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For Peer Review

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SCALE PERCEPTION BIAS IN THE VALUATION OF ENVIRONMENTAL RISKS

Abstract

The valuation of environmental risks is commonly approached with the utilization of stated preference methods such as contingent valuation. In these methods, money is utilized as the scale that reflects the individual's underlying utility function. However, this scale can vary across individuals due to different perceptions on what are the right or appropriate bounds for willingness to pay. In this paper we test for scale perception bias and propose a correction method based on the utilization of anchoring vignettes that define different degrees of preference for the non-market good. The proposed method is applied to study the commonly found anomaly "probability neglect", which is defined by the insensitivity to the probability levels in the valuation of environmental risks. The results show that probability neglect disappears when willingness to pay responses are corrected for self-perception bias through the utilization of the anchoring vignettes approach.

Keywords: Anchoring vignettes, Environmental risks, Embedding, Probability neglect, Measurement scales, Money, Willingness to pay.

1. Introduction

The measurement of environmental benefits is commonly approached with stated preference methods, such as contingent valuation (CVM). This method is based on the utilization of structured survey questionnaires to elicit from individuals their maximum willingness to pay (WTP) for some policy proposal about a well defined environmental good (e.g. Bateman and Willis (1999)). The central element of stated preference methods is the utilization of money as the utility measurement rod under the assumption that it should reflect the underlying change in individual's utility.

However, some authors such as Kahneman et al. (1997) and Kahneman et al. (1999) have pointed out that the reliance on money to approximate subjective utility raises some problems, because answers based on money might be subject to potential biases (e.g. the scope insensitivity effect, anchoring effects, warm glow), which could lead to unreliable results. The cumulative set of anomalies and potential mishaps performed by CVM led Kahneman and Sugden (2005) to conclude that contingent valuation questions tend to elicit attitudes rather than preferences. The main difference between preferences and attitudes lies in the fact that while the logic of preference assumes extensionality, the logic of attitudes do not¹. These authors argue that CVM responses are made without a "modulus"² or a standard, and it is the absence of modulus what induce unreliable responses and anomalies such as the anchoring effects found by Ariely et al. (2003) by recalling the social security number on respondents.

¹ More concisely, Kahneman and Sugden (2005) claim that "we have attitudes to many things that we don't have any reason to have preferences about because they are not choices that we could ever have to make". Therefore, these authors claim that this is problematic for the use of contingent valuation to inform public policy, since some of the common anomalies that are found in responses to contingent valuation surveys (i.e. framing and context effects) can be attributed to the fact that the logic of preferences assumes extensibility while the logic of attitudes do not guarantee such property.

² A "modulus" in a scale development can be formally defined as a certain value that is clearly identified and considered as the reference point to relatively place (i.e. valuate) any objet in the scale. See Hsee and Tang (2007) for a nice review.

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4 The absence of a “modulus” or standard in CVM responses could lead to the fact that
5
6 the monetary measurement scale can be subjectively interpreted across groups of
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8 individuals. It is well known that respondents to contingent valuation surveys often
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10 understand the same survey question differently. That may be especially true for the
11
12 more abstract concepts of interest to environmental economists, such as sustainable
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14 development or environmental quality perception. A policy that clearly leads to
15
16 “average environmental quality” to one respondent could lead to “very high
17
18 environmental quality” to another and “poor environmental quality” to a third. This
19
20 inter-personal incomparability potentially poses a non-trivial threat to the conclusions
21
22 drawn from survey questions applied in heterogeneous populations. Seemingly
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24 important inter-group differences in survey responses could, in fact, reflect differences
25
26 in question interpretation. The implication is that it would be useful to correct for these
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28 differences in the perception of the monetary scale, in order to harmonise answers
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30 across respondents. In this paper we propose a method for correcting individual
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32 heterogeneity in the perception of the monetary scale.
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42 To attempt to ameliorate this problem, researchers have developed the technique of
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44 anchoring vignettes (King et al. 2004, King and Wand 2007, Wand 2007, Soest et al.
45
46 2007). After a standard willingness to pay question, the survey respondent learns about
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48 hypothetical individuals through brief vignettes and is asked to place those individuals
49
50 on the same response scale. Variation in vignette responses across individuals reveals
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52 interpersonal incomparability and enables researchers to use one of several statistical
53
54 techniques to rescale the respondent’s own willingness to pay.
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2 As it has been shown in previous literature, when applied correctly, the technique can
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4 greatly increase the comparability in survey responses (Grzymala-Busse 2007,
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6 Kristensen and Johansson, Buckley 2008, Kapteyn, Smith, and Soest 2007, Soest et al.
7
8 2007, King et al. 2004, Salomon, Tandon, and Murray 2004, Damacena, Vasconcellos,
9
10 and Szwarcwald 2005, Javaras and Ripley 2007, Hsee and Tang 2007, Javaras et al.
11
12 2008, Datta Gupta et al., 2010, Vonkova and Hullegie, 2010, Baggo D'Uva et. al, 2007,
13
14 among many others).

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21 Following the approach developed by King et al. (2004) for qualitative survey
22
23 responses, a normalization of the WTP responses across individuals can be obtained by
24
25 questioning them about hypothetical anchoring vignettes or profiles, which are intended
26
27 to obtain the implicit anchors of the potential range of the WTP responses. The idea
28
29 behind this method is that respondents, in addition to stating how much are they willing
30
31 to pay for an specific environmental policy, are asked to evaluate, on the same scale,
32
33 how much they think that a set of hypothetical persons (vignettes) are willing to pay for
34
35 the same policy. This information is then used to rescale individuals' evaluation of the
36
37 environmental policy at hand, using a joint model for the willingness to pay questions
38
39 and the vignettes. Thus, if one particular subgroup of the population, systematically
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41 gives higher valuations of hypothetical vignettes compared to other subgroups that rank
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43 the exact same hypothetical vignettes, this would indicate that differences in willingness
44
45 to pay are due to cultural differences in evaluating such subjective questions and not due
46
47 to stronger preferences for the policy project under study.
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56 On the other hand, it is important to notice that scale perception bias is not simply
57
58 reflecting heterogeneity in respondents' preferences. Moreover, it does consider
59
60 heterogeneity in the definition of the appropriate scale of the money metric across

1
2 individuals leads to a bias that can be defined as a scale-perception bias. This bias is due
3
4 to the fact that individuals might hold a subjective perception of what should be the
5
6 WTP responses (or non-monetary scale level) of identical individuals but with varying
7
8 strengths of preference for an environmental good or policy proposal. In the context of
9
10 contingent valuation, scale-perception bias is a measurement bias, which is induced by
11
12 the different anchoring points that individuals have about the potential range of WTP.
13
14 This type of bias could be related to other anomalies commonly encountered with
15
16 monetary scales, such as the anchoring effects or the scope bias.
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22 Thus, the scale-perception of what would be the right scale range and intensity for the
23
24 measurement rod utilized in the valuation of environmental goods, could lead to
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26 individual responses which are not directly comparable, unless some corrections are
27
28 made for the anchor or scale effects. For instance, for some individuals the maximum
29
30 WTP of an individual with a strong preference for an environmental policy -given
31
32 income and other socioeconomic parameters- could be 1000 €, and for other individuals
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34 this could be 300 €. Thus, each subject could base her responses on a different monetary
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36 scale leading to a scale-perception or assessment bias that could be corrected by
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38 deriving a homogeneous scale across individuals.
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47 The main finding of this research is the fact that probability neglect disappears when the
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49 scale perception bias is accounted for. In other words, the correction for monetary scale
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51 perception bias leads to a more accurate approximation to individual utility, and
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53 provides a new way to challenge the potential anomalies commonly encountered in
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55 CVM, such as the scope effect. This type of effect is due to the fact that subjects might
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57 not be sensitive to the dimensions of the good to be valued.
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1
2 In this paper, we focus on a particular type of scope effect that might be found in the
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4 valuation of environmental risks, in what is also named “probability neglect” (Sunstein
5
6 (2003)). This follows from the fact that individuals might not be sensitive to the level of
7
8 risks (e.g. Kunreuther et al. (2001), Loewenstein (2001), Slovic et al. (2002)). For
9
10 instance, if some measure is undertaken to reduce the health risks across the population,
11
12 then subjects could respond the same monetary quantity regarding the extent of risk
13
14 reduction. There can be various reasons for this response, for example, just because any
15
16 small amount of risk is considered unacceptable, or because respondents are unable to
17
18 discriminate between different risk levels in monetary terms. In any case, the amount of
19
20 risk posed to the subject does not have an impact on the monetary scale although she
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22 might value different levels of risk reduction differently, according to her underlying
23
24 and informed preferences.
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33 The paper is organized as follows. In the next section we present the application and the
34
35 methods of anchoring vignettes utilized to elicit individuals valuations in the context of
36
37 a CVM survey. The application focuses on the evaluation of the reduction in the
38
39 environmental risks associated with the utilization of pesticides in agricultural products.
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41 Section 3 presents the econometric approaches to model the normalization approach to
42
43 rescaling the elicited individual values utilizing the methodology of anchoring vignettes
44
45 presented in the previous section. Section 4 presents and discusses the results of the
46
47 anchoring vignettes model, the correction of WTP for scale-perception bias and the test
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49 validity of the scope or probability neglect effect. Finally, section 5 presents the main
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51 conclusions and implications for future research.
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2. Data and methods

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4 The application focused on the valuation of the reduction of environmental risks caused
5 by the adoption of sound management practices in agricultural production. A CV survey
6 was conducted in the Canary Islands (Spain) in the summer of 2005. A pre-test survey
7 involving 70 subjects and two focus groups allowed us to define the critical elements of
8 the scenario, such as the amount and type of information, the payment vehicle and the
9 plausibility of the policy proposal.
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21 Individuals were posed with a policy proposal intended to enforce the adoption of sound
22 management practices in agricultural production that would reduce the risks to
23 environmental assets. It was remarked that agricultural production could cause several
24 external effects on the environment because of the intensive use of pesticides and
25 chemical fertilizers. The policy measures would reduce the amount of these substances
26 towards a level that would reduce the risk of damage to soil and ecosystems.
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37 The final sample included 525 subjects that were randomly selected from the sample
38 population. The sample was representative of the population of the Canary Islands with
39 a post sampling error of 4.3 %. In order to maximize sample representativeness, an ad
40 hoc polietapic sampling design was implemented. This process was tested successfully
41 in previous socioeconomic research for the same target population. The carefully
42 designed random routes along islands, regions, cities and neighbourhoods were fixed by
43 using sampling quotas for the most relevant demographic covariates. In order to test for
44 the scope insensitivity effect or probability neglect, the final sample was split in three
45 subsamples characterized by three alternative levels of risk reduction: 10%, 50% and
46 90%. Probability neglect would imply that WTP was insensitive to the amount of
47 environmental risk reduction. In strict terms, this hypothesis could be attributed to the
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2 fact that individuals would care only about the presence of risk but not about its
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4 magnitude. However, focus group results revealed that the amount of risk made a
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6 difference in subject's response to WTP as framed in a hypothetical market context.
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8 Thus, there might be a case for investigating the results with split samples in order to
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10 study if scope insensitivity is really an issue in the valuation of environmental risks.
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16 The elicitation method was the dichotomous choice format. This involved a single
17
18 binary yes/no WTP question to a bid price previously selected from a bid vector. The
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20 bid vector was designed following Cooper's (1993) optimal bid design procedure for a
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22 pre-determined number of bids, and using information from the open ended results in
23
24 the pre-test survey. Each subject received randomly one of the prices in the bid vector
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26 and was asked for a yes/no answer. 10% of subjects opted for declining any response
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28 because they did not know and could not formulate an answer, and were therefore
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30 excluded from the sample. Therefore, the response rate was of 90 %.
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37 Each subject was asked about her own self-assessment and about the assessment of
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39 hypothetical profiles or anchoring vignettes. These vignettes were studied in focus
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41 groups and were defined by individuals with different degrees of preferences toward the
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43 policy proposal, and depending on specific characteristics³. A crucial assumption of the
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45 anchoring vignettes model is the fact that there might be no "self-others gap", that is,
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47 responses to vignettes are evaluated under the same frame and preference structures as
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49 self-responses (King, 2004). In other words, responses to vignettes should represent
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51 different values but from the same preferences distribution. In the preliminary studies of
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53 this research (focus groups, pre-tests, experts' interview, ...) we observed that, for this
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60 ³ We also conducted individualized think-allowed experiments, which showed support for the hypothesis that individuals use to reflect about what would be the right amount to pay for the policy proposal and what would other individuals respond to the same question.

1
2 specific valuation scenario, after 4 vignettes respondents presented some fatigue and
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4 reported answers were less likely to come from the same distribution. For that reason,
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6 we decided to ask for 4 vignettes since, for our application at hand, they seem to
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8 provide the maximum amount of information to correct for scale bias that respondents
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10 may manage with average cognitive abilities. These four different profiles presented
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12 were described as follows:
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19 [Ann] is very worried about the environment when taking shopping
20 decisions. She always shops in organic foods markets and is very concerned
21 about the production techniques involved in raising fruits and vegetables.
22 She never eats food with artificial ingredients which could damage the
23 environment.
24

25 [Michael] is just average worried about the environmental impact of
26 agricultural food production. As much as he can, he avoids eating food with
27 dubious origin, and although this is not a priority, in the weekends he uses to
28 shop in ordinary markets where there is traceability of the agricultural
29 products.
30

31 [Richard] does not believe all the predictions by experts about the impact of
32 food production on the environment, and thinks that the benefits generated
33 by those practices which are characterized as environmentally unfriendly
34 techniques overcome the potential damages to environmental assets.
35
36

37 [John] is not concerned about environmental assets at all and does not think
38 that food production in the current state is causing damage to the
39 environment in any way. Even if damage is caused, he would not care about
40 it. His main priority is cheap food since when he shops for food the most
41 important issue is the price.
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45 Following the description of each profile, each individual was asked to assess the
46 potential response of the individual described in the hypothetical profile to the risk
47 reduction policy measure using a binary response WTP question to a bid price randomly
48 taken from a pre-designed bid vector. These bid price vectors for the hypothetical
49 profiles were designed in a similar way to the one employed for the self-assessment
50 question, i.e. utilizing Cooper's (1993) methods based on information from the open-
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2 ended pre-test sample and focus groups.⁴ Also, and in order to avoid order effects,
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4 vignettes were presented randomly to each respondent. Our results show that this
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6 procedure ameliorates the potential influence of first vignette responses on the follow-
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8 up questions and potential center-seeking biases.
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14 The response to these anchoring vignettes can be utilized for the correction of potential
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16 scale perception bias which could follow by the fact that otherwise identical individual
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18 with similar preferences could value differently the same environmental good because
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20 of a different use of the money metric implicit in the valuation.
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26 A simple way of correcting for scale bias involves a re-escalation of the individual
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28 responses by reparametrization. Figure 1 illustrates the idea of the correction of self
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30 perception bias for the case of WTP responses to a hypothetical open ended question.
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32 Individuals i and j respond differently to the maximum WTP assessment for the
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34 individual with the most favourable preference for the policy proposal, i.e. as described
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36 in profile for Ann ($WTP_{j \text{ MAX}} > WTP_{i \text{ MAX}}$). Accordingly, it seems that individual j
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38 values more the policy proposal than individual i , as can be appreciated by the fact that
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40 $WTP_j > WTP_i$. The normalization of the differences in the use of the scale can be done
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42 by harmonizing WTP_{MAX} across individuals. The ending result would be that individual
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44 B would value the policy proposal in a larger monetary amount than individual A.
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52 Thus, the utilization of anchoring vignettes can become a powerful tool for correcting
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54 the influence of unobserved anchors heterogeneity distributed across the target
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56 population. Individual survey responses can vary because of the utilization of different
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58 cues or anchors, which can be attributed to cognitive, emotional or cultural differences,
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⁴ The particular bid offered in each split sample were 12, 24, 36 and 52 euros.

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2 or to the personalized influence of the elements considered in the survey instrument. For
3
4 the dichotomous choice format, the incorporation of the anchoring vignette responses
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6 into the individual monetary valuation involves a simultaneous equation model which is
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8 presented in the next section.
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11 12 13 14 **3. Modelling approach** 15 16 17

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19 The model for accounting for the impact of anchoring vignettes in the correction of
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21 scale perception bias could be based on a simultaneous equation approach. The
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23 dichotomous choice elicitation process involves a “yes/no” response to a bid price,
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25 which is posed by the individual in each vignette assessment as well as in her own
26
27 assessment. Following Cameron’s (1988) parameterization⁵, we assume that the latent
28
29 variable willingness to pay (WTP) has two components: a deterministic component μ
30
31 and a random component ε . Thus, for each j assessment (own and others), we can define
32
33 willingness to pay as the following: $WTP_i^j = \mu_i^j + \sigma_j \varepsilon_i^j$, where μ_i^j and σ_j are,
34
35 respectively, the mean and the standard deviation of WTP_i^j ; $j=0$ for the self-assessment
36
37 WTP and ε_i^j is a random error term, which is assumed to follow a standard normal
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39 distribution.
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47 For each vignette, the respondent is asked to pay a given amount of money (B_j ;
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49 $j=1,2,\dots,J$). The interdependencies across the responses to self and others assessments of
50
51 WTP can be modelled using a simultaneous equations with limited dependent variables
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53 (SLDV) approach. This approach reduces to a general triangular system (Zellner, 1971)
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55 for complete data sets. The equations are the following:
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⁵ Cameron (1988) approach has the advantage of its easiness of interpretation. Alternatively, it can be used the random utility approach by Hanemann (1984).

$$WTP_i^1 = \mu_i^1 + \varepsilon_i^1$$

$$WTP_i^2 = \mu_i^2 + \varepsilon_i^2$$

$$WTP_i^3 = \mu_i^3 + \varepsilon_i^3$$

$$WTP_i^4 = \mu_i^4 + \varepsilon_i^4$$

$$WTP_i^5 = \mu_i^5 + \eta_1 WTP_i^1 + \eta_2 WTP_i^2 + \eta_3 WTP_i^3 + \dots \eta_4 WTP_i^4 + \varepsilon_i^5$$

(1)

and

$$(\varepsilon_i^1, \varepsilon_i^2, \dots, \varepsilon_i^5) \sim MVN(0_5, \Sigma) \text{ and } \Sigma = \begin{pmatrix} 1 & & & & \\ \sigma_{21} & \sigma_2^2 & & & \\ \sigma_{31} & \sigma_{32} & \sigma_3^2 & & \\ \dots & & & \dots & \\ \sigma_{51} & \sigma_{52} & \dots & \sigma_{54} & \sigma_5^2 \end{pmatrix} \quad (2)$$

where WTP_5 represents individuals own WTP and WTP_1, \dots, WTP_4 represents others WTP. On the other hand, vector μ_i^k ($k=1,2,\dots,5$) represent the mean of WTP^k and are linked to the probability of a positive response by a multivariate normal cumulative distribution (MVN), also known as the “link” function. These link functions can be made dependent on a set of explanatory variables or covariates. Simultaneity in the response effects across anchoring vignettes is captured by the lower triangular components of the symmetric matrix Σ ($\sigma_{i,j} \neq 0 \quad \forall i \neq j / i, j = 1, 2, \dots, 5$).

Given the calculation of multiple integrals in the likelihood function for the model, estimation using full information maximum likelihood methods is generally avoided in favour of less efficient (but computationally simpler) estimation procedures, such as two-step algorithms (see Blundell and Smith, 1994). On the other hand, by definition, the asymptotic properties of classical estimators are not guaranteed in small and finite

1
2 samples. A Bayesian approach obtains exact results in these cases, while at the same
3
4 time allows for simple estimation procedures. Our approach is an extension of Li's
5
6 (1998) approach for SLDV models and Araña and León (2002) methodology for DC1,
7
8 which are based upon the framework introduced by Chib (1992) and Albert and Chib
9
10 (1993).
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20 **4. Results**

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24 An important element in testing for the reliability of the monetary scale as an instrument
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26 for measuring environmental risks involves the consideration of the sensitivity of the
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28 responses to the amount of risks involved. Probability neglect follows from the fact that
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30 individual responses in the market construct are not sensitive to the amount of risks,
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32 while market evidence shows that this is not necessarily the case. This might happen to
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34 be the situation for the application involving the amount of environmental risk reduction
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36 attributed to unsound production practices utilized in agriculture. These practices can
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38 have relevant impacts on the environment, and there is both non-market and market
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40 evidence that shows that individuals choose consumption according to their perception
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42 of the associated environmental effects. For a nice review of probability neglect and key
43
44 references see for instance Sunstein (2003).
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53 In order to test in a non-market context for the hypothesis of probability neglect
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55 associated with environmental risks due to agricultural production, we can conduct a
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57 regression analysis. As explained in the previous section, for convenience and easiness
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59 of interpretation, we follow Cameron's (1988) parameterization of a binary response
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1
2 model, which can be seen as equivalent to the discrete choice alternative based on
3
4 Hanemann (1984). Table 1 displays the definition of the variables which were
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6 significant covariates in explaining WTP. Some other attitudinal variables were
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8 considered for the incorporation in the regression results, but showed weak significance
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10 in the context of the full regression model.
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16 Table 2 presents the estimation results for the standard WTP regression model, i.e.
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18 without the consideration of the impact of anchoring vignettes, and for the model
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20 incorporating the effects of anchoring vignettes. These models have been estimated by
21
22 maximum likelihood. The model with anchoring vignettes is a single equation model,
23
24 which consists of the incorporation of the yes/no responses to the hypothetical vignettes
25
26 as explanatory variables of the individual WTP. The socioeconomic variables of income
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28 and education make a positive contribution to mean WTP and are highly significant in
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30 explaining the elicited values with both models, while the health status of the individual
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32 also shows a positive sign and is significant at the 95% level. WTP is also larger for
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34 those individuals who use to eat substantial amounts of fresh food in their daily diet.
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42 The model with anchoring vignettes in Table 2 shows that some of the assessments of
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44 the potential responses of the hypothetical individuals are significant explanatory
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46 variables of WTP. This is the case for WTP2 and WTP4, i.e. for those individuals
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48 representing a moderate environmental preference [Michael] and a complete absence of
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50 environmental concern [John], respectively. The results are not significant for the
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52 alternative two vignettes.
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59 The significant impact of others assessments on the self individual assessment can be
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taken as evidence of the presence of a relationship between the vignettes and WTP. That

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2 is, the monetary scales utilized by individuals when grading different degrees of
3 preference for an environmental good are not equal across the sample. The overall
4 implication is that there could be individuals with identical socioeconomic variables
5 who rate differently the expected monetary value of various degrees of preference for
6 the reduction of the environmental risks caused by agricultural production.
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16 Therefore, the results support the evidence of the hypothesis of scale perception effect
17 or bias, which follows from the fact that individuals employ different comparative
18 scales consistent with a common monetary metric. The use of different monetary scales
19 across individuals can be due to the implicit anchors to be present in the subjective mind
20 when answering monetary valuation questions. It can also reflect the impacts across
21 groups of individual responses of other elements of the market construct, such as the
22 hypothetical context effect, yea saying, implicit cues, cognitive processes and affective
23 reactions.
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37 The hypothesis of probability neglect in the context of the valuation of environmental
38 risks cannot be rejected for the standard model in Table 2, since the dummy variables
39 RISK50 and RISK90 are not significant. That is, individual responses are not sensitive
40 to the amount of environmental risks, in what can be interpreted as giving support to the
41 embedding or scope effect. However, the results are more challenging when considering
42 the incorporation of anchoring vignettes in model M2. It can be seen that both risk
43 levels have a positive impact on WTP. This indicates that risk levels can have a positive
44 effect when anchoring effects are consequently incorporated into the model, thereby
45 correcting for unobserved anchors or scale bias. Thus, the result of probability neglect
46 with the traditional model can be attributed to the presence of self perception bias in the
47 use of the monetary scale across groups of individuals.
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4 The mean WTP estimated for each type of model and risk level are presented in Table
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7 3. The results confirm the relevance of the anchoring vignettes as was showed with the
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9 estimated WTP functions in Table 2. That is, WTP is not significantly different for
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11 model M1 across the risk levels of environmental risk, thereby it shows embedding or
12
13 probably neglect effects. However, when anchoring vignettes are considered for the
14
15 correction of self perception bias, the results show that WTP increases when the level of
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17 environmental risk is increased. Individuals are willing to pay higher amounts of money
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19 for agricultural production policies that enforce less risk of damage to the natural
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21 environment. The fact that the impact of implicit anchors on the individual's
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23 measurement scale does not allow to obtain this result for the standard model raises
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25 concerns about the standard approach to test for embedding effects and other anomalies
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27 encountered in non-market valuation.
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35 The results in Table 2 for the anchoring vignette model follow from a simple modelling
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37 approach which incorporates the vignette responses as explanatory variables. However,
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39 these results could be biased because of the endogenous bias following from the fact
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41 that the responses to the anchoring vignette situations are also endogenous variables,
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43 and therefore should be modelled accordingly. This is done following the model
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45 procedures outlined above, by the consideration of a simultaneous equation approach in
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47 which each of the anchoring vignette responses is modelled with an independent
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49 equation together with the equation explaining the individual's self assessment
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51 response.
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58 The results for the simultaneous equation modelling approach are presented in Table 4.
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60 The correlation coefficients across the responses of anchoring vignettes show a large

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2 value and are all significantly different from zero. The correction for endogenous bias
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4 certainly increases the significance of the anchoring vignette responses on WTP. Thus,
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6 the hypothesis of the utilization of a homogeneous scale monetary metric across the
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8 sample is rejected. Each individual clearly perceives a particularly personalized scale on
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10 which to base herself and others assessments of the WTP for the reduction of
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12 environmental risks caused by agricultural production. It can be seen that the hypothesis
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14 of probability neglect is also rejected, since monetary valuation, when corrected for
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16 scale perception bias, is sensitive to the variation in the risk reduction levels.
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28 **5. Conclusions**

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33 Contingent valuation and stated preference methods rely on the utilization of the money
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35 metric for the identification of individual preferences for environmental goods. There is
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37 a vast amount of research which indicates that this metric can be subject to important
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39 anomalies with respect to the theoretical precepts of consumer theory. This might call
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41 for alternative ways of eliciting individual preferences which bypass the encountered
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43 anomalies.
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50 In this paper we have considered the issue of the impact of unobserved anchors in the
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52 monetary scale of WTP, and have developed a method for correcting for these anchors
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54 utilizing the individual assessment of others responses as described by characters
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56 described in hypothetical vignettes. It is a maintained hypothesis sustained by a large
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58 body of research that individuals might care about the behaviour of other individuals
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60 with similar or different degrees of preferences for a public or a private good. In

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2 addition, individuals tend to use the monetary measures according to their specific
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4 perception of the impact of the proposed policy on their subjective well-being.
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9 Nevertheless, the differences in using the monetary scale metric across individuals can
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11 be also attributed to the impact of some elements of the market construct, such as the
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13 payment vehicle of the information content, which can be subjectively interpreted by
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15 the respondents. More generally, cognitive and emotional processes can also play a
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17 relevant role in the differences of the response scales across individuals in survey
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19 research.
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25 The utilization of anchoring vignettes in surveys can allow for the normalization of
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27 subjective responses across the sample of respondents. In these vignettes the individuals
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29 are asked to assess the potential response of individuals with different degrees of
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31 preference for the environmental policy proposal, given the same income level and
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33 socioeconomic characteristics. We have developed an econometric approach for the
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35 correction of the self perception bias based on the utilization of a simultaneous equation
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37 model which takes into account of the impact of anchoring vignette responses on
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39 individual willingness to pay.
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47 The performance of the technique of anchoring vignettes for correcting self perception
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49 bias with respect to the scale measure can be assessed with the investigation of the
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51 potential anomalies commonly encountered in contingent valuation and stated
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53 preference methods. We have considered the impact of probability neglect, which is one
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55 of the most important anomalies for which direct non-market valuation methods are
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57 criticised. Probability neglect follows from the fact that individuals are not sensitive to
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59 the levels of risk defined in a risk policy for ameliorating environmental risks. In this
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2 sense, probability neglect for risk assessment is similar to the embedding or scope effect
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4 encountered in the valuation of other types of non-market goods.
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9 Our results have shown that the phenomenon of probability neglect with respect to a
10 policy proposal for the reduction of the environmental risks caused by agricultural
11 production is present with standard valuation methods. However, when the responses
12 are corrected for self perception bias in the utilization of the measurement scale the
13 results show that individuals are concerned with the level of risks, and that WTP rises
14 significantly with the amount of environmental risk reduction.
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26 There is a large research schedule emerging from the results and the approach put
27 forward in this paper. First, further research should investigate more closely the impact
28 and implications of self perception bias and the utilization of different monetary scales
29 across individuals, both theoretically and empirically. Second, the potential anomalies
30 of stated preference methods can be also revised for the correction of self perception
31 bias utilizing the scale correction methods of anchoring vignettes. Third, although WTP
32 for health risk reduction is expected to change proportionally with changes in risk
33 according to the expected utility model, this may not be the case in other models of
34 behaviour under risk in which cumulative probabilities are transformed in decision
35 weights, such as prospect or rank-dependent utility theories (Hammit and Graham,
36 1999, Botzen and van der Bergh, 2009). These alternative interpretations of behaviour
37 under different risk conditions may be worth to explore be in future contingent
38 valuation studies. A final line of further research could follow from the investigation of
39 the cognitive and affective processes leading to anchoring behaviour in individuals'
40 decisions. From a more technical point of view, new research might contribute to define
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2 optimal vignettes, and to what extent this approach can be helpful in measuring social
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4 preferences in more “complicated” contexts (e.g. high emotional, unfamiliarity).
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10 11 12 13 14 **References**

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Table 1. Description of variables

Variables	Description	Statistic Mean (s.d.)
RISK10	= 1 for a 10 % risk reduction policy, 0 otherwise.	0.33
RISK50	= 1 for a 50 % risk reduction policy, 0 otherwise.	0.33
RISK90	= 1 for a 90 % risk reduction policy, 0 otherwise.	0.33
HS	Perceived Health status compared with other people of the same age. The range of values goes from 1 (very bad) to 6 (excellent). This variable has been rewritten as 6 binary covariates HSi, which takes value 1 if HS is equal to i and 0 otherwise. For values of I from 1 to 6.	3.8 (1.2)
FRESHF	=1 if individual regularly eat fresh food, 0 otherwise.	0.24
HRISKAT	This is a factor composed by responses to several attitudinal likert-type questions regarding health risk attitudes. ⁶ (cronbach-alpha = 0.8732)	0 (1)
INC	Annual respondent's household net income (in thousands of €).	25.81 (19.06)
EDUC	Number of years of completed education.	10.37 (3.94)
WTP ¹	Yes (1) /no (0) response in the case of the vignette represented by Anne	0.85
WTP ²	Yes (1) /no (0) response in the case of the vignette represented by Michael	0.62
WTP ³	Yes (1) /no (0) response in the case of the vignette represented by Richard	0.39
WTP ⁴	Yes (1) /no (0) response in the case of the vignette represented by John	0.12

⁶ Attitudinal questions asked the following: In a scale (1-5) where 1 is no concern at all and 5 is very concerned, how much are you concern with the following issues that may affect your health status?. The variables were i) living close to industrial companies; ii) smoking; iii) contaminated air; iv) genetic modified food; v) food with pesticides.

Table 2. WTP functions with and without anchoring vignettes information. (t-student in parentheses)

Variables	M1 model		M2 model	
	Standard		Anchoring vignettes I	
	Parameters	Elasticities*	Parameters	Elasticities*
Intercept	-1.31 (-0.22)	-	-11.98** (-2.45)	-
HS2	8.87** (3.15)	1.67	6.05** (2.94)	1.49
HS3	7.93** (3.81)	1.49	7.12** (3.56)	1.33
HS4	9.45** (3.02)	2.83	7.83** (2.41)	1.76
HS5	9.13** (4.18)	2.47	6.98** (2.95)	1.66
HS6	7.12** (3.11)	1.52	6.27** (3.73)	1.39
FRESHF	2.44** (2.5)	0.63	-8.45** (-0.93)	-1.12
HRISKAT	4.59** (1.3)	1.27	4.62** (1.51)	1.36
INC	4.22** (4.18)	4.52	2.81** (3.67)	2.15
EDUC	0.83** (5.07)	1.70	0.32 (1.85)	0.67
RISK50	2.31** (1.12)	0.43	5.19* (2.21)	0.79
RISK90	3.91** (0.93)	0.36	10.85** (3.37)	1.85
WTP1	-	-	17.32 (0.95)	3.83
WTP2	-	-	3.85** (2.47)	2.12
WTP3	-	-	-11.31 (-0.35)	-3.15
WTP4	-	-	6.29** (2.46)	2.85
σ	13.44** (21.42)	-	16.31** (24.85)	-
N	525	-	525	-
Log L	-471.11	-	-408.61	-

The reference class is RISK10. Elasticities are calculated for average values of variables.

Table 3. Mean WTP and mean attitude scale for alternative risk reduction programs.
(95% confidence intervals in brackets)

		<i>Probability Reduction</i>		
		<i>10 %</i>	<i>50 %</i>	<i>90 %</i>
M1	Mean WTP	17.36 (4.04)	18.85 (3.94)	21.15 (4.23)
M2	Mean WTP	11.75 (3.12)	15.37 (3.09)	23.54 (4.85)

Table 4. Results of the anchoring vignettes system of equations model.

Variables	Estimated equations				
	WTP ¹	WTP ²	WTP ³	WTP ⁴	WTP ⁵
Intercept	4.51** (-6.48)	6.42** (2.78)	5.87** (3.17)	-1.24 (-0.21)	10.23** (-4.72)
HS2	9.68** (3.75)	-4.37** (-1.02)	7.17** (2.32)	12.66** (5.84)	6.12** (3.05)
HS3	8.37** (3.25)	-4.01** (-2.07)	6.59** (2.34)	15.41** (4.16)	6.84** (1.25)
HS4	9.12** (4.06)	-5.12** (-2.34)	7.04** (2.91)	17.76** (8.87)	6.59** (1.93)
HS5	10.77** (4.94)	-4.77** (-1.54)	7.38** (2.89)	12.84* (7.31)	7.15** (2.15)
HS6	9.89** (4.09)	-5.88** (-1.18)	8.04** (3.46)	14.99** (5.23)	6.73** (1.84)
FRESHF	-5.68 (0.51)	8.51* (1.86)	11.89 (1.23)	5.33 (0.74)	11.82 (1.63)
HRISKAT	3.14* (1.98)	4.35** (1.72)	6.37* (3.48)	4.92** (2.06)	4.61** (1.83)
INC	2.92** (2.01)	3.22* (1.69)	4.01 (0.77)	3.15** (3.14)	1.37** (3.11)
EDUC	0.49* (1.82)	-2.43 (0.61)	1.32 (1.35)	0.65** (3.72)	0.03** (2.46)
RISK50	2.13* (1.66)	6.51 (1.49)	1.92 (0.96)	3.47** (4.41)	3.67** (5.42)
RISK90	9.40* (1.72)	8.22** (2.04)	13.21* (1.92)	9.78** (3.27)	11.26** (4.49)
WTP ¹	-	-	-	-	3.10 (3.43)
WTP ²	-	-	-	-	4.49** (2.12)
WTP ³	-	-	-	-	2.91 (1.93)
WTP ⁴	-	-	-	-	58.37** (6.83)
σ_i	9.13** (2.77)	14.31** (1.46)	11.91** (2.38)	18.33** (2.97)	12.62** (2.51)
ρ_{1i}		0,65** (0,26)	0,67** (0,31)	0,96** (0,48)	0,83** (0,32)
ρ_{2i}			0,87** (0,32)	0,63** (0,29)	0,74** (0,33)
ρ_{3i}				0,69** (0,47)	0,72** (0,54)
ρ_{4i}					0,77** (0,27)
N	525	525	525	525	525
Log L	469.34	512.14	498.84	473.22	408.61

Notes: The reference class are RISK10 and HS=1; * Significant at 0.10 level; ** Significant at 0.05 level. (t-Student values in parentheses)

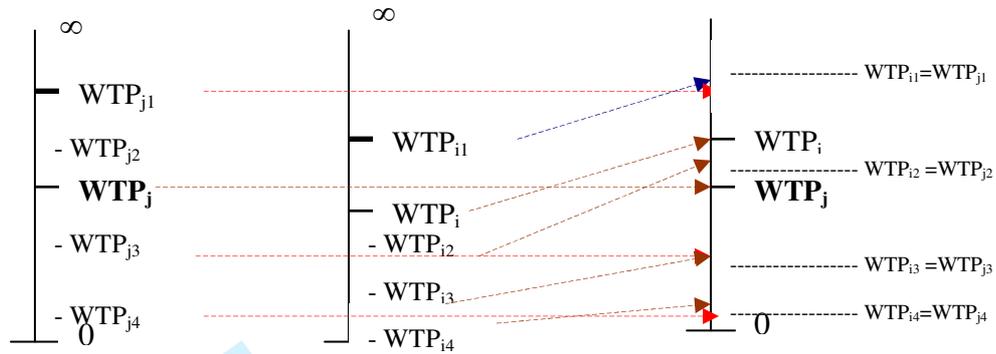


Figure 1