Is allocation affected by the perception of others' irresponsible behavior and by ambiguity?

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Abstract

The paper examines how the perception of others' irresponsible behavior and ambiguity regarding probabilities affect allocation among potential beneficiaries. To elicit these views, we conducted a survey where the participants were first asked to make an allocation of a fixed sum of money between a hereditary cancer, where chance plays a central role, and a lifestyle-related cancer, where individual lifestyle decisions are more important. Our estimation results show that a substantial share of the respondents allocates significantly more to the hereditary cancer. This may indicate that these respondents care about others' irresponsible behavior. Then, we elicited perceptions of cancer hazards in the form of imprecise probabilities and examined the interplay between allocating behavior and risk perceptions. Finally, we investigated the effects of various socio-economic characteristics, and of awareness of highly-publicized cancer cases, on respondents' allocations.

Keywords: responsibility, ambiguity, moral considerations, ethics, charitable contributions

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1 Introduction

Although risk has many facets, most research and applications related to the measurement of risk focus only on two key dimensions: the set of possible consequences and their likelihoods. Notable exceptions are Gardoni and Murphy (2014) who, following Keller and Sarin (1988), argue that ethical and moral considerations should also play a key role in the evaluation and comparison of diverse risks. Gardoni and Murphy expand the common definition of risk to include a third dimension, the source of a risk, that reflects (i) causation and responsibility for bringing about a hazard, (ii) whether the risk is voluntary and (iii) the relation between the risk bearer and the party who caused the risk. These authors construct a scale of risk as a multidimensional ranking, based on a comparative evaluation of the consequences, probability, and source of a given risk. According to them, the more morally culpable the source the higher the scale of the risk. Hansson (2016) echoes Gardoni and Murphy by arguing that limited coverage of ethical issues is one of the fundamental weaknesses of standard probabilistic risk analysis. He claims that risk analysis typically deals with probabilities and consequences and neglects intentionality, responsibility and justice, which are part of the ethics of risk-taking and risk imposition. One of the goals of the present paper is to mitigate this neglect by contributing to our understanding of the responsibility issue.

Another important facet of risk that is sometimes not a focus of attention in risk analysis pertains to the uncertain nature of likelihoods of different consequences.[1] Flage, Aven, Zio and Baraldi (2014) observe that "a broader perspective is required to allow uncertainty representations other than probability". Understanding how individuals perceive ambiguity and how this perception affect their behavior is another goal of this paper.

Next we review the relevant literature on responsibility and ambiguity, followed by a short description of our research and its objectives.

[1] For notable examples where uncertainty of likelihoods is at the center stage, see, e.g., Curley, Yates, and Abrams (1986) and Tversky and Fox (1995).

1.1 Literature Review

Responsibility. Considerations related to individuals' responsibility for bringing about a hazard are at the center stage of health, financial, environmental and many other risks. In health, a recent example is offered by a policy change in the operation of the National Health System (NHS) in the United Kingdom. In 2014, the NHS Blood and Transplant Service announced that it was changing its current policy by allowing people with severe drink-related liver diseases to be considered for liver transplants (The Guardian, 2014).[2] Many questioned the appropriateness of this decision mentioning that individuals who are likely to have harmed their own health are not as deserving of treatment.

In fact, the debate regarding liver transplantation for alcohol abusers can be traced to at least early nineteen-nineties, and one of the most notable exchanges of the time is offered by Moss and Siegler (1991) and Cohen and Benjamin (1991), who provide diametrically opposite views on the issue. More generally, for over 30 years the question of whether patients with illnesses caused by own actions should receive lower priority in access to healthcare resources has been at the centre stage of a heated debate involving prominent scholars from a variety of disciplines. Although this debate is still largely unresolved, a considerable progress has been made in understanding various forces shaping pros and cons of rationing healthcare resources for individuals who may have contributed to their illnesses.[3] Daniels (2008) and Segall (2009), who offer opposing views, are notable examples in this debate. Segall characterizes "disadvantages as being unjust ... [*only*] when they result from conduct or factors that it would be unreasonable to expect the agent to avoid" (page 10). Daniels rejects attempts at making "people bear the cost of risky lifestyle choices" (page 67) and advances a number of arguments against it, including difficulties associated with ascertaining individual responsibility for health outcome and adverse consequences of intrusiveness, and liberty and privacy infringement. Expanding on Daniels, Feiring (2008) distinguishes between backward-

[2]There are examples of changes in the opposite direction. In 2016 hospital leaders in North Yorkshire, UK, announced that overweight patients and smokers will be prohibited from most standard hip and knee surgeries for up to a year (The Telegraph, 2016).

[3]Sharkey and Gillam (2010) provide an insightful review of the debate surrounding the role of individual responsibility in the allocation of healthcare resources. They identify and examine twelve arguments for and against holding individuals responsible for the choices adversely affecting their health.

and forward-looking responsibility. The former is associated with past choices and Feiring voices doubts regarding the morality of holding people responsible for such choices. Instead, she advocates a forward-looking view according to which individuals are asked to commit to lifestyles that increase efficacy of medical treatments. Schmidt (2009) advances another approach that is compatible but wider than Daniels'. He puts forward a notion of health responsibility as co-responsibility, and advocates that it is more nuanced and less punitive than holding people fully responsible for their actions. Schmidt also provides useful tests for the applicability of his approach in health-care. More generally, Cappelen and Norheim (2005) and Buyx (2008) argue that liberal egalitarianism, which also advocates co-responsibility and emphasizes social solidarity, is preferable for setting rationing criteria for healthcare provision.[4]

Responsibility for actions that adversely affect other individuals and private and public property form a foundation of legal and regulatory systems in most societies (e.g., Shavell, 1984, Duff, 2007). Redistribution of income and wealth is another important area where individual responsibility for poor choices frequently has a key role. Fong (2001) analyzes a Gallup poll and finds that respondents care about responsibility. According to her findings, "A strong taste for equity or reciprocity is consistent with the basic concept of insuring industrious people against bad luck, but not providing unconditional assistance to the poor if their condition is due to idleness." Diverse views of how inadequate choices should influence redistributive policies also reverberated during the most recent global financial crisis.[5] While some defended the use of government funds to help the troubled financial institutions on the basis that the alternative was even worse, many individuals and interest groups vehemently objected to it. Among them was a group of prominent professional economists who wrote to the US Congress cautioning against a bailout of "particular investors and institutions whose choices proved unwise" (Wolfers, 2008).

Ambiguity. Flage, Aven, Zio and Baraldi (2014) argue that interval of imprecise proba-

[4]See also, e.g., Friedman et al. (2007) and Gulyn and Youssef (2010), for attributions of blame in health contexts and Bulman and Wortman (1977), Mikula (2003), and Shaver (2012) for general settings.

[5]Disagreements between experts regarding fairness are symptomatic of many other debates where both luck and individual responsibility affect the probability distribution over possible outcomes.

bilities can be a useful tool for representing uncertainty surrounding likelihoods of many hazards, especially catastrophic events. At an individual level, such uncertainty is prevalent for perceptions of many risks and, in particular, for those considered in the present paper. Individuals form their perceptions about cancer incidence and its dependence on lifestyle behavior based on a variety of sources, including popular media outlets and scientific publications. However, estimates coming from different sources, even scientific, are frequently contradictory. For example, Tomasetti and Vogelstein (2015) estimate that the majority of cancers are due to "bad luck" and are completely out of people's control while Wu et al. (2016) estimate that 70% to 90% of cancers are due to avoidable, extrinsic risk factors. Such diversity of scientific estimates may prevent individuals from forming precise risk estimates of their ability to prevent cancers. As a result, they may face ambiguity, a term used by Ellsberg (1961), in the form of multiple probabilities of getting different cancers and associated outcomes (Han et al., 2006, 2007). A similar notion (under a different name) is a major component of the probability dimension of Gardoni and Murphy's scale of risk.

1.2 Research Strategy

The cases described in relation to responsibility clearly demonstrate that society members, including policy makers, experts, scholars and the public, have different views regarding responsibility. To understand these views and to see how to incorporate them into models used in risk analysis and management we concentrate here, as a first step, on the general public, and conduct the survey described below. It is also not completely clear how the general public perceive ambiguity and to what extent this perception affects actual behavior. Understanding these latter issues is the second task of this paper, which is also carried out using the following survey.

(i) *Responsibility.* In order to understand how the general public relates to responsibility, we used an online survey of a representative sample of UK respondents. In the first two questions, the participants in our survey were told they were given a fixed hypothetical charitable donation for research on cancer treatment/prevention, and were asked to split it between two cancer types. The first was a hereditary cancer, where chance plays a central

role (being caused by inherited, unobservable, genetic defects) and the second was lifestyle-related cancer, where individual lifestyle decisions (like smoking and poor diet) are extremely important.[6] Since research benefits future victims of these cancers and since most victims of the largely avoidable cancer have probably contributed to their situation, it is reasonable to assume that the victims of the lifestyle-related cancer are perceived more responsible for their situation (see Rickard 2014). Hence, a respondent who allocates equal amounts to both cancer types seems not to care about these victims' perceived irresponsible behavior. On the other hand, a respondent who allocates a smaller share to the lifestyle-related cancer might be regarded as someone whose allocation is affected by the perception of others' perceived irresponsible behavior. The survey's third question had similar intent but asked about allocating compensation between two individuals, who contracted lung cancer after being exposed to a cancer hazard, taking into account that one of them was a heavy smoker. Finally, to find out whether additional factors affect respondents' allocations, we elicited socio-demographic and behavioral data including gender, education, income, smoking behavior, lifestyle quality and others.

(*ii*) *Ambiguity.* In light of possible perceptions of uncertainty by the general public, we also elicited the survey respondents' perceptions of ambiguity. Specifically, the respondents were asked for their beliefs about hazards of various cancers and were allowed to choose interval probabilities as their responses (Walley, 1991, Johnson and Slovic 1995, Flage et al., 2014). The difference between the maximal and minimal likelihoods for each question, called *the degree of ambiguity*, was used to measure a respondent's perceived ambiguity about the corresponding hazard (the higher the degree of ambiguity, the bigger is the perception of ambiguity). To reduce complexity, we did not elicit beliefs regarding other risk factors, like avoidance rate and survival rate. Moreover, and as mentioned above, even academics may have large disagreements about the correct estimate of the former. Using our theoretical and empirical models we then examine how these degrees of ambiguity may affect allocations.

Finally, perceptions of various cancer risks and associated behavior may be affected by individuals' awareness of highly-publicized cases, especially when these involve public figures.

[6] In 2015, 72% of the risk of getting lung cancer in the UK was attributed to smoking (and 79% to all lifestyle-related causes)

In our empirical model, we also investigate how knowledge of such highly publicized cases may affect perceptions of hazards associated with hereditary and lifestyle-related cancers, and the resulting behavior.

1.3 Predictions

A series of laboratory experiments, which address the issue of social preferences by eliciting willingness to make transfers to subjects who have taken risks compared to those who have not (see, e.g., Cappelen, Hole, Sørensen and Tungodden, 2007, Cappelen, Sørensen and Tungodden, 2010, and Cappelen et al., 2013), suggest that a considerable share of the population rewards responsibility. This result is also consonant with our companion paper (Melkonyan, Safra and Ma, 2017) where we used naturally occurring data. Since a lifestyle-related cancer is affected by victims' behavior much more than a hereditary one, we expect very few respondents to favor the former. Hence,

Prediction 1. *Most respondents either allocate more to the hereditary cancer or allocate equally.*

In our companion paper we also found that sensitivity to responsibility was mainly driven by women.[7] Given this, we expect

Prediction 2. *Allocating more to the hereditary cancer is more prevalent among women.*

Rickard (2014) reports that the attribution of responsibility to accident victims was more prevalent among people who acted responsibly. In the present work, this group is identified with non-smokers. Hence, one might expect that the share of non-smokers who donate more to the hereditary cancers will be greater than the corresponding share among all respondents. A similar result might hold for respondents who report having healthy lifestyles. Furthermore, in light of the existing studies that find a significant degree of self-interest and in-group favoritism (see Sumner, 1906, Akerlof and Kranton, 2000, Rudman and Goodwin, 2004 and Chen and Li, 2009), we expect some of the smokers to favor victims of the lifestyle-related cancers. Hence,

[7] This may be related to a phenomenon reported by a number of studies, that women are more likely to donate than men (see, e.g., Andreoni, Brown and Rischall, 2003, and Piper and Schnepf, 2008).

Prediction 3. *Healthier lifestyle positively correlates with allocating more to the hereditary cancer.*

Since many people have significant and regular concerns about cancer and its causes and people are continuously exposed to public news and information about hazards of various cancers, we might expect the elicited likelihoods to be close to the actual likelihoods. Moreover, as we argued above, given the multitude of expert opinions about these likelihoods, we expect the respondents to perceive a significant amount of ambiguity. Thus,

Prediction 4. *Respondents perceive cancer rates as ambiguous and their probability intervals include the actual rates.*

Finally and as was mentioned above, the scale of risk proposed by Gardoni and Murphy (2014) is based on three supposedly independent dimensions: consequences, probability, and the source of the risk. Therefore, in line with this hypothesized relationship, we expect no correlation between the degree of ambiguity (part of their probability dimension) and sensitivity to responsibility (part of their source of risk dimension). That is,

Prediction 5. *The degree of ambiguity has no effect on allocations.*

The remainder of the paper is organized as follows. Section 2 describes the methods. The empirical model and its findings are presented in Section 3. In Section 4 we draw conclusions from our empirical findings and compare them to the model's predictions. In the last section we suggest a number of avenues for future research.

2 Methods

2.1 Survey Data

2.1.1 Sampling Procedure and Participants

The study was conducted in November 24-28, 2014 using the online survey platform Maximiles. The participants were compensated with loyalty points for participating in the study. These points were issued in real time and could be redeemed immediately for various products (such as books, airline tickets, etc.).

A total of 166 valid responses were obtained out of a group of 203 respondents recruited from the UK general population.[8] Information on the socio-demographic characteristics of the respondents, including their gender, age bands, education level, household size, income level and number of children, were collected. Table I provides a summary of the background and demographics data for our sample.

Table I reveals that our sample is balanced exactly with respect to gender. All age groups have a significant representation in our sample. The individuals in 29-39 and 40-49 age groups each constitute 19% of the sample, the individuals in 18-28 age group make up 8% of the sample while the individuals who are over 70 years old are 13% of the sample. In terms of the highest level of education, 31% of the respondents finished a secondary school, 19% finished a vocational school, and 22% of the sample had a Bachelor's degree. Finally, 67% of the sample had income in the range of £20,001-£80,000 and 25% had income below £20,000.

2.1.2 Choice Questions and Descriptive Statistics

To elicit how charitable giving may be affected by sensitivity to responsibility, the respondents faced a series of hypothetical choice questions (see Appendix B). For two of the choice questions, the *prevention* and *treatment* questions, the respondents were asked to allocate £100 between two alternatives. For the first of these questions, the choice pertained to the allocation between research on the prevention of hereditary versus lifestyle-related cancers, while for the second question, it was between research on the treatment of hereditary versus lifestyle-related cancers. The third choice question, coined the *hazard* question, asked the participants how they would allocate some fixed amount of money between a smoker and non-smoker who both have been exposed to a lung cancer hazard. To reduce potential order effects, we randomly mixed the order in which questions were presented.

[8] "Catch" trial questions preceded the main body of the survey and only data for the respondents who paid sufficient attention was retained. In some of the survey questions, the respondents were asked to choose minimum and maximum values for a certain variable. If they ignored the instructions that "the minimum should be less than the maximum", they were removed from the sample (31 respondents). There were also 6 respondents who failed to answer at least one of the choice questions.

To avoid biasing the respondents toward one of the causes, we chose the equal division between the alternatives as the default allocation for all choice questions.[9] The deviations of the respondents' selections from this default are denoted by y_p, y_t and y_h for the prevention, treatment and hazard questions, respectively. In what follows, we will call these variables as *allocations relative to the default* or, simply, *relative allocations*. Positive values of these variables reflect preference for giving to the hereditary cancers in the case of variables y_p and y_t and to non-smokers in the case of variable y_h.

The sample statistics for the three relative allocations are reported in Table II. From the first column of the table it follows that the aggregate donation to the hereditary cancers is about twice the aggregate donation to the lifestyle-related cancers (65-67% vs. 33-35%). Table II also reveals that 64%-66% of the respondents allocated a strictly larger share to the prevention and treatment of hereditary cancers while 12%-13% strictly preferred the lifestyle-related cancers. For the hazard question, 67% of the respondents strictly favored the non-smoker and only 3% strictly favored the smoker. The percentages of the respondents who chose the equal split were 22% for the prevention question, 22% for the treatment question, and 30% for the hazard question. Note that a small minority of the subjects chose negative relative allocations. As will become clear shortly, a number of factors, including family history, risk perceptions and individual health-related choices, may have contributed to such decisions.

2.1.3 Causal Factors

In addition to the three allocation questions, we have elicited information on several factors that may affect the respondents' answers to the choice questions. First, we categorized the respondents according to their awareness of two highly publicized cancer cases. We asked them whether they have knowledge of Angelina Jolie's decision to take preventive actions against a hereditary cancer and Sean Connery's treatment for ailment which was likely to be a lifestyle-related cancer. In 2013, Angelina Jolie, an actress and humanitarian, revealed in

[9] Given the tendency of some individuals to choose the default allocation, by selecting the 50:50 as the default we are stacking the deck against the view that respondents value responsibility.

a New York Times article that she took a preventive double mastectomy[10] after learning she had an estimated 87% risk of developing breast cancer due to an inherited defective gene, BRCA1. In her case, the chance of developing breast cancer dropped to under 5% after the surgery. The share of the respondents who knew about this or similar cases was substantial (84%). In 1993, it was revealed that Sean Connery, who is probably best known for his role as the first James Bond, had received radiation therapy for undisclosed throat ailment. This news sparked media reports that the actor was suffering from throat cancer following years of heavy smoking (he started smoking when he was nine years old). The respondents who knew about this or similar cases were not as many as in Angelina Jolie's case (only 34%).[11] One expects that individuals who are aware of these cases have more knowledge about hereditary and lifestyle-related cancers and their potential causes and consequences.

The proportions of the respondents in our sample who had suffered from cancer or had relatives who had cancer were 6.6% and 63.9%, respectively. The respondents' self-descriptions of lifestyles were recorded on a five-point scale (1 = very healthy to 5 = very unhealthy). The average score for this variable was 2.6. We also categorized the participants as smokers or non-smokers because we hypothesized that the respondents in these groups might exhibit favoritism toward individuals from the same group. The proportion of smokers in our sample is 18.1%, which is very close to the proportion of the wider UK population (HSCIC, 2015).

The survey also elicited the respondents' perceived individual likelihoods of getting various cancers: the overall likelihood of getting cancer and the likelihoods of getting either a hereditary or a lifestyle-related cancer. The respondents were also asked to provide their estimates of the percentage of UK population that gets cancer in their lifetime and the percentages, out of all possible cancers, of the cancers related to hereditary and lifestyle causes. For each of these six questions, the respondents could choose between intervals of estimates and single estimates. As was noted above, the degree of ambiguity (the difference between the maximal and minimal likelihoods for each question) was used to measure a respondent's perceived ambiguity about the corresponding hazard. Table III reports the descriptive sta-

[10] Preventive double mastectomy is a prophylactic surgery of removing both breasts to reduce the risk of breast cancer in women.

[11] Our choice of these two individuals was based on a pilot study that attempted to identify well-known cancer cases that involved celebrities.

tistics for the *minimum,* which is equal to the minimal likelihood estimate, and degree of ambiguity variables. We have also obtained estimates of the respondents' cancer risk factor perceptions (CRUK, 2011) which included the minimum and maximum benefits from avoiding risk factors.

2.2 The Theoretical Model

Some of our assumptions seem straightforward. Such is, for example, the assertion that an individual who values responsibility would allocate more to the hereditary cancer. Indeed, questioning it may sound too pedantic when no imprecise variables, like ambiguous probabilities, intervene. However, in real life probabilities are not precise and hence such assertions should be formalized and verified.

This is what we do in Appendix A, where we present a theoretical model that analyzes the behavior of individuals who face allocation problems similar to the ones appearing in the survey. To emphasize the distinction between the survey and the theoretical model, we do not refer to these individuals as "respondents" in this subsection.[12] We start with a simple situation, in which no ambiguity exists, and we add it later on.

The first proposition deals with a situation in which the donation contributes to the effectiveness of cancer treatment. That is, the donation goes toward cancer research which increases the corresponding patients' probability of survival.

Proposition 1 *Suppose that an individual is given £*100 *to allocate between the hereditary and lifestyle-related cancers, where both sums are for research that improves the treatment of the disease and no ambiguity exists. Then*

(a) *an individual who does not value responsibility allocates equal amounts to both types of*

[12] Note that our setup is different from that in Fishburn and Sarin (1994, 1997) and Van Koten, Ortmann, and Babicky (2013). In contrast to these papers, we explicitly model the link between the individuals' actions and the probability distribution over outcomes and consider how such link may affect sensitivity to responsibility. On the other hand, Fishburn and Sarin (1994, 1997) examine various notions of fairness in the presence of social risks that are side-stepped in the present paper. Van Koten, Ortmann, and Babicky (2013) provide an experimental investigation of the relationship between risk aversion and inequality aversion that are not considered in our study either.

cancer;

(b) *an individual who values responsibility allocates a larger amount to the hereditary cancers.*

Proposition 2 deals with a situation in which ambiguity exists and the donation contributes to research to prevent cancer. In accordance with our questionnaire and for the reasons mentioned above, we assume that the individuals' beliefs about the cancer rates are vague, and are given by probability intervals of the form $\left[\underline{p}_c^{0i}, \bar{p}_c^{0i}\right]$, where $\underline{p}_c^{0i}$ and $\bar{p}_c^{0i}$ are, respectively, the minimal and maximal cancer rates for cancer i.

Proposition 2 *Suppose that an individual is given £100 to allocate between the hereditary and lifestyle-related cancers, where both sums are for research that improves prevention of the disease, and assume that all individuals have common beliefs about the cancer rates. Then:*
(a) *an individual who does not value responsibility allocates more (less) to the hereditary cancer than to the lifestyle-related cancer if, and only if, the maximal cancer rate of the hereditary cancer is less (more) than the maximal rate of the lifestyle-related cancer;*
(b) *an individual who values responsibility contributes to the hereditary cancer more than an individual who does not value responsibility;*
(c) *an increase in the degree of ambiguity of cancer i's rate, holding the mid point of the likelihood interval constant, decreases the amount that both individual types allocate to the prevention of this cancer;*

Parts (a) and (b) of Proposition 2 imply that if all individuals have identical beliefs and all believe that the maximal cancer rates of the two cancers are the same, then only individuals who value responsibility will donate a larger share of their £100 to the hereditary cancer. Assuming that, in a given set of individuals, some value responsibility, then the aggregate donation for the hereditary cancer must be larger than for the lifestyle-related cancer. Moreover, if both types believe that the maximal cancer rate of the lifestyle-related cancer is greater than that of the hereditary cancer, then this relation is exacerbated with even a higher proportion of individuals giving more to the hereditary cancer.

3 The Empirical Model and its Results

We first examine the differences across the respondents' attitudes toward the role of potential beneficiaries' in affecting the likelihood of a cancer (see Table II for the descriptive statistics of the choice questions). The results of both Wilcoxon sign-rank test and t-test indicate that the relative allocations y_p, y_t and y_h are all significantly different from zero ($p = 0.00$ for both tests). The statistical tests also indicate that the respondents prefer to contribute more to the hereditary cancer (in the prevention and treatment questions) and to non-smokers (in the hazard question).

Result 1. *The respondents allocated significantly more to the hereditary cancer (in the prevention and treatment questions) and non-smokers (in the hazard question).*

The relative allocations in our survey don't differ across the prevention, treatment, and hazard questions. All of the differences are found to be statistically insignificant (Wilcoxon signed-rank tests yield $p = 0.27$ for the comparison of the prevention and treatment questions, $p = 0.66$ for the prevention and hazard questions, and $p = 0.98$ for the treatment and hazard questions).

Our second result deals with how smoking status affects the relative allocations. As one may have expected, the non-smokers tend to give more to the alternatives with less individual responsibility ($p = 0.00$ for Wilcoxon sign-rank test and t-test in all three choice situations). Somewhat unexpectedly, smokers still tend to give more to the hereditary cancers in the prevention question, and more to the nonsmokers in the hazard question ($p = 0.01$ and 0.02, respectively, for the Wilcoxon sign-rank test). For the treatment question, the null hypothesis that the smokers are indifferent between hereditary and lifestyle-related cancers, however, cannot be rejected. Furthermore, we find that the smokers tend to give more to the lifestyle-related cancers in the treatment question than in the prevention question ($p = 0.01$ for the Wilcoxon sign-rank test).

The Mann-Whitney test reveals that the smokers on average allocate less to cancers with less individual responsibility ($p = 0.07$ for the prevention question, 0.00 for the treatment question and 0.00 for the hazard question, respectively), compared to the non-smokers. We summarize these findings in the following:

Result 2. *The non-smokers allocated significantly more than the smokers to the cancer with less individual responsibility. However, the smokers still allocated significantly more to the hereditary cancer than to the lifestyle-related cancer in the prevention question and allocated significantly more to the non-smokers in the hazard question.*

We now turn to exploring the effects of other individual characteristics on the respondents' relative allocations (see Table III for the descriptive statistics of these characteristics). Note that the relative allocations belong to the interval $[-50\%, 50\%]$ for each of the three choice questions. Since the relative allocations are censored at 50%, we used the Tobit model (Tobin, 1958) in our estimation. We let y_i^* $(i = p, t, h)$ denote the unobserved latent variable which corresponds to the observed variable y_i (Greene, 1997):

$$y_i = \begin{cases} -50 & \text{if } y_i^* \leqslant -50 \\ y_i^* & \text{if } -50 \leqslant y_i^* \leqslant 50 \\ 50 & \text{if } y_i^* \geqslant -50 \end{cases}.$$

We separately estimated the following version of the Tobit model for each of the three questions:[13]

$$y_i^* = \beta_0 + \mathbf{C}_i'\delta + \mathbf{D}_i'\gamma + \varepsilon_i, \tag{1}$$

where $\mathbf{C}_i$ is the vector of all continuous variables (*likelihood perceptions* and *risk factor perceptions* variables, Table III), and $\mathbf{D}_i$ is the vector of all dummy variables and dummy-coded categorical variables (*group identity* and *socio-demographic data* variables, Table III). In the estimation, we accounted for heteroskedasticity by using White's (1980) estimator (see also Cameron and Trivedi, 2010). The main regression results are reported in Table IV.[14]

[13] Since the relative allocations were chosen contemporaneously, the disturbances in the estimated equations for the three choice questions may be correlated. To investigate this possibility, the equations in (1) were estimated simultaneously as a system, using the seemingly unrelated regression technique (Zellner, 1962). The results were similar to the case of a separate estimation.

[14] Multicollinearity is not a cause for concern since the variance inflation factors for all of our variables are below 4.

The estimation of equation (1) yields a number of interesting findings. None of the socio-demographic characteristics are statistically significant in affecting the relative allocations for the treatment and hazard questions while gender and income are the only statistically significant effects for the prevention question. It was estimated that, compared to men, women donate £8.06 more to the hereditary cancers in the prevention question. Finally, we found that the respondents with more financial means donate significantly more to the hereditary cancers in the prevention question; an estimated increase of £3.17 as a result of an increase of £20,000 in the income category.

Result 3. *Women and respondents in relatively high-income categories allocate more to the hereditary cancer in the prevention question.*

Behavior is also sensitive to the respondents' degrees of ambiguity. To the best of our knowledge, this channel has been overlooked in the existing literature and ours is the first study to connect donation behavior with perceived ambiguity of cancer risk. The estimation reveals that a 1 unit increase in the degree of ambiguity of the lifestyle-related cancer in the UK leads to £0.36 decrease in the allocation to lifestyle-related cancer in the prevention question and to £0.30 decrease in the treatment question.

Result 4. *The respondents allocated less to the prevention and treatment of the lifestyle-related cancer when they perceived a relatively large degree of ambiguity.*

The respondents' awareness of highly publicized cancer cases had a statistically significant impact on the corresponding relative allocations. The respondents who were aware of Angelina Jolie's or similar cases are estimated to invest 16.50% more in the treatment of the hereditary cancers. Similarly, the respondents who were aware of Sean Connery's or similar cases are estimated to invest 6.98% more in the prevention of the lifestyle-related cancers. Thus, possessing information of this nature positively affects the corresponding donation irrespective of whether the cancer in question is hereditary or lifestyle-related.

Result 5. *Knowledge of highly publicized cases affects the relative allocations in favor of the publicized cancer type.*

Our estimation results suggest that the respondents' personal history does not affect the relative allocations. A possible explanation for this phenomenon is the small proportion of the respondents (6.6%) who reported relevant personal history.

In contrast to personal history, a much larger share of the participants in our survey reported that one or more of their family members suffered from cancer (about 64%). It was found that having a family history of cancer results in a statistically significant decrease of 9.28% in the donation to the hereditary cancers for the treatment question. The effects of a family history for the other two questions are statistically insignificant.

Our estimation results show that the relative allocations were affected by the respondents' perceptions of own lifestyles. The less healthy the respondents' self-described lifestyle, the more she/he allocated to the smokers in the hazard question. Specifically, a 1 unit decrease in the self-reported healthiness of lifestyle, represented by a 1 unit increase in the corresponding index, is estimated to lead to a statistically significant increase of £4.27 in the amount allocated to the smokers.

As one could have also expected, the smoking status impacted the respondents' relative allocations. Compared to the non-smokers in our sample, the smokers are estimated to allocate £12.48 more to the lifestyle-related cancers in the treatment question and £11.97 more to the smoker in the hazard question.

Result 6. *The amount allocated to the smoker in the hazard question is larger for the respondents who reported smoking compared to the non-smokers as well as for the respondents who reported a relatively unhealthy lifestyle.*

The relationship between the respondents' donations and their perceptions of contracting cancer themselves reveals that self-interest plays an important role in their choices. A 1 unit increase in a respondent's perceived minimal likelihood of contracting a lifestyle-related cancer herself/himself leads to an estimated £0.47 increase in the donation to the lifestyle-related cancer in the prevention question.

Result 7. *The respondents exhibit a certain degree of self-interest in their choices by allocating more to the lifestyle-related cancer in the prevention question, when they perceive a larger minimal individual likelihood of contracting this cancer.*

The respondents risk factor perceptions also affect their choices. For a 1% increase in the perceived minimum benefits from avoiding risk factors, the share allocated to hypothetical smokers decreased by 0.17% in the hazard question.

4 Discussion

In this section we draw conclusions from our empirical findings and compare them to the model's predictions. We conclude the section with a short discussion of the limitations of our analysis.

4.1 Attitudes towards Responsibility

Except for the smokers in the treatment question, less than 14% of the respondents allocated larger sums to the lifestyle-related cancer. This seems to confirm Prediction 1. Furthermore, except for this group-question combination, the hypothesis that negative values of y_p, y_t and y_h are significant is always rejected.

Following the theoretical results of Propositions 1 and 2, Result 1 may suggest that the allocation of a considerable share of the respondents is affected by the perception of others' perceived irresponsible behavior. In the treatment scenario, for example, about two-thirds of the respondents allocated more to the hereditary cancer. Hence, if most of them are impartial, i.e. if they can detach themselves from the decision problem and ignore potential self-interested motives, then valuing responsibility may be the reason behind their choice.[15] The situation with respect to prevention is less revealing since, on average, people perceive the lifestyle-related cancer to have a higher cancer rate and hence, following Proposition 2 part (b), even respondents who do not value responsibility will allocate more to the hereditary cancer.[16]

The conclusion that a considerable share of the population may value responsibility is

[15] As correctly pointed out by an anonymous reviewer, there could be another expanation for Result 1. It might be that the respondents' allocations reflect views about which research ought to be prioritized, rather than views about the cancer patients and their behavior.

[16] See Table 2: the conditional estimates are such that $\bar{p}_c^{0h} < \bar{p}_c^{0l}$ while $\bar{p}_c^{0h} - \underline{p}_c^{0h} \approx \bar{p}_c^{0l} - \underline{p}_c^{0l}$.

further supported by analyzing the answers of the smokers' group. Consider the extreme case where all respondents follow their self-interests and allocate more to the hazards that directly affect them. In this case, the smokers would donate more than 50 to the lifestyle cancer and we would expect all y_is $(i = p, t, h)$ to be negative among them. However, in all questions at least 30% of the smokers chose positive y_i, thus ignoring their self-interests and positive attitudes towards fellow smokers. Summarizing, allocating more to the hereditary cancer by these respondents may well suggest that they also value responsibility. Finally, since it may be reasonable to assume that valuing responsibility is independent of smoking behavior, the above conclusion may indicate that at least 30% of the whole population values responsibility.

Similarly, Result 3 may suggest that women and high-income earners are more likely to value responsibility. The finding regarding women confirms Prediction 2 and, as noted there, a previous observation that sensitivity to responsibility is mainly driven by women (see Melkonyan, Safra and Ma, 2017). The finding regarding high-income earners is new.

Finally, Table II reveals that the shares of the respondents who allocated more to the prevention and treatment of the hereditary cancers were quite similar (66.3% in the prevention vs. 63.9% in the treatment). However, as we mentioned above and demonstrate in Appendix A (Proposition 2, part (b)), even respondents who do not value responsibility are expected to behave in this way in the prevention scenario. Therefore, this finding may suggest that allocating more to the hereditary cancer is context-dependent, and that it is more prevalent in the treatment situation. One possible explanation is as follows. It is sensible to expect that individuals experience more emotions when contemplating treatment compared to prevention. The former may be associated with intense feelings related to specific individuals suffering from cancer or images of cancer patients seen in real life or media. The latter may not trigger such strong response as it is likely to be associated with future cancer sufferers only. Thus, our results may suggest that allocating more to the hereditary cancer, and perhaps valuing responsibility, is not emotion-free.

4.2 Self-interest and In-group Favoritism

As Results 2, 6 and 7 demonstrate, the respondents exhibit a significant degree of self-interest and in-group favoritism. The respondents who reported smoking, or having a relatively unhealthy lifestyle, allocated more to smokers, in accordance with Prediction 3. Furthermore, the respondents allocated more to the cancers which they perceived to be riskier for themselves. Such behavioral pattern is not very surprising, although one would expect it to be less prevalent in decisions involving donations, where the emphasis is on giving to others.

The findings that the smokers tend to give more to the lifestyle-related cancers in the treatment question than in the prevention question (reported before Result 2) have some interesting implications. The smokers will tend to allocate more money to the treatment of the lifestyle-related cancer than to the hereditary cancer if they believe that such treatment will benefit them and perceive a high likelihood of needing such treatment. Our findings suggest that the smokers' perceptions of such direct benefit to themselves are sizeable. This kind of direct effect is muted for the prevention question if a large share of the smokers perceive programs to prevent "bad" behavior (such as smoking and excessive drinking) as ineffective or do not have intentions of changing their behavior. The results of the statistical test for the prevention question suggest that a considerable share of the smokers possess at least one of these two beliefs. Regarding the hazard question, since it deals with a group of smokers to which even the smokers in our sample do not belong, the fact that they allocate more to the non-smokers in this question suggests that the feelings of camaraderie and social identity with fellow smokers are relatively weak.

Two other channels may explain the disproportionate allocation of money toward the non-smoker in the hazard question. First, it may in part be due to the desire of the subjects to compensate the individuals affected by the exposure to smoking rather than other causes. Second, the smokers may feel sympathy and identification with future victims and, as a result, donate more to the lifestyle-related cancer.[17]

[17] We are grateful to an anonymous reviewer for bringing these two channels to our attention.

4.3 Ambiguity

Our empirical results reveal that the respondents perceived a significant level of ambiguity. This is reflected by the size of their declared interval probabilities. On average, the size of these intervals is around one quarter (0.2-0.28) of the whole probability interval $[0, 1]$. As for the effect of ambiguity on the respondents' choices, from Result 4 and in accordance with part (c) of Proposition 2, an increase in the degree of ambiguity of the lifestyle-related cancer rate has a negative effect on the amount allocated to the prevention of this cancer. When we examined a possible correlation between ambiguity and allocating more to the hereditary cancer, we found that for the smokers, the difference between the degree of ambiguity of the respondents who allocated more to the hereditary cancer and the rest is insignificant ($p = 0.20$, Mann-Whitney test). These findings partially confirm Prediction 5.

As can be seen in Table III, the respondents' perceptions about the likelihoods of getting a cancer (both for the UK population and for themselves) are in line with the estimates of the corresponding likelihoods based on incidence data. According to the Cancer Research UK (2017), the lifetime risk of getting a cancer is estimated at 50%, which falls in the (average) interval stated by the respondents. With conditional likelihoods of getting these types of cancers, the answers are only partially true. The estimated conditional likelihood of getting a lifestyle-related cancer in the UK in 2015 was 38%. Although this value falls in the stated interval, its complement (62%) does not fall in its corresponding interval. Hence, our empirical findings partially confirm Prediction 4.

4.4 Familiarity effect

Result 5 is consistent with previous studies, where media coverage has been found to be positively related to prosocial behavior toward the reported issue (see, e.g., Simon, 1997; Brown and Minty, 2008). There are a number of potential drivers of this relationship. Preferences over donations to a cause may depend on various types of information about that cause. In our context, this information may pertain, for example, to the group affected by the disease and the urgency of the need (see, e.g., Bekkers and Wiepking, 2011).

Media coverage may also decrease the "social distance"[18] between beneficiaries and donors. The closer the social distance, the stronger the empathy. When a disease has been covered by the media, respondents may feel connected with its (potential) victims. As a result, these victims may become "identifiable" and no longer be perceived as simply unknown or "statistical" lives (Schelling, 1968).

4.5 Limitations

Our analysis has certain limitations. First, the choice questions in our study are hypothetical. One might question whether respondents would behave similarly if they dealt with actual money and actual cancer causes. It would be very interesting to conduct field, laboratory, or online experiments where individuals were choosing how to allocate actual money between specific hereditary and lifestyle-related cancers or between some other specific causes that are differentiated by the degree of the beneficiaries' responsibility.

Another limitation of our study is the relatively small sample size and its representativeness. One could forward an argument that individuals who participate in surveys in exchange for money or products might have prevalence of certain characteristics. However, it is hard to identify any a priori reasons that individuals who participated in the study have a characteristic that correlates with the answers to the survey questions. In addition, since an online experiment like ours targets a broad population, it offers a sensible route to overcome a sample representativeness problem that is common to many laboratory experiments (which usually use student populations).

Another potential disadvantage of the setup in the present paper is that donations are made on the respondents' behalf rather by the respondents themselves. Individuals may behave differently with respect to their own money than with respect to somebody else's. One way, albeit imperfect, to circumvent this shortcoming is to endow individuals with some amount of money and then ask them whether and how much they would like to donate to the causes proposed by the experimenter.[19]

[18] According to Loewenstein and Small (2007), social distance refers to "feelings of connection (or lack thereof) between two individuals".

[19] This procedure is also imperfect because people may exhibit different behavior with respect to windfall

Finally, there is strong evidence that a non-negligible share of population believes (possibly as a psychological coping mechanism) that people get what they deserve: good things tend to happen to good people and bad things to bad people (Furnham, 2003, Hafer and Sutton, 2016). One may naturally wonder about the relationship between such "beliefs in a just world" (BJS) and preferences and behavior exhibited in environments similar to that considered in the present paper. For example, one could contemplate that people with strong BJS may favor causes where choices play a bigger role than bad luck (because they believe that bad luck "justifiably" affects bad people). It is also possible to envision a scenario where people with BJS are indifferent between luck and choices as causes of adverse outcomes. The possibilities for the relationship between BJS and preferences over charitable contributions as a function of risky behavior, as well as the causes of such relationship, are abundant and we leave it to future research.

5 Future Research

The current work opens up a number of avenues for future research. It would be very interesting to conduct a similar study using as the subject pool healthcare professionals and those among them who are in charge of formulating and implementing healthcare policies. Taking this design to other contexts, such as the financial sector, could also prove fruitful. Finally, constructing a study where responsibility views are compared to "warm glow" and, more generally, to impure altruism would undoubtedly shed new light on the importance of all these behavioral traits and prove useful in guiding future policies.

and hard earned money.

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6 Appendix

6.1 Appendix A: The Theoretical Model and its Predictions

Consider an individual who is endowed with a sum of £100 to donate to cancer research. The sum can be allocated either to a (typical) hereditary cancer or to a (typical) lifestyle-related cancer. We assume that the individual is impartial and a utilitarian, in the sense that her utility is derived by adding the utilities of the potential beneficiaries (who are cancer patients benefitting from improved treatment and a better prevention policy). In what follows, we first consider the case of the optimal donations to cancer treatment and then turn to the optimal donations to cancer prevention. For the first, we focus on the case where the individual makes her choice under risk while, for the second, she makes her decision under ambiguity.

6.1.1 Donation to Cancer Treatment (no ambiguity)

An individual allocates £100 between two projects with each affecting a distinct cancer patient, one suffering from a hereditary cancer, denoted by h, and the other suffering from a lifestyle-related cancer, denoted by l. To simplify our notation, we call the patients suffering from cancers h and l patients h and l, respectively. Let $d^i \in [0, 100]$, $i = h, l$, denote the amount allocated to cancer i (therefore, if $d^h = d$ then $d^l = 100 - d^h$). The individual assumes that her donation contributes to the effectiveness of cancer treatment. That is, the donation goes toward cancer research which increases the corresponding patients' expected probability of survival. The expected survival rate functions for cancers h and l are assumed, for simplicity, to be equal to each other and, for a generic d, are given by

$$p_s = p_s\left(d; p_s^0\right) \tag{2}$$

where $p_s^0 \in (0, 1)$ denotes the (current) survival rate for both cancers. The function $p_s : \mathbb{R}_+ \times (0, 1) \to (0, 1]$ is assumed to be twice continuously differentiable, strictly increasing and strictly concave in its first argument and strictly increasing in its second argument. The monotonicity assumptions reflect the individual's subjective belief that (1) the expected survival rate is increasing in the survival rate and (2) her donation has a positive effect on

the expected survival rate. It is further assumed that the expected survival rate is equal to the survival rate if the individual doesn't allocate any amount to the cancer (that is, $p_s\left(p_s^0, 0\right) = p_s^0$). Since in the sequel the survival rates are held fixed, we simplify the notation by using $p_s\left(d\right)$ instead of $p_s\left(d; p_s^0\right)$.

It is assumed that surviving a cancer, an outcome denoted by H, gives both patients, in the eyes of the individual, a utility of one unit. That is, $u^h\left(H\right) = u^l\left(H\right) = 1$. Dying from cancer, an outcome denoted by M, yields a lower utility. Under contingency M, the utility of patient h as perceived by the individual is assumed to be zero; $u^h\left(M\right) = 0$. On the other hand, the utility attached by the individual to patient l (under contingency M) depends on whether or not the individual thinks patient l is to blame for his cancer-inducing behavior. To model this, let $p_a \in (0, 1)$ denote the individual's perceived probability that cancer l is induced by a specific, avoidable, lifestyle. An individual who *values responsibility* realizes that unhealthy lifestyle is a decision made by supposedly informed individuals and presumes that patients following such lifestyle care less about their possible death. Thus, this individual assumes that the utility difference for patient l between outcomes H and M is smaller than that for patient h. More specifically, an individual who values responsibility assigns a positive utility p_a to patient l under contingency M, $u_r^l\left(M\right) = p_a$, where subscript r stands for such an individual. Hence, the utility difference between the two outcomes is $1 - p_a$, and is decreasing with the lifestyle-related avoidable risk of cancer l. Thus, this individual attributes a higher utility to adverse outcomes for self-harming individuals. An individual who does not value responsibility assigns a utility of zero in this case: $u_{nr}^l\left(M\right) = 0$, where nr is the subscript for such an individual.

An individual who does not value responsibility assigns the expected utilities EU_{nr}^h and EU_{nr}^l to patients h and l, respectively. It follows from our assumptions that, when $d^h = d$, and $d^l = 100 - d$,

$$\begin{aligned} EU_{nr}^h\left(d\right) &= p_s\left(d\right)u^h\left(H\right) + \left(1 - p_s\left(d\right)\right)u^h\left(M\right) = p_s\left(d\right), \\ EU_{nr}^l\left(d\right) &= p_s\left(100 - d\right)u^l\left(H\right) + \left(1 - p_s\left(100 - d\right)\right)u_{nr}^l\left(M\right) = p_s\left(100 - d\right). \end{aligned} \tag{3}$$

Therefore, the utilitarian objective function of this individual is given by

$$V_{nr}\left(d\right) = EU_{nr}^h\left(d\right) + EU_{nr}^l\left(d\right) = p_s\left(d\right) + p_s\left(100 - d\right). \tag{4}$$

Similarly, the individual who values responsibility assigns the expected utilities EU_r^h and EU_r^l to patients h and l, and

$$\begin{aligned} EU_r^h(d) &= p_s(d)\,u^h(H) + (1-p_s(d))\,u^h(M) = p_s(d), \\ EU_r^l(d) &= p_s(100-d)\,u^l(H) + (1-p_s(100-d))\,u_r^l(M) \\ &= p_s(100-d) + p_a(1-p_s(100-d)). \end{aligned} \tag{5}$$

The utilitarian objective function $V_r(d)$ of this individual is therefore given by

$$V_r(d) = EU_r^h(d) + EU_r^l(d) = V_{nr}(d) + p_a(1-p_s(100-d)). \tag{6}$$

Analyzing the optimal donations of the two individual types, we obtain the following:

Proposition 1 *Suppose that an individual is given £100 to allocate between the hereditary and lifestyle-related cancers, where both sums are for research that improves the treatment of the disease and no ambiguity exists. Then*

(a) *an individual who does not value responsibility allocates equal amounts to both types of cancer;*

(b) *an individual who values responsibility allocates a larger amount to the hereditary cancer.*

Proof: For the individual who does not value responsibility,

$$\frac{\mathrm{d}}{\mathrm{d}d}V_{nr}(50) = \frac{\mathrm{d}p_s}{\mathrm{d}d}(50) - \frac{\mathrm{d}p_s}{\mathrm{d}d}(50) = 0$$

and hence, the optimal allocation entails an equal split between the two cancer types.[20]

Next consider an individual who values responsibility. Since $V_r(d) = V_{nr}(d) + p_a(1-p_s(100-d))$,

$$\frac{\mathrm{d}}{\mathrm{d}d}V_r(50) = \frac{\mathrm{d}}{\mathrm{d}d}V_{nr}(50) + p_a\frac{\mathrm{d}p_s}{\mathrm{d}d}(100-d)_{d=50} > 0,$$

which implies that the optimal allocation satisfies $d > 50$. Thus, the individual gives more than 50 to the hereditary cancer and less than 50 to the lifestyle cancer. ■

[20] The first-order condition is sufficient by strict concavity of p_s with respect to its second argument.

6.1.2 Donations to Cancer Prevention (with ambiguity)

Similarly to the analysis for the cancer treatment case, we assume that the individual considers two cancer patients, h and l, and that $d^i \in [0, 100]$ $(i = h, l)$ denotes the amount allocated to cancer i. Here, the individual focuses on contributing to research to prevent cancer and assumes that her donation positively affects the cancer prevention by decreasing the potential patients' probability of getting the cancer. Let p_c^h and p_c^l denote the resulting expected cancer rates for cancers h and l, respectively. The expected cancer rates for the two cancer types are assumed to be given by

$$p_c^i = p_c\left(d^i; p_c^{0i}\right) \quad \text{for} \quad i = h, l,$$

where $p_c^{0i} \in (0, 1)$ denotes the (current) cancer rate for cancer i (as perceived by the individual). Note that we allow for the current rates to be different. The function $p_c : \mathbb{R}_+ \times (0, 1) \to (0, 1]$ is assumed to be twice continuously differentiable, strictly decreasing and strictly convex in its first argument and strictly increasing in its second argument. The monotonicity assumptions reflect the individual's subjective belief that (1) the expected cancer rate is increasing in the cancer rate and (2) her donation can decrease the expected cancer rate. It is further assumed that the expected cancer rate is equal to the cancer rate if the individual doesn't allocate any amount to cancer i (that is, $p_c\left(0; p_c^{0i}\right) = p_c^{0i}$). Finally, we assume that the effect of the donation on the expected cancer rate is positively related to the cancer rate: $\frac{\partial^2 p_c}{\partial d \partial p_c^{0i}} > 0$. This assumption reflects situations where an individual associates relatively ineffective efforts to prevent the cancer with a relatively high current rate (note that $\frac{\partial p_c}{\partial d} < 0$). That is, a high cancer rate signals to the individual that various actions to decrease the expected rate are not very productive and, as a result, she believes that increasing her donation to such cancer will have a relatively small effect on the expected cancer rate.

In accordance with our questionnaire and for the reasons mentioned in the introduction, we assume that the individual's beliefs about the cancer rates for both cancers are vague, and are given by the *probability intervals* $\left[\underline{p}_c^{0i}, \bar{p}_c^{0i}\right] \subset [0, 1]$, $i = h, l$. The end points $\underline{p}_c^{0i}$ and $\bar{p}_c^{0i}$ are called, respectively, minimal and maximal rates for cancer i. If there are several competing hypotheses about cancer i's rate, but the individual is convinced that only one is truly valid, then $\left[\underline{p}_c^{0i}, \bar{p}_c^{0i}\right]$ would be a singleton. In this case, the individual faces pure risk with respect

to cancer i. In contrast, complete ambiguity is characterized by $\left[\underline{p}_c^{0i}, \bar{p}_c^{0i}\right] = [0,1]$. This represents a situation where the individual has no information on the cancer rate other than that it falls somewhere in $[0,1]$. We will call the difference $\bar{p}_c^{0i} - \underline{p}_c^{0i}$ between the maximal and minimal probabilities a *degree of ambiguity* for cancer i.

In this subsection we assume that the survival rate for both cancers is fixed and equal to $p_s \in (0,1)$. Finally, the utility assigned to the beneficiaries by both types of individuals under the two possible outcomes, H and M, are the same as in the previous subsection. Without loss of generality, we also assume that the utility of not getting the cancer is the same as the utility of getting it and being cured.

For any given values of the cancer rates $p_c^{0i} \in \left[\underline{p}_c^{0i}, \bar{p}_c^{0i}\right]$ $(i = h, l)$, the expected utilities assigned by an individual who does not value responsibility to patients h and l are denoted by $E\tilde{U}_{nr}^h$ and $E\tilde{U}_{nr}^l$, and are given by (when $d^h = d$)

$$\begin{aligned} E\tilde{U}_{nr}^h\left(d; p_c^{0h}\right) &= \left(1 - p_c\left(d; p_c^{0h}\right)\right) u^h(H) + p_c\left(d; p_c^{0h}\right)\left(p_s u^h(H) + (1-p_s)\, u^h(M)\right) \quad (7) \\ &= 1 - (1-p_s)\, p_c\left(d; p_c^{0h}\right), \\ E\tilde{U}_{nr}^l\left(d; p_c^{0l}\right) &= \left(1 - p_c\left(100-d; p_c^{0l}\right)\right) u^l(H) \\ &\quad + p_c\left(100-d; p_c^{0l}\right)\left(p_s u^l(H) + (1-p_s)\, u_{nr}^l(M)\right) \\ &= 1 - (1-p_s)\, p_c\left(100-d; p_c^{0l}\right), \end{aligned}$$

Therefore, depending on $\left(p_c^{0h}, p_c^{0l}\right)$, the utility of an individual who does not value responsibility is

$$\begin{aligned} \tilde{V}_{nr}\left(d; p_c^{0h}, p_c^{0l}\right) &= E\tilde{U}_{nr}^h\left(d; p_c^{0h}\right) + E\tilde{U}_{nr}^l\left(d; p_c^{0l}\right) \quad (8) \\ &= 2 - (1-p_s)\left[p_c\left(d; p_c^{0h}\right) + p_c\left(100-d; p_c^{0l}\right)\right]. \end{aligned}$$

Similarly, for any given $\left(p_c^{0h}, p_c^{0l}\right)$ the assigned expected utilities $E\tilde{U}_r^h$ and $E\tilde{U}_r^l$ of an

individual who does not value responsibility are

$$\begin{aligned} E\tilde{U}_r^h\left(d;p_c^{0h}\right) &= \left(1-p_c\left(d;p_c^{0h}\right)\right)u^h(H)+p_c\left(d;p_c^{0h}\right)\left(p_s u^h(H)+(1-p_s)\,u^h(M)\right) \quad (9)\\ &= 1-(1-p_s)\,p_c\left(d;p_c^{0h}\right), \\ E\tilde{U}_r^l\left(d;p_c^{0l}\right) &= \left(1-p_c\left(100-d;p_c^{0l}\right)\right)u^l(H) \\ &\quad +p_c\left(100-d;p_c^{0l}\right)\left(p_s u^l(H)+(1-p_s)\,u_r^l(M)\right) \\ &= 1-(1-p_s)(1-p_a)\,p_c\left(100-d;p_c^{0l}\right), \end{aligned}$$

and her utility is given by

$$\begin{aligned} \tilde{V}_r\left(d;p_c^{0h},p_c^{0l}\right) &= E\tilde{U}_r^h\left(d;p_c^{0h}\right)+E\tilde{U}_r^l\left(d;p_c^{0l}\right) \quad (10)\\ &= 2-(1-p_s)\left[p_c\left(d;p_c^{0h}\right)+(1-p_a)\,p_c\left(100-d;p_c^{0l}\right)\right] \\ &= \tilde{V}_{nc}\left(d;p_c^{0h},p_c^{0l}\right)+(1-p_s)\,p_a p_c\left(100-d;p_c^{0l}\right). \end{aligned}$$

Finally, to explicitly account for the probability intervals $\left[\underline{p}_c^{0i},\bar{p}_c^{0i}\right]$ $(i=h,l)$, we follow the popular model of Gilboa and Schmeidler (1989) and assume that both individuals have *maxmin expected utility* (MEU) preferences:

$$W_j(d)=\min_{\left(p_c^{0h},p_c^{0l}\right)\in\left[\underline{p}_c^{0h},\bar{p}_c^{0h}\right]\times\left[\underline{p}_c^{0l},\bar{p}_c^{0l}\right]}\tilde{V}_j\left(d;p_c^{0h},p_c^{0l}\right) \quad (11)$$

$(j=nr,\,r)$. The MEU model corresponds to *complete pessimism* on the individual's part in the sense that, when evaluating stochastic outcomes, she always uses the probability distribution that yields the lowest possible utility $\tilde{V}_j$ over $\left[\underline{p}_c^{0h},\bar{p}_c^{0h}\right]\times\left[\underline{p}_c^{0l},\bar{p}_c^{0l}\right]$. It follows immediately from (8) and (10) that a MEU individual will use the maximal rates for both cancers, $\bar{p}_c^{0h}$ and $\bar{p}_c^{0l}$, in her evaluation of different outcomes. Hence,

$$W_{nr}(d)=2-(1-p_s)\left(p_c\left(d;\bar{p}_c^{0h}\right)+p_c\left(100-d;\bar{p}_c^{0l}\right)\right) \quad (12)$$

and

$$W_r(d)=2-(1-p_s)\left(p_c\left(d;\bar{p}_c^{0h}\right)+(1-p_a)\,p_c\left(100-d;\bar{p}_c^{0l}\right)\right). \quad (13)$$

To conclude, we compare the donations of both types and obtain the effect of the degree of ambiguity on the two individuals' donation behavior.

Proposition 2 *Suppose that an individual is given £100 to allocate between the hereditary and lifestyle-related cancers, where both sums are for research that improves prevention of the disease, and assume that all individuals have common beliefs about the cancer rates. Then:*
(a) *an individual who does not value responsibility allocates more (less) to the hereditary cancer than to the lifestyle-related cancer if, and only if, the maximal cancer rate of the hereditary cancer is less (more) than the maximal rate of the lifestyle-related cancer;*
(b) *an individual who values responsibility contributes to the hereditary cancer more than an individual who does not value responsibility;*
(c) *an increase in the degree of ambiguity of cancer i's rate, holding the mid point of the likelihood interval constant, decreases the amount that both individual types allocate to the prevention of this cancer;*

Proof of Proposition 2: Differentiating (12) and (13), we obtain the following expressions for the first-order condition of the two individual types:

$$\frac{\partial}{\partial d}W_{nr}(d) = -(1-p_s)\left(\frac{\partial p_c}{\partial d}\left(d;\bar{p}_c^{0h}\right) - \frac{\partial p_c}{\partial d}\left(100-d;\bar{p}_c^{0l}\right)\right) = 0 \text{ and} \tag{14}$$

$$\begin{aligned}\frac{\partial}{\partial d}W_r(d) &= -(1-p_s)\left(\frac{\partial p_c}{\partial d}\left(d;\bar{p}_c^{0h}\right) - (1-p_a)\frac{\partial p_c}{\partial d}\left(100-d;\bar{p}_c^{0l}\right)\right) \\ &= \frac{\partial}{\partial d}W_{nr}(d) - (1-p_s)\,p_a\frac{\partial p_c}{\partial d}\left(100-d;\bar{p}_c^{0l}\right) = 0.\end{aligned} \tag{15}$$

We denote the optimal allocations of the individuals who value and do not value responsibility by d_{nr} and d_r, respectively.

(a) Consider an individual who does not value responsibility. Since

$$\frac{\partial}{\partial d}W_{nr}(50) = -(1-p_s)\left(\frac{\partial p_c}{\partial d}\left(50;\bar{p}_c^{0h}\right) - \frac{\partial p_c}{\partial d}\left(50;\bar{p}_c^{0l}\right)\right),$$

the inequality $\frac{\partial^2 p_c}{\partial d\partial \bar{p}_c^{0i}} > 0$ implies

$$\frac{\partial}{\partial d}W_{nr}(50) > 0 \quad\Leftrightarrow\quad \frac{\partial p_c}{\partial d}\left(50;\bar{p}_c^{0h}\right) < \frac{\partial p_c}{\partial d}\left(50;\bar{p}_c^{0l}\right) \quad\Leftrightarrow\quad \bar{p}_c^{0h} < \bar{p}_c^{0l}.$$

Therefore, $d_{nr} > 50$ if, and only if, $\bar{p}_c^{0h} < \bar{p}_c^{0l}$.

(b) By (15),

$$\frac{\partial}{\partial d}W_r(d) = \frac{\partial}{\partial d}W_{nr}(d) - (1-p_s)\,p_a\frac{\partial p_c}{\partial d}\left(100-d;\bar{p}_c^{0l}\right) > \frac{\partial}{\partial d}W_{nr}(d).$$

Hence at d_{nr}, $\frac{\partial}{\partial d}W_r\left(d_{nr}\right) > 0$, which implies $d_r > d_{nr}$.

(c) First, consider cancer h and differentiate $\frac{\partial}{\partial d}W_{nr}$ and $\frac{\partial}{\partial d}W_r$ with respect to $\bar{p}_c^{0h}$, holding $\mathrm{d}\bar{p}_c^{0h} = -\mathrm{d}\underline{p}_c^{0h}$, and evaluate at the optimal d_{nr} and d_r, respectively (see equations (14) and (15)), to obtain

$$\frac{\mathrm{d}}{\mathrm{d}\bar{p}_c^{0h}}\left(\frac{\partial}{\partial d}W_{nr}(d_{nr})\right)|_{\mathrm{d}\bar{p}_c^{0h}=-\mathrm{d}\underline{p}_c^{0h}} = -\left(1-p_s\right)\frac{\partial^2 p_c}{\partial d\partial p_c^{0h}}\left(d_{nr};\bar{p}_c^{0h}\right) < 0$$

and

$$\frac{\mathrm{d}}{\mathrm{d}\bar{p}_c^{0h}}\left(\frac{\partial}{\partial d}W_{r}(d_{r})\right)|_{\mathrm{d}\bar{p}_c^{0h}=-\mathrm{d}\underline{p}_c^{0h}} = -\left(1-p_s\right)\frac{\partial^2 p_c}{\partial d\partial p_c^{0h}}\left(d_{r};\bar{p}_c^{0h}\right) < 0.$$

It then follows from the implicit function theorem that the optimal amounts d_{nr} and d_r decrease as a result of an increase in $\bar{p}_c^{0h}$ and an equal decrease in $\underline{p}_c^{0h}$.

Next consider cancer l and differentiate $\frac{\partial}{\partial d}W_{nr}$ and $\frac{\partial}{\partial d}W_r$ with respect to $\bar{p}_c^{0l}$, holding $\mathrm{d}\bar{p}_c^{0l} = -\mathrm{d}\underline{p}_c^{0l}$, and evaluate at the optimal d_{nr} and d_r, respectively, to obtain

$$\frac{\mathrm{d}}{\mathrm{d}\bar{p}_c^{0l}}\left(\frac{\partial}{\partial d}W_{nr}(d_{nr})\right)|_{\mathrm{d}\bar{p}_c^{0l}=-\mathrm{d}\underline{p}_c^{0l}} = \left(1-p_s\right)\frac{\partial^2 p_c}{\partial d\partial p_c^{0l}}\left(100-d_{nr};\bar{p}_c^{0l}\right) > 0$$

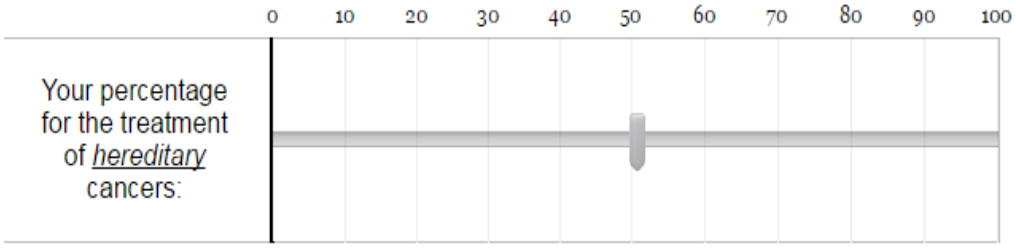
and

$$\frac{\mathrm{d}}{\mathrm{d}\bar{p}_c^{0l}}\left(\frac{\partial}{\partial d}W_{r}(d_{r})\right)|_{\mathrm{d}\bar{p}_c^{0l}=-\mathrm{d}\underline{p}_c^{0l}} = \left(1-p_s\right)\left(1-p_a\right)\frac{\partial^2 p_c}{\partial d\partial p_c^{0l}}\left(100-d_{r};\bar{p}_c^{0l}\right) > 0.$$

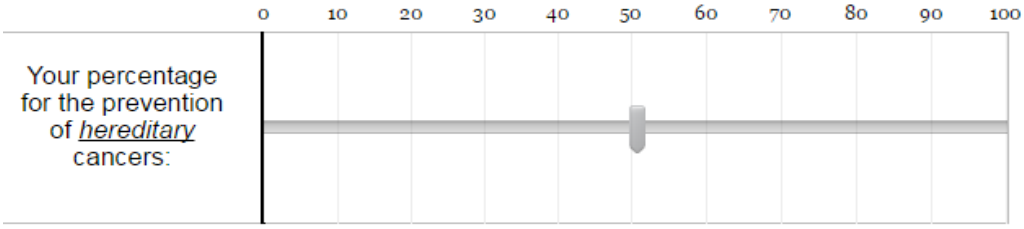
It then follows from the implicit function theorem that d_{nc} and d_{ch} increase with such a change. Therefore, the amounts $100 - d_{nr}$ and $100 - d_r$ allocated to the lifestyle-related cancers by the two types of individual decrease. ■

6.2 Appendix B: Choice Questions

Question 1. Suppose that £100 would be donated on your behalf to research on cancer treatment (such as chemotherapy and radiotherapy). Please indicate the percentage of this amount that you would allocate to the treatment of hereditary cancers (caused by an inherited genetic defect). The rest of the funds will go to the treatment of lifestyle-related cancers (such as smoking, poor diet, and physical inactivity).

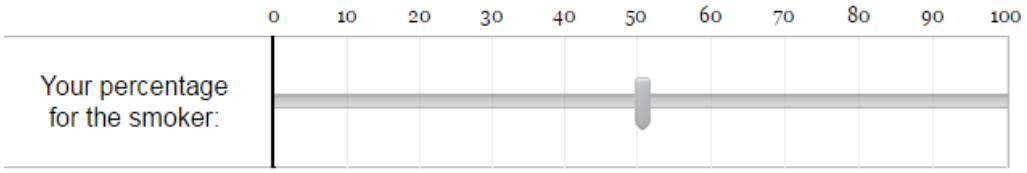


Question 2. Suppose that £100 would be donated on your behalf to research on cancer prevention (such as genetic testing). Please indicate the percentage of this amount that you would allocate to the prevention of hereditary cancers (caused by an inherited genetic defect). The rest of the funds will go to the prevention of lifestyle-related cancers (such as smoking, poor diet, and physical inactivity).



Question 3. Consider the following scenario. Suppose that a segment of general population has been exposed to a cancer hazard (for example, due to negligence by some third party). After this incident, some proportion of the exposed population contracted lung cancer. In response to this adverse outcome, the government allocated a fixed amount of funds to compensate the individuals that were exposed to the hazard.

Consider the compensation scheme of the following two individuals; both were exposed to the hazard and contracted the disease, while the first was a heavy smoker and the second not. A fixed amount of money has been allocated to compensate these two individuals. Please indicate the percentage of this amount that you would allocate to compensating the smoker (the rest of the funds will go to the non-smoker):



6.3 Appendix C: Tables

Table I. Background and Demographics (N=166)

Variable	Response Category	Percentage
Gender	Male	50.0
	Female	50.0
Age	18-28 years old	8.4
	29-39 years old	18.7
	40-49 years old	18.7
	50-59 years old	24.1
	60-69 years old	16.9
	Over 70 years old	13.3
Education	Primary school	0.6
	Some secondary school	3.6
	Secondary school	30.7
	Vocational school	18.7
	Some university modules	9.0
	Bachelors degree	22.3
	Some graduate-level modules	4.8
	Masters degree	8.4
	Some doctoral-level modules	0.6
	Doctorate degree	1.2
Household	Live alone	25.3
	Live with others	74.7
Income	£0 to £20,000	25.3
	£20,001 to £40,000	32.5
	£40,001 to £60,000	16.9
	£60,001 to £80,000	17.5
	£80,001 to £100,000	6.0
	Over £100,000	1.8
Children	Have no children	38.0
	Have children	62.0

Table II. Descriptive Statistics of Choice Questions

Task	Mean	Standard deviation	Median	Share of subjects with $-50 \leqslant y_i < 0$	Share of subjects with $y_i = 0$	Share of subjects with $0 < y_i \leqslant 50$
Overall						
Prevention	16.26	22.92	17.00	12.05	21.69	66.27
Treatment	15.47	23.00	12.00	13.86	22.29	63.86
Hazard	17.02	18.42	16.00	3.01	30.12	66.87
Non-smokers						
Prevention	17.35	23.51	20.00	12.50	16.91	70.59
Treatment	18.04	22.50	20.00	11.76	16.91	71.32
Hazard	19.68	18.76	20.00	2.21	23.53	74.26
Smokers						
Prevention	11.33	19.59	0.00	10.00	43.33	46.67
Treatment	3.83	21.97	0.00	23.33	46.67	30.00
Hazard	4.97	10.40	0.00	6.67	60.00	33.33

Table III. Means and Standard Deviations of the Independent Variables

Variable	Mean	Std. dev.	Variable	Mean	Std. dev.
Group identity			*Likelihood perceptions*		
Angelina Jolie's case	0.843	0.365	Personal_ambiguity	0.241	0.221
Sean Connery's case	0.343	0.476	Personal_hereditary_minimum	0.214	0.197
Personal history	0.066	0.249	Personal_hereditary_ambiguity	0.195	0.189
Family history	0.639	0.482	Personal_lifestyle-related_minimum	0.231	0.184
Personal lifestyle	2.578	0.749	Personal_lifestyle-related_ambiguity	0.204	0.177
Smoke	0.181	0.386	*Risk factor perceptions*		
Presenting order	0.560	0.498	Avoid RFs, benefit minimum	0.292	0.150
Likelihood perceptions			Avoid RFs, benefit ambiguity	0.238	0.152
UK_minimum	0.286	0.142	*Socio-demographic data*		
UK_ambiguity	0.278	0.179	Gender_male	0.500	0.502
UK_con_hereditary_minimum	0.288	0.164	Age bands	3.620	1.504
UK_con_hereditary_ambiguity	0.218	0.142	Education level	4.723	1.831
UK_con_lifestyle-related_minimum	0.375	0.171	Household size (> 1)	0.747	0.436
UK_con_lifestyle-related_ambiguity	0.247	0.166	Income level	2.018	0.937
Personal_minimum	0.292	0.192	Number of children (> 0)	0.620	0.487

Table IV. Regression Results From Tobit Models

Variable	Prevention	Treatment	Hazard
Angelina Jolie's case	10.62	16.50***	−0.51
	(7.17)	(6.14)	(4.32)
Sean Connery's case	−6.98*	−5.26	−1.49
	(4.21)	(4.05)	(2.97)
Personal history	2.58	−8.95	−6.86
	(9.16)	(7.04)	(5.07)
Family history	−6.11	−9.28**	−4.16
	(4.17)	(3.80)	(3.05)
Personal lifestyle	3.67	1.11	−4.27**
	(3.16)	(2.51)	(1.97)
Smoke	−5.14	−12.48***	−11.97***
	(4.43)	(4.67)	(3.76)
Presenting order	3.24	0.60	−9.21***
	(4.08)	(3.80)	(2.78)
UK_minimum	−0.23	−0.16	−0.01
	(0.21)	(0.19)	(0.16)
UK_ambiguity	0.22	0.38***	0.07
	(0.15)	(0.13)	(0.13)
UK_con_hereditary_minimum	−0.05	−0.24	−0.03
	(0.16)	(0.15)	(0.12)
UK_con_hereditary_ambiguity	−0.24	−0.57***	−0.15
	(0.19)	(0.17)	(0.17)
UK_con_lifestyle-related_minimum	0.28**	0.35***	−0.02
	(0.13)	(0.12)	(0.10)
UK_con_lifestyle-related_ambiguity	0.36**	0.30**	0.12
	(0.15)	(0.15)	(0.10)
Personal_minimum	0.17	0.08	−0.18
	(0.21)	(0.20)	(0.18)
Personal_ambiguity	−0.04	−0.01	−0.05
	(0.11)	(0.10)	(0.09)
Personal_hereditary_minimum	0.08	0.17	0.31***
	(0.18)	(0.17)	(0.11)
Personal_hereditary_ambiguity	0.05	−0.02	0.07
	(0.12)	(0.09)	(0.08)
Personal_lifestyle-related_minimum	−0.47***	−0.26	−0.12
	(0.18)	(0.17)	(0.13)
Personal_lifestyle-related_ambiguity	−0.05	−0.04	0.03
	(0.15)	(0.13)	(0.11)
Avoid RFs, benefit minimum	0.18	0.03	0.17*
	(0.15)	(0.14)	(0.10)
Avoid RFs, benefit ambiguity	0.03	0.19	−0.16
	(0.17)	(0.16)	(0.14)
Gender_male	−8.06*	−5.13	0.57
	(4.23)	(3.75)	(2.87)
Age bands	0.37	1.71	−0.17
	(1.39)	(1.31)	(1.09)
Education level	−0.86	−1.29	−0.11
	(1.15)	(1.07)	(0.74)
Household size (>1)	−0.47	2.31	0.67
	(5.67)	(4.95)	(3.83)
Income level	3.17*	2.25	−0.29
	(1.85)	(1.78)	(1.48)
Number of children (>0)	−6.04	−5.92	−1.53
	(4.65)	(4.53)	(3.64)

*,**,*** indicate significance at the 10, 5, and 1 percent levels, respectively.

Robust standard errors are reported in parentheses.