the responses to our conjoint choice questions, which we describe below, we should (i) test for scope, namely that people are willing to pay more for larger risk reductions (Carson, 2000), (ii) control for familiarity and personal experience with the health risk we study, namely cancer risks, and (iii) test the internal validity of the responses.

B. Our Conjoint Choice Experiments

The goal of our research is to estimate the VSCC in the context of contaminated site remediation and reuse policies. We use a sample that is presumably familiar with cancer risks from contaminated sites, and wish to see if the VSCC is influenced by beliefs and perceptions about cancer.

To answer these questions, we devised conjoint choice experiments where the alternatives are public programs described by a total of four attributes. These programs would be implemented by the Region, a jurisdiction that is roughly comparable to the State in the United States or the Province in Canada. Over ten years, the hypothetical programs would (i) attain a specified reduction in cancer rates in areas with contaminated sites, (ii) provide for the reuse of the targeted sites (for industrial or residential purpose, or to construct public parks and recreational facilities), or completely prohibit reuse, if appropriate, and (iii) impose a specified one-time cost on the respondent's household that would be incurred immediately.

Regarding (i), it is clear that a cancer rate reduction is possible only if the program targeted contaminated sites to start with. But we also ask people to consider programs that would target idle sites that are not contaminated (in which case, the reduction in cancer rates would be zero), as well as programs that would target contaminated sites, but offer no reduction in cancer rates (because no remediation would be implemented). The initial contamination status of the sites to be targeted by the program is thus another attribute of our hypothetical programs.[9] Hypothetical programs targeting sites that were not contaminated to begin with, or sites that are contaminated but for which no remedial action is offered, there would be no risk reduction benefits—only reuse benefits.

We wish to emphasize that the Marghera site itself would not be addressed by these hypothetical programs, since they would focus on less heavily contaminated sites than those on the Italian National Priority List. The hypothetical programs respondents were to examine and express preferences should create no conflict of interest or perverse incentives for the respondent, since funding for them would come from the Region, whereas cleanup at the Marghera site is funded by the central national government in Italy.

The specific cost amounts provided to the respondents in the survey ranged from €50 to 2000, and were selected because, taken together with the hypothetical risk reductions, they would cover a wide range of possible VSCC values. Specifically, the implied VSCC ranged from a minimum €50,000 (€50 and risk reduction equal to 100 in 100,000) to a maximum of €10 million (€2000 and risk reduction equal to 20 in 100,000).

Attributes and levels of the attributes are summarized in table 1. An example of sample conjoint choice questions is reproduced in the Appendix. As shown in Figure A.1, we first asked respondents to choose between hypothetical programs A and B, each described by the four abovementioned attributes. This question was followed by another question that asked respondents which they would prefer—program A, program B, or no program at all.

Each respondent was shown a total of 6 program A-program B pairs, plus 6 program A-program B-neither program elsewhere questions, for a total of 12 conjoint choice questions.

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

Attribute	**Levels of the attribute**
Condition of the abandoned industrial areas to be targeted by the program	- Contaminated - Not contaminated
Cases of cancer per 100,000 avoided over the next 10 years	0, 20, 50, 100
Reuse	- No reuse - Industrial reuse only - Residential reuse - Public parks and recreational facilities
One-time cost to the respondent's household (in euro)	50, 100, 500, 1000, 2000

Respondents were to be randomly assigned to one of 32 sets of 6 pairs of programs. We created these pairs by (i) first forming all possible combinations of the values of the attributes, (ii) excluding combinations that respondents would find as meaningless or

[9] To the extent it was possible, we kept the levels of the attributes—including contamination status, risk

worthless (e.g., a program that targets non-contaminated abandoned sites, does not do remediation, and plans no reuse, but costs money, or one that proposes to do cleanup at sites that are not contaminated to start with), (iii) selecting pairs at random from the admissible universe of programs thus created, and (iv) ruling out pairs with dominated alternatives. Our final experiment design was balanced, in the sense that each specified alternative was assigned to roughly the same number of respondents and each attribute level appeared evenly in the final sample.

C. Risk Communication

In surveys about the risk of dying, contracting cancer, or experiencing a relatively rare adverse outcome, it is customary to educate respondents about small risks using visual aids. Corso et al. (2001) examine whether people's ability to grasp the magnitude of small risks is affected by different risk visual renditions. Krupnick et al. (2002) and Alberini and Chiabai (2007) use grids of squares to depict probabilities. Alberini et al. (2007) deploy bar charts to convey mortality rate for various causes, including cardiovascular illnesses, cancer, and cancer and other illnesses specifically linked with exposure to pollutants from contaminated sites, and a "denominator" (i.e., a reference population out of which X deaths would be observed) of one million people.

In this questionnaire, however, we did not use risk visuals in this questionnaire, because we felt that they would be distracting and impractical. Instead, we simply presented the incidence of cases of cancer as "X new cases of cancer every year for every 100,000 people." We chose 100,000 because (i) 100,000 is the size of the population living in buffers

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reduction, and type of reuse—as independent as possible from one another to allow us to separately identify the effect of each.

1 and 2 in the area of our sample (see Section 3.D), (ii) the size of the population living in central Mestre, the nearest city, and because (iii) focus groups suggested that people were capable and willing to compute absolute and relative frequencies out of such a reference population.

Exposure to carcinogens at contaminated sites is generally thought to have a latent effect on cancer risks. Likewise, contaminated site cleanup attains reductions in *future* cancer risks, a delay known as "cessation lag" in policy circles (Robinson, 2007). In contrast to previous research (Alberini et al., 2007, Alberini et al., 2009a, 2009b), in this questionnaire we did not present the time lag between remediation actions and cancer risk reductions, or a profile of risk reduction over time. We simply stated to the respondent that the risk reduction would be attained over the next 10 years. One implication of this decision is that we cannot estimate the rate at which respondents discount future risk reductions.

D. Sampling Plan

The goal of our study was to administer the questionnaire to a sample selected from the population that lives near the Marghera NPL site, which is located on the mainland side of Venice, Italy. We focus on the Marghera site because it is extensive (3,690 hectares), it has a very severe and complex contamination problem caused by the chemical and industrial plants that were once housed there, and it is the site on the Italian NPL with the most expensive cleanup (€1,862 million).[10] The cleanup Master Plan (Regione Veneto and Comune di Venezia, 2004) reports that about 1,050 hectares of the Marghera site are

[10] Soil and surface water at the Marghera site contain high levels of volatile hydrocarbon compounds, polycyclic aromatic hydrocarbons, furans, arsenic and other heavy metals.

available or potentially available for reuse, implying that this site is appropriate for studying preferences for remediation within the remediation/reuse context.

Ideally, we would have liked to administer our questionnaire to individuals with different levels of cancer risk due to the contaminants from the Marghera hazardous waste site. Unfortunately, unlike Gayer et al. (2000) and Viscusi and Hamilton (1999), we did not have exact estimates of excess lifetime cancer risks associated with each dwelling in a given area of interest. However, based on prevailing winds and groundwater movement patterns, the distance from one's home to the Marghera site is a reasonable proxy for exposure, and hence cancer risks and familiarity with the issue of contaminated site-induced cancer (Benatelli et al., 2002).

Accordingly, we created three "buffers" around the site with a radius of 1.5, 5 and 10 km, respectively, from the centroid of the Marghera NPL site. Our goal was to sample a pre-selected number of residents from each of the "rings" around the Marghera NPL site thus created. Rings and buffers are displayed in Figures 1 and 2.

We hired a professional market research firm, asking them to recruit residents in each of these three rings to mirror the local population in terms of gender, age, and socio-demographics like education and employment status. Potential survey participants were contacted over the phone by random digital dialing and then invited to a professional facility in downtown Mestre, where they would self-administer the questionnaire using the computer.

The final sample was comprised of 400 people. The dots in Figure 2 represent the homes of individual survey respondents who accepted to participate in the study. Of these 400 respondents, 127 (31.75%) are residents of Buffer 1 (within 1.5 km. of the Marghera site), 190 (47.50%) live in the ring immediately around it (Buffer 2), between 1.5 and 5 km.

of the Marghera site, and 83 (20.75%) live between 5 and 10 km. of the Marghera site, in Buffer 3.

Figure 1. Buffers around the Marghera NPL site.
Red=Buffer 1; Orange=Buffer 2; Green=Buffer 3.

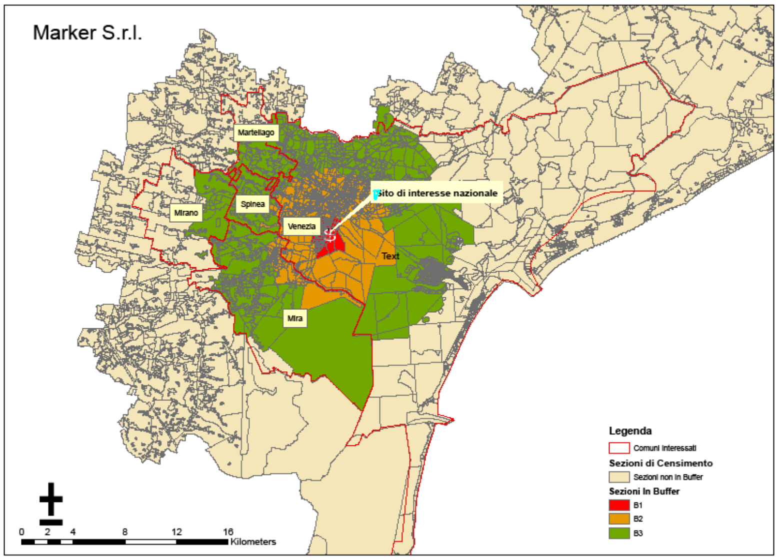
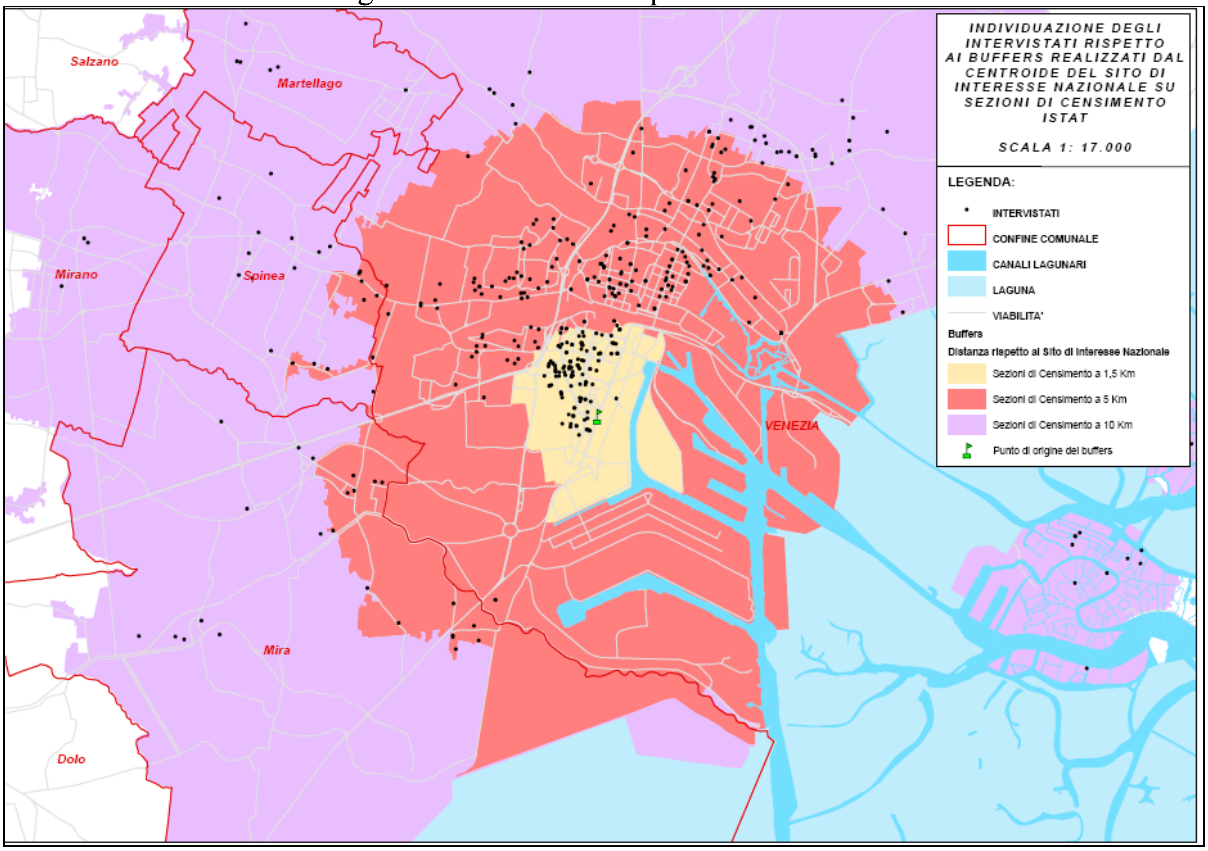


Figure 2. Buffers and respondents' homes.



Legend: Yellow=Buffer 1, Red=Buffer 2, Purple=Buffer 3. The dots represent the homes of the survey respondents.

One concern with our sample is that residents may have self-selected into the riskier areas. In other words, the buffer closest to the site houses persons who are highly exposed to carcinogens, and perceives themselves as such, but are tolerant of such risks. If this is the case, these persons may well report a lower WTP to reduce risks, despite their higher level of exposure and familiarity of risks.

An alternate conjecture is that those persons that live closest to the Marghera NPL Site might have moved there, perhaps recently, because they are less highly educated and unaware of risks. It is unclear how this might affect the WTP to reduce cancer risks, once information about risks is provided in the questionnaire.

Finally, it is possible that persons living very close to the Marghera contaminated site may have chosen to live there because they work or worked at the Marghera chemical plants. If so, they may be subject to occupational exposure to carcinogens, in addition to residential exposure. Theory suggests that the higher the baseline risks, the greater the marginal WTP to reduce *own* risks (the "dead anyway" effect, Pratt and Zeckhauser, 1996), but here we are asking respondents about their preferences for programs addressing other, more diffuse risks associated with contaminated sites exposures.

For good measure, we perform various analyses to check for the presence of these effects in section 6.B below, bearing in mind that it is unclear how they will play out on the WTP for risk reductions, especially since the risk reductions would be incurred in the entire Veneto region, and would be associated with cleanup of sites other than the Marghera site.

4. Structure of the Questionnaire

Our survey questionnaire is self-administered by the respondents using the computer, and was tested in focus groups and one-on-one interviews prior to the final survey. In the early stages of the questionnaire development work, we realized that to understand how people perceive various consequences of the pollution problems associated with contaminated sites (e.g., on property values, on ecological systems, etc.), it is important to avoid mentioning the health risks too soon in the questionnaire, since they tend to overwhelm other non-health concerns. For this reason, the questionnaire begins with asking questions about abandoned sites—without mentioning health concerns—and only later moves to matters of contamination, perceived exposures, and health risks. The questionnaire is divided into 5 sections.

In section 1, respondents are invited to think about abandoned factories, gas stations and other obsolete properties, and to express their opinions about reasons that might make it difficult to reuse such sites. How important would the possible consequences of reusing such sites be for the city they live in and to them personally? Among such possible consequences, we list appreciation in property values, new jobs, human health effects, traffic, aesthetic improvements, reduction in soil, groundwater and air pollution, and benefits to ecological systems. Respondents are, therefore, allowed to think about environmental remediation at these properties, even though contamination was not mentioned in the first place.

In section 2, we zero in on contaminated sites. We begin by inquiring about the respondent's awareness of contaminated sites in general and in his or her neighborhood. Since a respondent's notion of contaminated site may well be different from our own, we then define a contaminated site as "an area with hazardous substances in amounts large enough so as to pose a danger to human health or the environment, now or in the future." We also specify that such substances are found at these sites as a result of prior economic activity, and that hazardous substances include toxic, carcinogenic or corrosive substances. We conclude this section by providing examples of such substances (e.g., heavy metals).

Next, we explain that people can be exposed to pollutants at contaminated sites through dermal contact, by drinking contaminated water, breathing soil and dust laced with contaminants, etc. and ask respondents to estimate their likelihood of being exposed to contamination on a scale from 0 to 100, where 0 means no exposure and 100 means certain exposure. Our subjects are also asked to indicate on a Likert scale their perceived exposure to contaminants for each of five possible exposure pathways (dermal contact, drinking water, inhalation of soil and dust, ingestion of foods that are laced with contaminants, and inhalation of toxic vapors) over the past 20 years and now.

In this section of the questionnaire we also inform respondents that every year areas with contaminated sites experience 20 new cases of cancer for every 100,000 residents[11] more than areas without contaminated sites. This excess is attributed to the hazardous wastes at the contaminated sites.

Since the remainder of the questionnaire is centered around the notion that cleaning up contaminated site reduces cancer rates, it is important to inquire about the respondents' perceptions of the possible causes of cancer. We do so by asking respondents to express their degree of agreement or disagreement with several statements, including the claim that "The same pollutant can cause different types of cancer," "It takes exposure to carcinogens over many years for a person to get cancer," "Cancer is so common that in almost all families someone will get cancer sooner or later," and "Tobacco is one of the main causes of cancer." To ascertain whether respondents believe that cancer can be avoided, we then ask them to rate the effectiveness of specific individual behaviors—including quitting smoking, exercising more, losing weight, etc.—in reducing cancer risks.

Section 3 of the questionnaire illustrates the concept of remediation and describes three widely used remediation techniques—soil excavation, bioremediation, and groundwater pump-and-treat—providing basic information about the types of contaminants for which each technique is best suited, its cost, and the time it takes to complete remediation. This section also inquires about the respondent's familiarity with sites that have undergone remediation, and the perceived effects of remediation on the community. Does the respondent believe that property values will appreciate as a result of cleanup? That jobs will be created? That the aesthetic quality of the neighborhood will be improved? And how important are each of these effects for the city where the respondent lives, and to the respondent personally?

Section 4 of the questionnaire contains the conjoint choice questions. These questions are preceded by an introduction that informs respondents that in the Veneto—the Region whose capital city is Venice and where the survey takes place—there are several contaminated sites that must be assessed and cleaned up. The most severely contaminated of these sites—including the Marghera chemical and industrial complex—are on the National Priorities List and under the oversight of the national government. Others (about 400) fall on the shoulders of the Region or of individual municipalities. The Region also deals with a number of abandoned industrial and commercial sites. All of these properties contain obsolete structures. Some, but not all, may also be contaminated.

The respondent is told that the Region is currently considering programs that would target abandoned sites that were formerly industrial properties. If these sites were found to be contaminated, then cleanup would be necessary. Remediation would be undertaken directly by the government at sites where it is difficult to track down the party responsible for the pollution, the contamination problem is severe, and it is necessary to intervene quickly even though the owners or responsible have not been identified yet. In sum, the Regional programs would promote the reuse of abandoned sites, making sure that remediation is undertaken if such sites are found to be contaminated.[12] We wish to emphasize that these policies would be Region-wide, and they would *not* address the Marghera site because this is covered by the Italian Superfund program, which is run by the central national government.

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[11] These figures were based on our extrapolations from Doll and Peto (1981), and Benedetti et al. (2001).
[12] We chose the Region as the level of government in charge of these public programs because the national government is generally not involved with local land use and land development decisions. The Region is truly in charge of moderately contaminated sites in Italy, and does have some involvement with land use decisions.

Respondents are also told that the Region would acquire the properties to be addressed by the programs, and that such programs would be at least in part financed through new taxes. Respondents are then instructed to examine pairs of hypothetical plans described by four attributes. For each pair, they are asked to indicate which they prefer out of the two programs (a forced choice question), and then which they prefer out of a choice set that includes the two programs, plus an opt-out response option ("program A, program B, or neither program?").

The conjoint choice questions are followed by a task where the respondent must express his or her degree of agreement (or disagreement) with a number of statements about (i) the effects of remediation on the environmental, ecological systems and natural resources, (ii) possible ways to finance cleanup, (iii) policy instruments designed to encourage cleanup and reuse of contaminated sites, and (iv) general goals of remediation programs.

The fifth and last portion of the questionnaire elicits the usual sociodemographics, the health status of the respondent, familiarity with cancer, and an estimate of cancer survival rates.

5. Econometric Model

A. The Model

The statistical analysis of the responses to conjoint choice questions relies on the random utility model (RUM) (see Alberini et al., 2007). In this paper, we assume that respondent *i*'s indirect utility from alternative *j* in choice question *m* (where *m*=1, 2, …, 12) is

(1) $$V_{ijm} = \mathbf{x}_{ijm}\boldsymbol{\alpha} + (y_i - C_{ijm}) \cdot \beta + \varepsilon_{ijm},$$

where **x** is the vector of attributes (which vary across alternatives *and* individuals), C_{ijm} is the cost of the program to the respondent household (expressed in euro and spelled out to be a one-time tax payment) and *y* is income, so that the term in parentheses is residual income, and ε_{ijm} is an error term that captures individual- and alternative-specific factors that influence utility, but are not observable to the researcher. Coefficients $\boldsymbol{\alpha}$ and β are the marginal utilities of the attributes and of income, respectively.

We assume that respondents choose the alternative in the choice set that gives them the highest utility. If the error terms ε are independent and identically distributed and follow a standard type I extreme value distribution, it can be shown that the probability that the respondent chooses alternative *k* out of K alternatives in choice task *m* is

(2)
$$\pi_{ikm} = \frac{\exp(\mathbf{w}_{ikm}\boldsymbol{\theta})}{\sum_{j=1}^{K}\exp(\mathbf{w}_{ijm}\boldsymbol{\theta})}$$

where $\mathbf{w}_{ijm} = \begin{bmatrix} \mathbf{x}_{ijm} \\ C_{ijm} \end{bmatrix}$ is the vector of all attributes of alternative j, including cost, and $\boldsymbol{\theta}$ is equal to $\begin{bmatrix} \boldsymbol{\alpha} \\ -\beta \end{bmatrix}$.

Equation (2) is the contribution to the likelihood in a conditional logit model.[13] It should be noted that in our study K=2 for *m*=1, 3, 5, 7, 9, and 11, in which case the

[13] Implicit in the conditional logit model is the assumption of Independence of Irrelevant Alternatives (IIA), which states that the ratio of the odds of choosing any two alternatives depends only on the attributes of the alternatives being compared, and is not affected by the attributes of other alternatives. An implication of the IIA is that adding another alternative, or changing the characteristics of a third alternative, does not affect the relative odds between alternative *k* and *h*. This imposes very specific substitution patterns among the alternatives.

contribution to the likelihood is simplified to that of a binary logit, and K=3 for m=2, 4, 6, 8, 10, and 12. The log likelihood function is:

(3) $$\ln L = \sum_{i=1}^{n} \sum_{m=1}^{12} \sum_{k=1}^{K_m} y_{ikm} \ln \left[\frac{\exp(\mathbf{w}_{ikm}\boldsymbol{\theta})}{\sum_{j=1}^{K_m} \exp(\mathbf{w}_{ijm}\boldsymbol{\theta})} \right],$$

where y_{ikm} is an indicator that takes on a value of one if respondent *i* select alternative *k* in choice question *m*. The coefficients are estimated using the method of Maximum Likelihood. The VSCC is estimated as the ratio between the coefficient on the risk reduction and the marginal utility of income.

The model described by equations (1)-(3) posits that the marginal utilities of attributes and income are constant for all respondents. We relax this assumption by estimating variants of the model where equation (1) is augmented with interactions between the attributes and individual characteristics of the respondents (or their opinions with respect to specific issues related to the topic of the survey; see section 3.B).

In addition, we also estimate mixed logit models, i.e., models that allow one or more coefficients to be random variables. Formally, we replace $\boldsymbol{\alpha}$ in equation (1) with $\boldsymbol{\alpha}_i$ where $\boldsymbol{\alpha}_i$ is respondent *i*'s vector of coefficients. If the distribution of each $\boldsymbol{\alpha}_i$ is described by a common multivariate density function f($\boldsymbol{\alpha}$), the unconditional probability of observing the sequence of responses exhibited by respondent i is P_i, where P_i is

(4) $$P_i = \int \ldots \int \prod_t \left[\frac{\exp(\mathbf{w}_{it}\boldsymbol{\theta}_i)}{\sum_{j=1}^{K_m} \exp(\mathbf{w}_{ij}\boldsymbol{\theta}_i)} \right] f(\boldsymbol{\alpha}_i) d\boldsymbol{\alpha}_i ,$$

and $\mathbf{w}_{it}$ denotes the attributes of the alternative that was selected by the respondent in choice occasion *t*. The log likelihood function is now:

(5) $$\log L = \sum_{i=1}^{n} \log P_i .$$

Implicit in the notation of equations (4)-(5) is our decision to treat some or all of the marginal utilities of the attributes as potentially random, but the marginal utility of income as a fixed (but unknown) constant. Mixed logit does not impose a restrictive substitution pattern, and caters to situations where some people view an attribute as desirable and others regard it as unattractive. See Henscher and Greene (2003) for a discussion of the properties and performance of mixed logit models.

B. Specification of the Model and Testable Hypotheses

In our base specification, we assume that the indirect utility depends on the reduction in cancer rates, the reuse options offered by the program, interaction terms between the reuse options and the contamination status of the sites that would be targeted by the program, and, of course, residual income. We include the interaction terms because we reason that the attractiveness of the propose reuse options might be modified by concerns about residual contamination. Formally,

(6) $$V = \alpha_{NEITHER} + \alpha_1 \cdot \Delta R + \mathbf{D}\boldsymbol{\alpha}_2 + (\mathbf{D} \times \text{CONTAM})\boldsymbol{\alpha}_3 + (y - C) \cdot \beta + \varepsilon$$

where we have omitted the subscripts to avoid notational clutter, $\alpha_{NEITHER}$ is an alternative-specific intercept, **D** is the vector of INDUSTRIAL reuse only, RESIDENTIAL reuse and PARKSRECREATION reuse dummies, and CONTAM denotes whether the idle sites targeted by the program would be contaminated. Since α_1 is the marginal utility of a one-unit reduction in the probability of contracting cancer, $(\alpha_1 / \beta) \cdot 100{,}000$ is the value of a statistical case of cancer. In (6) and in the other specifications of the model (see below), we code the reuse and contamination attributes as using effects coding (e.g., -1 and 1), and enter the cost of the program as a continuous variable.[14]

The VSCC may vary across respondents, depending on their income, perception of risk, age and other individual characteristics. If respondents associate different groups of beneficiaries of the cancer risk reductions with different uses of the land, and their valuation of cancer outcomes varies with the type of beneficiary, the VSCC depends on the reuse option. Given the local community's concerns about occupational exposures over the last decade, we test this hypothesis by including interactions between ΔR and the use dummies **D** in the indirect utility:

(7) $$V = \alpha_{NEITHER} + \alpha_1 \cdot \Delta R + \mathbf{D}\boldsymbol{\alpha}_2 + (\mathbf{D} \times \text{CONTAM})\boldsymbol{\alpha}_3 + (\mathbf{D} \times \Delta R)\boldsymbol{\alpha}_4 + (y - C) \cdot \beta + \varepsilon .$$

The null hypothesis is that the $\boldsymbol{\alpha}_4$s are all equal to zero.

The theoretical model in section 2 shows that the VSCC should depend on the probability of getting cancer and the probability of surviving it, given that one gets it. It seems, therefore, important to control for perceptions of such risks. For this reason, we test the hypothesis that the valuation of reductions in the probability of developing cancer depends on individual characteristics of the respondent and his or her perceived exposure. Since our respondents were recruited at different distances from the Marghera contaminated sites, and we treat distance from these sites as a proxy for intensity of and familiarity with

[14] We include the interactions between the reuse dummies and the contamination binary indicator to allow for the total WTP for a hypothetical program to depend on the fact that the program targets contaminated sites, whether or not it promises to reduce the health risks associated with the contamination problem.

cancer risks due to contaminants, we create interactions between dummies indicating which buffer the respondent resides in and the risk reductions offered by the hypothetical program:

(8) $V = \alpha_{NEITHER} + \alpha_1 \cdot \Delta R + \mathbf{D}\boldsymbol{\alpha}_2 + (\mathbf{D} \times \mathrm{CONTAM})\boldsymbol{\alpha}_3 + (\mathbf{BUFFER} \times \Delta R)\boldsymbol{\alpha}_5 + (y - C) \cdot \beta + \varepsilon.$

When interpreting results, we need to keep in mind that coefficients $\boldsymbol{\alpha}_5$ may capture both risk perceptions and different tastes for risk reductions and income. In subsequent specifications, equation (8) is augmented to include other interactions between self-assessed exposure and opinions on cancer risks.

6. The Data

A. Descriptive Statistics

Descriptive statistics of respondents are displayed in table 2. Our sample is well-balanced in terms of gender, and its age distribution is consistent with the sampling plan. The average age is 46. The average annual household income is approximately €32,250, which is slightly higher than the Veneto Region average (€29,421, ISTAT, 2008).

Table 2: Descriptive statistics of the respondents (N=400)

VARIABLE	DESCRIPTION	MEAN	STD. DEV.	MIN	MAX
Male	Dummy = 1 if the respondent is a male	0.52	0.50	0	1
Age	Respondent age	46.04	14.48	20	70
age2029	Respondent is aged 20-29	0.17	0.38	0	1
age3044	Respondent is aged 30-44	0.28	0.44	0	1
age4559	Respondent is aged 45-59	0.32	0.47	0	1
Age60plus	Respondent is aged 60 or older	0.23	0.42	0	1
Collegedegree	Dummy = 1 if respondent has a college degree	0.24	0.43	0	1
Highschool	Dummy = 1 if respondent has a high school diploma	0.32	0.44	0	1
Household income	Net household income (€/year)	32250	16803	10000	100000

Almost 32% of our sample has a high school diploma and 24% has a college degree. Comparison with the population of residents of the City of Venice shows that our sample has a larger share of people with high school diploma and college degree than the population. (The population statistics of the City of Venice are 26% and 10%, respectively.)

As shown in Table 3, about 79% of the respondents state that they are aware of contaminated sites, and 42% of them state that these sites are within 1-2 km of their homes. Seventeen percent of the respondents indicate that they can see the contaminated sites from their homes. About 93% of the respondents are acquainted with the concept of cleanup, and 72% state that they are personally aware of previously contaminated sites that had subsequently been cleaned up.

Table 3: Descriptive statistics of the respondents (N=400)

VARIABLE	DESCRIPTION	MEAN	STAND. DEVN.	MIN.	MAX.
Knowsite	Dummy equal to 1 if respondent knows contaminated sites	0.79	0.41	0	1
Knowdov1	Dummy equal to 1 if respondent knows contaminated sites in 1-2 km from home	0.42	0.49	0	1
Seesite	Dummy equal to 1 if respondent sees contaminated sites from their homes	0.17	0.37	0	1
Hearboni	Dummy equal to 1 if respondent has heard about cleanup of contaminated sites before	0.93	0.26	0	1
Knowboni	Dummy equal to 1 if respondent is aware of a contaminated site that has been cleaned up	0.72	0.45	0	1

B. Evidence of Self-Selection

In creating our sampling frame, we assumed that people living closest to the Marghera site would be most strongly aware of cancer risks associated with contaminated site exposure. Because of the potential for self-selection (e.g., people choose to live close to the Marghera site *because* they are risk-tolerant), and because people are asked about programs that would address *other* contaminated sites (and not the Marghera site), it remains to be seen whether these people would, all else the same, hold larger WTP than people living farther from the Marghera site.

In section 3.D we discussed alternate conjectures about exposure, cancer risks, awareness about them, and other constraints that local residents might face. How these play out on the VSCC is uncertain. Briefly, in this section we examine perceptions, education and income levels among the residents of the three "buffers" around the contaminated sites.

Complete descriptive statistics for the three groups are displayed in table A.1 in the Appendix. For starters, the percentage of respondents with income less than €25,000 a year is 59% in buffer 1, 51% in buffer 2, and 47% in buffer 3. The percentage of persons holding college degree, however, is around 25% in all buffers. The percentage of respondents who have worked at the Marghera chemical plants in the past is 64% in buffer 1, 50% in buffer 2, and 47% in buffer 3, and the fraction of respondents who work there currently follows a similar pattern (23%, 16% and 13%, respectively).

Regarding risk and exposure perceptions, we had asked people to estimate the probability of being exposed to the contaminants from contaminated sites (presumably, the Marghera site), and the average probabilities were 68% in buffer 1, 64% in buffer 2, and 59% in buffer 3. When asked about specific pathways, out respondents offered educated and reasonable guesses. For example, over three-quarters of the sample in each buffer rated their exposure via drinking water as non-existent or extremely low. (This is correct, since they do not drink locally drawn groundwater.) By contrast, the percentage of people rating their exposure to vapors (volatile compounds are a major type of contamination at the Marghera site) and particulates/dust as “high” declines with distance from the Marghera site.

Taken together, these statistics suggest that individuals living close to the Marghera site are aware of and concerned about risks, and that they live there because of proximity to their workplace or because they cannot afford to move.

C. Responses to the Conjoint Choice Questions

Table 4 reports the relative frequencies of the responses to the conjoint choice questions. Perusal of table 4 suggests that the responses to the choice questions are reasonable and well-balanced. Potentially abnormal response patterns are limited to very few respondents.

For example, only 5% of the sample always selected the right-hand alternative in a choice question, only 2.25% of the respondents always selected the left-hand side alternative, and only 8.75% of the subjects always selected the “neither program” option when it is was offered to them. Preference reversals—which occur when, for example, a subject selects program A out of program A and program B, but program B out of the choice set consisting of program A, program B and neither program—were observed for only 4.50% of the respondents.

Table 4: Summary of the responses to the choice questions.

PAIR	DISTRIBUTION OF RESPONSES IN PROGRAM A V. PROGRAM B QUESTION	DISTRIBUTION OF RESPONSES IN PROGRAM A V. PROGRAM B V. NEITHER PROGRAM QUESTION
1	Choose A: 52.00% Choose B: 48.00%	Choose A: 38.50% Choose B: 33.25% Choose Neither: 28.25%
2	Choose A: 56.00% Choose B: 44.00%	Choose A: 40.25% Choose B: 29.50% Choose Neither: 30.25%
3	Choose A: 50.25% Choose B: 49.75%	Choose A: 37.25% Choose B: 35.25% Choose Neither: 27.50%
4	Choose A: 63.25% Choose B: 36.75%	Choose A: 50.25% Choose B: 25.25% Choose Neither: 24.50%
5	Choose A: 48.25% Choose B: 51.75%	Choose A: 33.75% Choose B: 37.50% Choose Neither: 28.75%
6	Choose A: 43.00% Choose B: 57.00%	Choose A: 28.75% Choose B: 43.00% Choose Neither: 28.25%

7. Results

Table 5 summarizes the regressors included in our logit models, and tables 6.a and 6.b display estimation results from selected specifications. In our logit models, we treat the risk reductions and the cost of the program as continuous variables, and adopt effects coding for our binary attributes (e.g., reuse for industrial purposes). All responses are assumed independent across and within respondents. In general, the usual goodness-of-fit statistics (not reported) indicate that the model is well behaved and that the regressors jointly considered are significantly associated with the responses.

Table 5: Definition of variables in the conditional logit model.

Variable name	Definition
industrialreuseR	= 1 if industrial reuse for sites targeted by the hypothetical program, and -1 otherwise
residentialreuseR	= 1 if residential reuse for sites targeted by the hypothetical program, and -1 otherwise
parksrecreationR	= 1 if parks/recreational facility reuse for sites targeted by the hypothetical program, and -1 otherwise
Highincome	Dummy =1 if income higher than €32,000, 0 otherwise
age3044	Dummy =1 if respondent is aged 30-44, 0 otherwise
age4559	Dummy =1 if respondent is aged 45-59, 0 otherwise
age60plus	Dummy =1 if respondent is aged 60 and older, 0 otherwise
probsurv	Respondent self-assessed 5-year cancer survival rate
fatalist	Dummy =1 if respondent agrees or completely agrees with the statement that cancer is so common that most households will be affected at some time
manyrs	Dummy =1 if respondent agrees or completely agrees with the statement that an exposure of many years is needed to get cancer
permanent	Dummy =1 if respondent agrees or completely agrees with to give priority to permanent and effective cleanups even if they are more expensive
prosalute	Dummy =1 if respondent agrees or completely agrees that cleanup should be done only if the sites pose human health risks
futurebenefit	Dummy =1 if respondent agrees or completely agrees that we should avoid spending money in cleanups that will save human lives only 30 years from now

Specification (A) is our base specification. Clearly, people are more likely to choose programs with larger risk reduction, and less likely to choose, all else the same, more expensive program. In other words, our survey results indicate that WTP satisfies the "scope" requirement, and are consistent with the economic paradigm. The implied value of a statistical case of cancer is €2.612 million (standard error €0.274 million).[15]

People are not especially attracted to programs that would imply industrial reuses, but are more favorable to programs that offer residential reuse when the targeted properties were

[15] If one assumes that a conditional mortality of 70%, as in Alberini et al. (2007), the implied value of a statistical life, when the cause of death is cancer, is €3.732 million. This is slightly smaller than, but within the

initially contaminated, and to turning idle properties—whether or not contaminated—into public parks and community recreational facilities. The "neither program" alternative-specific intercept is positive, but statistically weak, indicating that people tend to choose the "neither program" option only just slightly more frequently than would be predicted by the mere value of the attributes for that alternative.

Panel (B) corresponds to equation (7), where we ask whether the VSCC varies with the type of reuse and the likely beneficiaries of the risk reduction. The estimated coefficients are very similar to their counterparts in panel (A), and the coefficients on the interaction terms between the cancer risk reductions and the reuse options offered by the hypothetical programs are individually and jointly insignificant,[16] indicating that the VSCC does not depend, after all, on the type of reuse or the likely beneficiaries of the associated risk reductions.

In specification (C), we wish to explore whether the VSCC varies with the distance from the Marghera contaminated sites, reflecting risk perceptions as well as different tastes for risk and income. This model suggests that, all else the same, the VSCC is roughly the same among people living up to 1.5 km from the contaminated site (BUFFER1) and 1.5-5 km from the sites (BUFFER2), for whom it is equal to €2.77 million (s.e. €0.351 million) and €2.98 million (s.e., €0.334 million), respectively. These figures are significantly larger than the VSCC held by people that live the farthest from the sites, which is about €1.62 million (s.e. €0.333 million). These results imply that the heightened level of concern about cancer risks among residents that live closest to a notorious (Italian) Superfund site translates into a

ballpark of, our own earlier estimates of the VSL in the hazardous waste site cleanup policy context, based on a survey of the Italian public (Alberini et al., 2007).

[16] The likelihood ratio statistic is 2, and thus falls within the acceptance region of the chi square with 3 degrees of freedom at the conventional levels.

higher willingness to pay per unit of risk reduction, even though the risk reduction promised by the program is not strictly associated with the Marghera site.

We speculate that persons that hold little hope of surviving cancer would be willing to pay more to reduce the risk of contracting it (at least through contaminated site exposures). It is unclear to us if those people who believe that there will be someone who gets cancer in virtually every family—an attitude which we consider "fatalistic"—and those who believe that it takes continued exposure to pollutants for many years before cancer arises would be willing to pay more or less to reduce the risk of cancer.

To examine these questions empirically, in specification (D) we enter interactions between the risk reduction and PROBSURV, the respondent's estimate of the 5-year cancer survival rate, and dummies denoting strong agreement with the abovementioned beliefs. Against our expectations, we find that those respondents who estimate higher 5-year cancer survival rates are actually willing to pay more for any given risk reduction delivered by the program. However, while statistically significant at the 5% level, the coefficient on ($\Delta R \times$PROBSURV), where PROBSURV denotes the respondent self-assessed 5-year cancer survival rate, implies only a very small effect on the VSCC.[17] We speculate that the positive sign of this coefficient may reflect optimism about the possibility that it is actually possible to fight or limit the incidence of cancer.

Specification (D) further suggests that there is no particular association between "fatalism" about cancer or beliefs about continuous exposure to carcinogens over a long period of time and the VSCC. Among other things, the results of this specification also

[17] To illustrate, consider a resident of the area at 5-10 km. from the site who believes that the cancer survival rate at 5 years is 0%. For such a respondent, based on model (D) we estimate the VSCC to be €2.04 million. Had this respondent assessed the 5-year survival rate to be 50%, the VSCC would have been €2.08 million. The VSCC would rise to €2.13 million—a rather modest increase—had the estimated 5-year survival rate been 90%.

confirm that people that live closest to the site and those in the 1.5-5 km buffers share a similar VSCC, which is higher than that held by people living in the area at 5-10 km from the contaminated sites.

Finally, in specification (E) we enter a high-income dummy, age group dummies, and further dummies capturing the respondents' beliefs that (i) priority should be given to permanent cleanups, even if they are more expensive, (ii) remediation should be undertaken only if human health risks are present, and (iii) remediation should be avoided at sites where the benefits are incurred only 30 years or more into in the future. All of these variables are entered in the form of interactions with the cancer risk reduction.

The results show that our basic story does not change: the coefficient on risk reductions continues to be positive and significant, and that on the interaction between risk reduction and the high-income dummy is positive and significant, suggesting that persons with annual household income greater than €32,000 have a VSCC that is almost twice as large as that of the other respondents. We did not find evidence that the VSCC varies with the age of the respondent, but persons that expressed support for long-term remediation appear to hold a larger VSCC. By contrast, those who would want to do remediation only if human health is at risk hold lower VSCC values, as do those who disapprove of cleanup program priorities that risk reduction that occur only well into the future.

All in all, the results of specification (A)-(E) suggest that respondents were trading off the attributes of the alternatives as expected, and that in doing so they did take their budget constraint and their beliefs about the effectiveness of the policy, the timing of the benefits, and the permanence of the risk reductions into account. Importantly, the coefficient on the risk reduction is positive and significant, implying that the responses to the conjoint choice questions satisfy the "scope" requirement.

We re-ran all models allowing for specific coefficients to be random. In all of these mixed logit runs, we treated the marginal utility of income as a fixed coefficient. Even in the simplest mixed logit models (i.e., those where the only random coefficients are those on the risk reduction and its interactions with other variables) our routines either experienced convergence problems or ended up showing little evidence of unobserved heterogeneity.[18]

[18] We used proc MDC in SAS.

Table 6.a: Conditional logit model. Basic Specifications.

	(A)		(B)		(C)	
	coeff	t stat	coeff	t stat	coeff	t stat
deltarisk	0.009875	14.64	0.0113	7.67	0.006174	5.28
cost	-0.00038	-11.53	-0.00038	-11.48	-0.00038	-11.61
industrialreuseR	-0.0199	-0.38	-0.0709	-1.04	-0.0143	-0.27
residentialreuseR	-0.0095	-0.18	-0.0579	-0.85	-0.00351	-0.07
parksrecreationR	0.4117	6.68	0.3649	4.95	0.4169	6.76
contaminationstatus × industrialreuseR	-0.0449	-0.92	-0.0405	-0.72	-0.0442	-0.9
contaminationstatus × residentialR	0.1718	3.37	0.1639	2.88	0.1693	3.32
contaminationstatus × parksrecreationR	-0.0418	-0.75	-0.0571	-0.97	-0.043	-0.77
deltarisk × industrialR			0.000871	0.8		
deltarisk × residentialR			0.001098	1		
deltarisk × parksrecreationR			0.001252	1.22		
deltarisk × buffer1					0.004406	3.01
deltarisk ×buffer2					0.005183	3.8
Neither (alternative-specific intercept)	0.1309	1.61	0.0349	0.3	0.1401	1.72
Nobs	4800		4800		4800	
log L	-3902		-3901		-3895	

Table 6.b: Conditional logit model. Specifications with Attitudinal Variables.

	(D)		(E)	
	coeff	t stat	coeff	t stat
deltarisk	0.007593	5.71	0.005292	2.38
cost	-0.00037	-11.19	-0.000382	-11.52
industrialreuseR	-0.0372	-0.69	-0.0320	-0.60
residentialreuseR	-0.00554	-0.10	-0.0128	-0.24
parksrecreationR	0.4287	6.81	0.4038	6.52
contaminationstatus × industrialR	-0.0232	-0.46	-0.0532	-1.08
contaminationstatus × residentialR	0.154	2.96	0.1679	3.27
contaminationstatus × parksrecreationR	-0.0559	-0.98	-0.0409	-0.73
deltarisk × buffer1	0.003332	2.21		
deltarisk × buffer2	0.00447	3.15		
deltarisk × highincome			0.005392	4.70
deltarisk ×age3044			0.000852	0.50
Deltarisk ×age4559			0.000287	0.17
Deltarisk ×age60plus			-0.00223	-1.27
deltarisk × probsurv	0.000423	2.17		
deltarisk × fatalist	-0.00115	-1.03		
deltarisk × manyrs	-0.00126	-1.00		
deltarisk × permanent			0.004686	2.93
deltarisk × prosalute			-0.00302	-2.23
deltarisk × futurebenefit			-0.0136	-6.00
Neither (alternative-specific intercept)	0.1428	1.72	0.1098	1.34
N	4632		4800	
log L	-3744		-3849	

8. Conclusions.

Scholars and critics of the US Superfund program (see Viscusi and Hamilton, 1999, or Greenstone and Gallagher, 2006) bemoan the high cost of this program relative to its achievements. To judge whether this program or similar programs addressing hazardous waste sites in other countries pass the benefit-cost test, it is important to obtain reliable estimates of the Value of a Statistical Case of Cancer, since risk assessment outcomes are often comprised of excess lifetime cancer risks.

In this paper, we have deployed stated-preference methods to obtain estimates of the VSCC. Our survey questionnaire was self-administered by respondents selected from the population living at specified distances of the most notorious site on the Italian NPL—the Marghera site near Venice, Italy.

Our conjoint choice questions asked people to indicate the most preferred among public programs defined by four attributes—cancer risk reduction, contamination status of the properties that would be targeted by the program, proposed reuse, and cost. We were especially curious to see if people living closest to the site would actually have higher or lower marginal utility of cancer risk reduction, as a result of perceived exposure, self-selection, etc. even though the hypothetical programs would cover other, less heavily contaminated, sites in the Region.

Conditional logit models of the responses to our conjoint choice questions show that our respondents' value of a statistical case of cancer is about €2.6 million. Despite the possibility that people living closest to the Marghera site might be more risk-tolerant, they still have the highest WTP for reducing cancer risks associated with contaminated site exposures, even if such risk reductions were incurred by populations living near *other* sites. The VSCC is higher among respondents with higher income, and is affected in reasonable ways by the respondents' opinions of priorities for cleanup.

We conclude that our VSCC estimate of €2.6 million is a reasonable candidate for benefit-cost analyses of remediation programs that reduce lifetime cancer risks in Italy. Since our sample is highly sensitized to contaminated site issues, more research is needed to see if our VSCC can be applied at other locales with contaminated site problems within the same country (in Italy) or in other countries. More research is also needed to ascertain how applicable our VSCC figures are to other environmental policy contexts.

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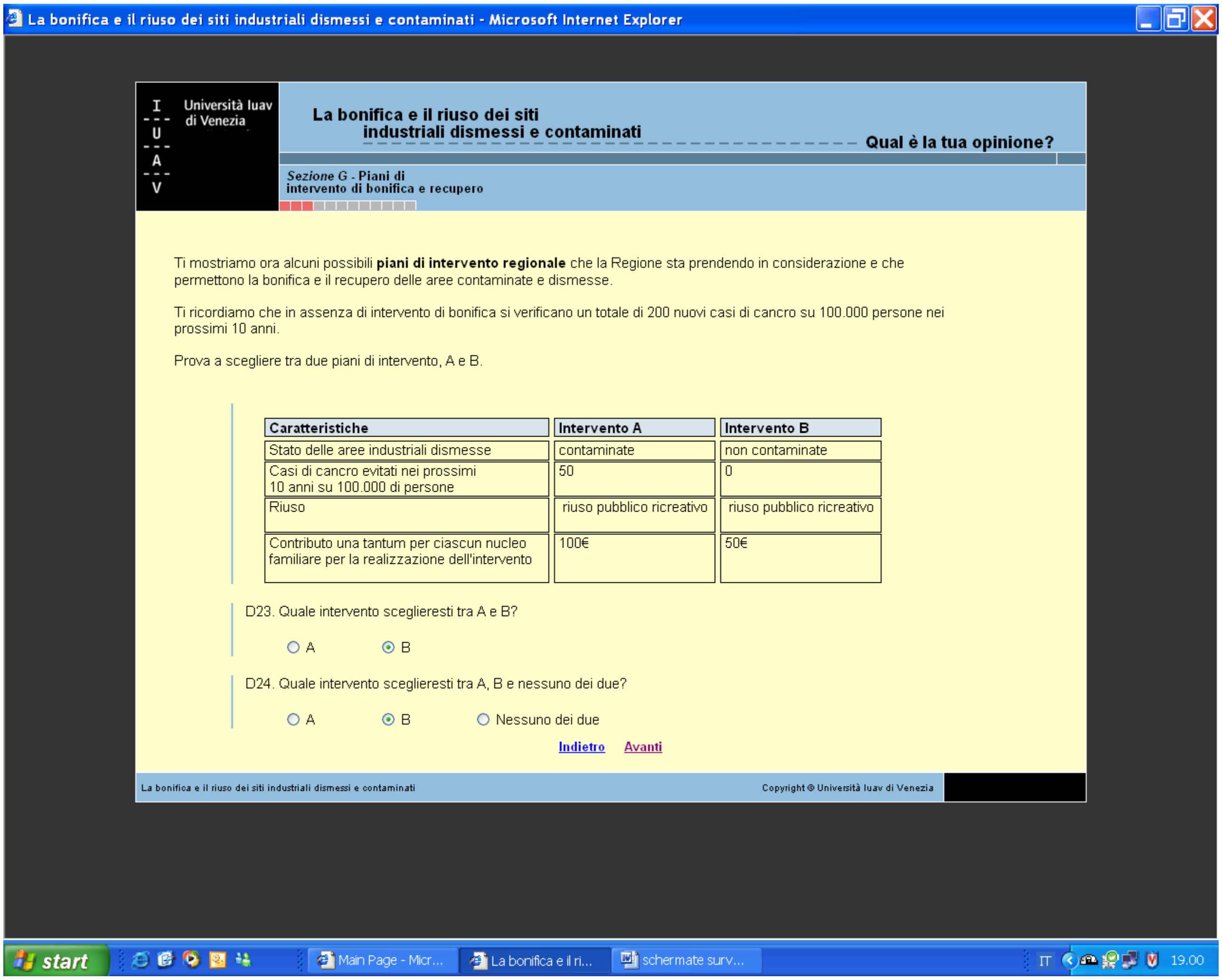
Appendix.

Figure A.1: Example of Choice question


La bonifica e il riuso dei siti industriali dismessi e contaminati - Microsoft Internet Explorer

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La bonifica e il riuso dei siti industriali dismessi e contaminati

Qual è la tua opinione?

Sezione G - Piani di intervento di bonifica e recupero

Ti mostriamo ora alcuni possibili **piani di intervento regionale** che la Regione sta prendendo in considerazione e che permettono la bonifica e il recupero delle aree contaminate e dismesse.

Ti ricordiamo che in assenza di intervento di bonifica si verificano un totale di 200 nuovi casi di cancro su 100.000 persone nei prossimi 10 anni.

Prova a scegliere tra due piani di intervento, A e B.

Caratteristiche	Intervento A	Intervento B
Stato delle aree industriali dismesse	contaminate	non contaminate
Casi di cancro evitati nei prossimi 10 anni su 100.000 di persone	50	0
Riuso	riuso pubblico ricreativo	riuso pubblico ricreativo
Contributo una tantum per ciascun nucleo familiare per la realizzazione dell'intervento	100€	50€

D23. Quale intervento sceglieresti tra A e B?

○ A ◉ B

D24. Quale intervento sceglieresti tra A, B e nessuno dei due?

○ A ◉ B ○ Nessuno dei due

Indietro Avanti

La bonifica e il riuso dei siti industriali dismessi e contaminati

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Table A.1.: Main descriptive statistics explaining self-selection

VARIABLE	DESCRIPTION	MEAN	STAND. DEVN.	MIN.	MAX.
Lowincome1	People living in buffer 1 with less than 25000 euros	0.59	0.49	0	1
Lowincome2	People living in buffer 2 with less than 25000 euros	0.51	0.50	0	1
Lowincome3	People living in buffer 3 with less than 25000 euros	0.47	0.50	0	1
College1	Dummy equal to 1 in people living in buffer 1 has college degree	0.26	0.44	0	1
College2	Dummy equal to 1 in people living in buffer 2 has college degree	0.28	0.45	0	1
College3	Dummy equal to 1 in people living in buffer 3 has college degree	0.25	0.43	0	1
Worked1	Dummy equal to 1 in people living in buffer 1 worked in the past in the industrial area of Porto Marghera	0.64	0.48	0	1
Worked2	Dummy equal to 1 in people living in buffer 2 worked in the past in the industrial area of Porto Marghera	0.50	0.50	0	1
Worked3	Dummy equal to 1 in people living in buffer 3 worked in the past in the industrial area of Porto Marghera	0.47	0.50	0	1
Worknow1	Dummy equal to 1 in people living in buffer 1 works in the industrial area of Porto Marghera	0.23	0.42	0	1
Worknow2	Dummy equal to 1 in people living in buffer 2 works in the industrial area of Porto Marghera	0.16	0.37	0	1
Worknow3	Dummy equal to 1 in people living in buffer 3 works in the industrial area of Porto Marghera	0.13	0.34	0	1
Probexp1	Estimated probabilities of being exposed to the contaminants from contaminated sites in buffer 1	0.68	0.27	0.03	1
Probexp2	Estimated probabilities of being exposed to the contaminants from contaminated sites in buffer 2	0.64	0.26	0	1
Probexp3	Estimated probabilities of being exposed to the contaminants from contaminated sites in buffer 3	0.59	0.27	0.01	1
Water1	Dummy equal to1 in people living in buffer 1 think that their exposure via drinking water is low or extremely low	0.80	0.40	0	1
Water2	Dummy equal to1 in people living in buffer 2think that their exposure via drinking water is low or extremely low	0.76	0.43	0	1
Water	Dummy equal to1 in people living in buffer 3 think that their exposure via drinking water is low or extremely low	0.75	0.44	0	1
Vapor1	Dummy equal to1 in people living in buffer 1 think that their exposure to vapors is high or extremely high	0.36	0.48	0	1
Vapor2	Dummy equal to1 in people living in buffer 2 think that their exposure to vapors is high or extremely high	0.34	0.47	0	1
Vapor3	Dummy equal to1 in people living in buffer 3 think that their exposure to vapors is high or extremely high	0.24	0.23	0	1

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SD	39.2009	Alexey Kushnir (lxxxv): Matching Markets with Signals
SD	40.2009	Alessandro Tavoni (lxxxv): Incorporating Fairness Motives into the Impulse Balance Equilibrium and Quantal Response Equilibrium Concepts: An Application to 2x2 Games
SD	41.2009	Steven J. Brams and D. Marc Kilgour (lxxxv): Kingmakers and Leaders in Coalition Formation
SD	42.2009	Dotan Persitz (lxxxv): Power in the Heterogeneous Connections Model: The Emergence of Core-Periphery Networks
SD	43.2009	Fabio Eboli, Ramiro Parrado, Roberto Roson: Climate Change Feedback on Economic Growth: Explorations with a Dynamic General Equilibrium Mode
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SD	46.2009	Eftichios S. Sartzetakis, Anastasios Xepapadeas and Emmanuel Petrakis: The Role of Information Provision as a Policy Instrument to Supplement Environmental Taxes: Empowering Consumers to Choose Optimally
SD	47.2009	Jean-François Caulier, Ana Mauleon and Vincent Vannetelbosch: Contractually Stable Networks
GC	48.2009	Massimiliano Mazzanti, Susanna Mancinelli, Giovanni Ponti and Nora Piva: Education, Reputation or Network? Evidence from Italy on Migrant Workers Employability
SD	49.2009	William Brock and Anastasios Xepapadeas: General Pattern Formation in Recursive Dynamical Systems Models in Economics
SD	50.2009	Giovanni Marin and Massimiliano Mazzanti: Emissions Trends and Labour Productivity Dynamics Sector Analyses of De-coupling/Recoupling on a 1990-2005 Namea
SD	51.2009	Yoshio Kamijo and Ryo Kawasaki (lxxxv): Dynamics, Stability, and Foresight in the Shapley-Scarf Housing Market
IM	52.2009	Laura Poddi and Sergio Vergalli: Does Corporate Social Responsibility Affect the Performance of Firms?
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IM	55.2009	Giacomo Calzolari and Carlo Scarpa: On Regulation and Competition: Pros and Cons of a Diversified Monopolist
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IM	57.2009	Emmanuel Farhi and Jean Tirole: Collective Moral Hazard, Maturity Mismatch and Systemic Bailouts
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SD	59.2009	Rob Dellink, Michel den Elzen, Harry Aiking, Emmy Bergsma, Frans Berkhout, Thijs Dekker, Joyeeta Gupta: Sharing the Burden of Adaptation Financing: An Assessment of the Contributions of Countries
SD	60.2009	Stefania Tonin, Anna Alberini and Margherita Turvani: The Value of Reducing Cancer Risks at Contaminated Sites: Are More Heavily Exposed People Willing to Pay More?

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