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Designing choice experiments to Test for Anchoring and Framing Effects

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Table of Contents

Abstract

Choice Experiments (CE, otherwise known as Choice Modelling) are an increasingly used stated preference technique to estimate the values of changes in non-market goods and services. Respondents to a CE survey are asked to make repeated choices between alternative future resource use options. Each alternative is described by a number of attributes, with the levels of the attributes varying across alternatives and choice sets. A cost attribute is typically included to enable estimation of the marginal monetary values for changes in the non-market attributes presented. Notwithstanding the central importance of the monetary attribute, limited research has been undertaken on the impacts of varying the (range of) levels of the cost attribute on respondents' choices in CE surveys. Furthermore, the 'framing' of non-market attributes may affect value estimates. Attribute framing refers to the context in which the attributes are presented to respondents. The challenge for CE practitioners is to identify how particular attribute frames may influence respondents' choices.

This research report provides a review of anchoring and framing effects in CEs. A CE questionnaire is described to incorporate tests for anchoring and framing effects. Eight hypotheses are developed about the impacts of various attribute 'anchors' and 'frames' on respondents' choices and subsequent estimated values.

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1. Introduction

Discrete Choice Experiments (CEs), otherwise known as Choice Modelling (CM), have become an increasingly popular stated-preference (SP) approach to estimate the values of non-market goods and services. CE studies have been conducted in fields ranging from health and environmental management to transportation and infrastructure services. CEs have been advocated as a flexible and cost-effective technique to determining the costs and benefits of public projects (Louviere et al., 2000, Alpízar et al., 2001, Bennett and Blamey, 2001). In a CE, individuals are given a series of questions (choice sets), where each question shows the outcomes of alternative (hypothetical) policy scenarios (Figure 1). The outcomes are described by different levels of the attributes, or characteristics, used to depict the good that is being valued. Respondents are asked to choose their preferred option from the array of alternatives. In choosing between alternative options, respondents are expected to make a trade-off between the levels of the attributes. This allows the researcher to observe the relative importance of the different attributes. If a monetary attribute (cost) is included in the choice sets, the researcher is able to calculate the individual's marginal willingness-to-pay (WTP) or *implicit price* for a change in each of the other -non-marketed- attributes (see Section 2.2).

Figure 1 Example choice set

This is an example of a choice set containing three alternative options A, B and C. The outcomes of each option is described by the amount to pay, the area of seagrass, the length of riverside vegetation and the number of rare native animal and plant species.

Question 4

Consider each of the following three options for managing the George catchment.
Suppose options A, B and C are the **only ones** available.
Which of these options would you choose?

Features	Your one-off payment	Seagrass area	Native riverside vegetation	Rare native animal and plant species	YOUR CHOICE
Condition now		690 ha (31% of total bay area)	74 km (65% of total river length)	80 rare species live in the George catchment	
Condition in 20 years					Please tick **one** box
OPTION A	$0	420 ha (19%)	40 km (35%)	45 rare species lost	☐
OPTION B	$200	560 ha (25%)	74 km (65%)	30 rare species lost	☐
OPTION C	$400	560 ha (25%)	56 km (50%)	15 rare species lost	☐

The SP methodology and the set-up of the survey used to estimate non-market values can influence the outcomes and therefore affect both the validity and reliability of value estimates. Validation of methods and results therefore plays an important role when using SP techniques. Many studies have investigated the validity of SP techniques (see, for example, Bennett et al., 1998, Carlsson and Martinsson, 2001, Grijalva et al., 2002, Johnston, 2006, and Boyle and Özdemir, in press). It has been found that CEs are associated with less hypothetical bias than contingent valuation (Murphy et al., 2005), and that CEs can avoid bias from strategic behaviour and reduce embedding effects (Morrison et al., 1996, Hanley et al., 2001). The setting and

wording of the questionnaire forms a vital part of any choice experiment. It is critical to find the appropriate survey design, in order to estimate the true values respondents hold for the non-marketed resources under consideration. The focus of this research report is on designing a CE that explores the effects of 'anchoring' and 'framing' on respondents' answers. This research is part of EERH project Theme D: 'Valuing Environmental Goods and Services'.

Anchoring arises when respondents base their answers on the attribute levels provided in the questionnaire, rather than on their own true preferences. In the contingent valuation (CV) literature, this effect is typically observed as a *starting point* bias. Starting point bias is said to occur when respondents perceive the bid levels included in SP questions as a suggestion of 'acceptable' answers (Mitchell and Carson, 1989). In CV studies, it has been observed that initial bids may be correlated with respondents' WTP (Herriges and Shogren, 1996, Lechner et al., 2003, Chien et al., 2005, Flachaire and Hollard, 2007). Choice Experiments may also suffer from anchoring effects if different cost-attribute levels, or different ranges in those levels[1], affects the estimates of implicit prices.

There is considerable evidence that the **framing** of the questions and the information provided in a survey may affect the answers (Ajzen et al., 1996). Framing refers to the context in which choices are made (Rolfe et al., 2002). When using CEs to value non-market goods, it is important to know whether the respondents' choices are sensitive to the survey context, and if so, how. The questionnaire frame will need to match the context of the issue and the respondents' choices in order to elicit realistic value estimates.

There is currently limited research on anchoring effects in the CE literature and relatively little is known about the impacts of framing questions. This report provides a discussion on anchoring and framing in CEs and describes how tests for anchoring and framing effects can be incorporated in a CE survey. The next section gives a general introduction to the economic theory underlying CEs. This is followed by a discussion of anchoring and framing effects in CEs in Sections Three and Four. In Section Five the development of a CE questionnaire that incorporates anchoring and farming tests is described. The final section summarises and discusses implications for further CE studies

[1] In the CE literature, different definitions are used. Whereas some authors refer to 'bid or price vector' (e.g. Carlsson and Martinsson, 2008), others refer to 'attribute level ranges' (e.g. Hensher, 2006). The use of 'vector' or 'range' is confusing, incorporating both the levels and the variation in levels of the attribute. In this report, 'range' refers to varying *widths* in levels of an attribute, with a narrow range nested within a wider range of the attribute levels. Varying attribute 'levels' refers to changing the *magnitude* of the attribute levels presented in the survey, with a low and a high range in levels that may or may not overlap.

2. The economic model

Choice Experiments have their theoretical foundation in random utility theory and in Lancaster's 'characteristics theory of value' (Lancaster, 1966). The random utility model describes utility U_{ij} that individual i derives from choice alternative j as a latent variable that is observed indirectly through the choices people make. Each utility value consists of an observed 'systematic' utility component V_{ij} and a random unobserved component "error term" ε_{ij}, which represents unobserved individual idiosyncrasies of tastes (Louviere et al., 2000):

$$U_{ij} = V_{ij} + \varepsilon_{ij} \qquad j=0,1,\ldots\ldots\ldots\ldots J \qquad \text{(Equation 1)}$$

The unobserved utility U_{ij} obtained from choosing alternative j, is influenced by a vector of attributes $\boldsymbol{X_j}$ (including non-market attributes), the costs C_j associated with each alternative and individual i's socio-economic characteristics $\boldsymbol{W_i}$ (Equation 2)[2].

$$U_{ij} = f(\mathbf{X}_j, C_j, \mathbf{W}_i, \varepsilon_{ij}) \qquad \text{(Equation 2)}$$

Alternative j will be chosen if and only if the utility derived from that option is greater than the utility derived from any other alternative k (Equation 3). It is expected that if the quantity or quality of a 'good' attribute in an alternative rises, the probability of choosing that alternative increases, *ceteris paribus*.

$$\Pr(j \left| \mathbf{X}_j, C_j, \mathbf{W}_i, \varepsilon_{ij}) = \Pr\{(V_{ij} + \varepsilon_{ij}) > (V_{ik} + \varepsilon_{ik})\} \right. \qquad \text{(Equation 3)}$$

2.1. The conditional logit model

Different econometric models can be used to analyse discrete choice responses. A conditional logit (CL) model[3] is the fundamental model recommended for use as a starting point for any analysis of discrete choice data (Louviere et al., 2000, Hensher and Greene, 2003). In a CL model specification, it is assumed that the error terms ε_{ij} are independently and identically distributed (IID) with a type I extreme-value (Weibull) distribution (Cameron and Trivedi, 2005: 490-503). The systematic component of utility is assumed to be a linear, additive function of the non-market attributes of alternative j ($\boldsymbol{X_j}$), costs (C_j) and individual socio-economic characteristics ($\boldsymbol{W_i}$)[4]. An alternative specific constant (ASC) reflects the systematic, but unobserved component of individual i's choices:

$$U_{ij} = f(\mathbf{X}_j, C_j, \mathbf{W}_i, \varepsilon_{ij}) = V_{ij} + \varepsilon_{ij} = ASC_j + \beta' \mathbf{X}_j + \alpha C_j + \gamma' \mathbf{W}_i + \varepsilon_{ij} \qquad \text{(Equation 4)}$$

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[2] Note that the analyst could add choice-set specific, or questionnaire specific variables to this model.

[3] The CL model is appropriate for regressors that vary across alternatives. Some authors incorrectly refer to this model as the multinomial logit model, which is appropriate for alternative-invariant regressors. Any variable that does not vary across alternatives can be included in the CL model by interacting the variable with an ASC (Cameron and Trivedi, 2005: 491-495)

[4] This assumption, although restrictive, greatly simplifies the computation of the results and the estimation of welfare measures. More elaborate models are available that can account for non-additive utility specifications (Alpízar *et al.*, 2001)

The probability that individual *i* chooses alternative *j* out of *J* alternatives can then be estimated by:

$$\Pr(j|\mathbf{X}_j, C_j, \mathbf{W}_i, \varepsilon_{ij}, \beta', \alpha, \gamma') = \frac{\exp(\mu V_{ij})}{\sum_{j=1}^{J} \exp(\mu V_{ij})}$$

$$\Pr(j|(...)) = \frac{\exp(\mu \cdot [ASC_j + \beta' \mathbf{X}_j + \alpha C_j + \gamma' \mathbf{W}_i] + \varepsilon_{ij})}{\sum_{j=1}^{J} \exp(\mu \cdot [ASC_j + \beta' \mathbf{X}_j + \alpha C_j + \gamma' \mathbf{W}_i] + \varepsilon_{ij})} \quad \text{(Equation 5)}$$

where μ is a scale parameter that is included to account for the confounding between the error variance and the estimated parameters (Louviere and Eagle, 2006). In the CL model, $\mu = \sqrt{\pi^2 / 6 \cdot \sigma_\varepsilon{}^2}$, where σ_ε is the standard deviation of the error distribution. From Equation 5, the estimated parameter values are equal to the true parameters multiplied by the scale parameter. Although this is irrelevant when calculating the probability of choosing alternative *j* within one data-set[5], it does confound the comparison of parameters between models or data-sets. Simple Wald tests can therefore not be used to compare estimated coefficients across different experiments. Swait and Louviere (1993) propose a procedure for CL parameter comparisons between data-sets by using the *ratio* of scale parameters. This relative scaling test consists of pooling the two data-sets (***A*** and ***B***), in which one of them has been rescaled by a *hypothesised* value of the scale parameter. The analyst then conducts a grid search using different values of the scale parameter. The correct value of the relative scale parameter is found at the maximum log-likelihood of the pooled model. The test statistic is:

$$LR = -2\left[LL_{pooled} - (LL_{\mathbf{A}} + LL_{\mathbf{B}})\right] \quad \text{(Equation 6)}$$

where LL_{pooled} is the log-likelihood of the pooled model ($\boldsymbol{A} + \mu_{A/B}\, \boldsymbol{B}$) and $LL_{\boldsymbol{A}}$ and $LL_{\boldsymbol{B}}$ are the log-likelihoods of the separately estimated models. The *LR*-statistic is χ^2-distributed with $(k+1)$ degrees of freedom, with *k* the number of parameters estimated in the models.

[5] Because all parameters within an estimated model have the same scale

2.2. Implicit prices

Respondents are assumed to make complete trade-offs between the levels of the attributes when deciding on their preferred alternative *j*. The trade-offs between attributes expressed by respondents' choices can be used to estimate the marginal utility of each attribute (Bateman et al., 2006). If money is one of the attributes, it is possible to express value estimates for the non-market attributes in terms of the marginal WTP for each individual attribute (known as *part-worths* or *implicit prices*):

$$WTP = -\frac{\beta_{attribute}}{\alpha} \qquad \text{(Equation 7)}$$

where ($\beta_{attribute}$) is the estimated coefficient on the non-market attribute, and (α) is the estimated coefficient on the cost attribute. Note that these estimated coefficients are both confounded with the scale parameter μ. But since the scale parameter is identical for all parameter estimates within one model, μ cancels out of Equation 7. One can therefore readily compare WTP results between data-sets.

3. Anchoring in Choice Experiments

The *starting point* bias often mentioned in the CV literature appears in situations where respondents use the bid proposed in the questionnaire to develop and/or revise their own 'true' WTP. When respondents base their choice on this revised WTP, they are said to *anchor* their answers on the proposed bid[6]. Ignoring such anchoring effects will lead to biased estimation of the mean and the standard deviation of the WTP (see, for example, Silverman and Klock, 1989, Herriges and Shogren, 1996, Green et al., 1998, Frykblom and Shogren, 2000, and Flachaire and Hollard, 2007).

In CEs, the same type of anchoring is observed when respondents' choices are influenced by the proposed range in levels of the cost attribute (Carlsson and Martinsson, 2008). Economic theory suggests that models with varying ranges of the cost attribute should produce similar parameter estimates if respondents have stable and well-formed preferences. As long as the cost attribute range used in the survey reflects the distribution of respondents' preferences, a wider versus narrower range or a lower versus higher range in cost levels should not influence value estimates if the marginal utility of money is constant (a common assumption in Choice Experiments) (Stevens et al., 1997). However, given the observed sensitivity to bid levels from CV experiments, there is a potential risk that respondents interpret the proposed levels of the cost attribute as an indication of the "appropriate" value[7], in which case CEs could

[6] Specifically, an *anchoring effect* occurs when respondents "fasten upon elements of the scenario that are not intended by the researcher to convey information about the value of the good and use them as cues to the good's approximate 'correct value'". *Starting point bias* is said to occur when "the respondent regards an initial value proposed in the survey as conveying an approximate value of the amenity's true value and anchors his WTP around the proposed amount" (Mitchell & Carsson, 1989, pp 240).

[7] There is even evidence that survey respondents can anchor their answers to completely arbitrary numbers (Ariely *et al.*, 2003).

suffer from a similar anchoring bias as CV studies. This section reviews the existing studies on *anchoring* bias in Choice Experiments. The various studies show conflicting results, indicating the need for further research.

3.1. Varying attribute levels

Before describing studies that have focused specifically on the possible anchoring effects of the monetary attribute, it is worthwhile mentioning that multiple studies have investigated the effects of varying non-monetary attribute level ranges on WTP estimates in the CE context. Verlegh *et al.* (2002) found significant effects of varying attribute levels and their range widths on respondents' choices in a marketing context. Results in Hensher (2006b) indicated that a narrower range in attribute levels can increase WTP estimates. Further results showed that as the range of attribute levels narrows, the propensity for respondents to ignore attributes when making their choice increases[8]. In contrast, a study by Ohler *et al.* (2000) failed to find significant effects of varying attribute level ranges on parameter estimates, even after accounting for possible differences in scale parameters. Ryan and Woodsworth (2000) assessed the sensitivity of WTP to changes in the levels of attributes for a CE of cervical cancer screening programmes in Scotland. Two split-samples were administered with the levels varying for some of the attributes. Although their results indicated a significant impact of varying attribute levels on mean WTP estimates, there was no clear directional trend between samples[9].

These studies show that the levels of the (non-monetary) attributes presented in a CE could influence the estimates of marginal values. There is, however, no conclusive result on the magnitude or direction of these impacts. Furthermore, since the levels of *multiple* attributes were varied between questionnaires, the studies do not provide a test of respondents' tendencies to anchor choices to different levels of the monetary attribute proposed in the CE questionnaire.

3.2. Varying the monetary attribute

Recent research by Carlsson and Martinsson (2008) on people's preferences for power outrages in Sweden tested whether anchoring effects are present in CEs[10]. A split sample was used where only the cost attribute's levels varied between designs (Table 1). The *differences* in cost levels were kept equal between the two designs. In this study, no status quo or 'opt out' alternative was offered to respondents. The results showed that the marginal WTP was consistently higher for respondents to questionnaire design B (with the higher cost levels). The authors conclude that "the level of the cost attributes may work much like a signalling effect, where high cost levels signal to the respondent that one should pay more money".

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[8] This phenomenon has been labelled 'attribute non-attendance' (see Section 5)
[9] Note that the authors do not correct for possible scale differences across subsamples.
[10] The authors refer to a 'scope effect in costs'.

Table 1 Attributes and levels in Carlsson and Martinsson (2008)

Attributes	Levels design A	Levels design B
Number of outages of 4 h duration over 5 years	2, 1, 0	2, 1, 0
Number of outages of 8 h duration over 5 years	2, 1, 0	2, 1, 0
Number of outages of 24 h duration over 5 years	1, 0	1, 0
Connection fee per household (SEK)	125, 200, 225, 275, 375	325, 400, 425, 475, 575

A study of river health improvements (Hanley et al., 2005) also investigated whether WTP estimates in a CE are sensitive to the presented levels of the monetary attribute. The monetary attribute varied between two questionnaire designs, with the cost vector in design B being one-third of the cost vector in design A (Table 2). In line with *a priori* expectations, the proportion of respondents choosing the status quo option (no payment, no change in environmental attributes) was significantly higher for design A (with higher costs) compared to design B. The implicit prices estimated from a mixed logit model specification were also lower in the low-price sample. However, and in contrast with Carlsson and Martinsson (2008), the differences in the WTP estimates between the two samples were not *statistically* significant. Furthermore, the results indicated that the variability in the price estimates is much larger in the low-cost sample.

Table 2 Attributes and levels included in river health experiment (Hanley et al., 2005)

Attributes	Levels design A	Levels design B
Ecology	'good', 'fair'	'good', 'fair'
Aesthetics	'good', 'fair'	'good', 'fair'
Bank condition	'good', 'fair'	'good', 'fair'
Price (£)	2, 5, 11, 15, 24	0.67, 1.67, 3.67, 5, 8

Another environmental valuation study for water resources development in the Fitzroy Basin (Windle and Rolfe, 2004) showed similar results. WTP estimates did not vary between two questionnaire designs with different ranges in payment levels (Table 3), indicating that different levels of the cost attribute did not affect respondents' preferences.

Table 3 Attributes and levels included in Fitzroy Basin study (Windle and Rolfe, 2004)

Attributes	Levels questionnaire A	Levels questionnaire B
Annual payment for 20 years ($)	10, 20, 50, 100	50, 100, 150, 250
Healthy vegetation remaining	20, 30, 40, 50	

in the floodplain (%)	
Waterways in good health (km)	1500, 1800, 2100, 2400
Protection of Aboriginal cultural sites	80% marked trees + 25% all other sites, 80% historic camp sites + 25% all other sites, 80% art sites + 25% all other sites, 80% burial sites + 25% all other sites
River estuary in good health (%)	50, 55, 60, 65, 70, 75, 80, 85

3.3. Starting point bias

More in line with the 'traditional' definition of *starting point* anchoring, Ladenburg and Olsen (2006) tested the impacts of the costs proposed in an "Instruction Choice Set" (ICS) on respondents' answers to a CE survey about motorway construction in Denmark. The ICS was an example choice set presented to respondents before the actual choice questions in the survey. To test for starting point anchoring bias, the level of the monetary attribute in the ICS was different between two subsamples (Table 4). The levels of the attributes in the subsequent choice sets were identical for the two subsamples. As hypothesised, there was a significantly higher propensity for respondents in subsample A to choose the 'more expensive' option in each choice set, indicating that respondents may anchor their preferences in the payment levels presented in the first choice set. The authors further found significant differences between WTP estimates in the two samples. In particular, female respondents in subsample B were found to have a lower WTP than female respondents in subsample A, but no significant differences were found between male respondents. This is in contrast with the results of Hanley *et al* (2005) and Windle and Rolfe (2004).

Table 4 Attributes and levels of the Instruction Choice Sets (ICS) and the choice questions in Ladenburg and Olsen (2006)

Attributes	Levels ICS A	Levels ICS B	Levels questionnaires A and B
Number of km through			
Forest	0, 5, 10	0, 5, 10	0, 5, 10
Wetland	0, 5	0, 5	0, 2.5, 5
Heath/pastoral land	0, 5	0, 5	0, 2.5, 5
Arable land	80, 90, 95	80, 90, 95	80, 82.5, 85, 87.5, 90, 92.5, 95, 97.5, 100
Annual payment (DKK)	0, 400, 1100	0, 100, 200	0, 100, 200, 400, 700, 1100, 1600

3.4. Discussion

Notwithstanding evidence of cost anchoring effects in the contingent valuation literature (Bateman et al., 1999), there are very few studies that have investigated the effects of varying the levels of the monetary attribute in CEs. Although the CE

literature agrees that varying attribute levels -in general- will affect respondents' choices, there is no conclusive evidence on the impacts of varying levels of the *monetary* attribute on WTP estimates. Studies by Ladenburg and Olsen (2006) and Carlsson and Martinsson (2008) found significant differences between subsamples that were presented with different cost-levels. In contrast, Hanley *et al* (2005) and Windle and Rolfe (Windle and Rolfe, 2004) concluded that varying the levels of the monetary attribute does *not* impact WTP estimates between subsamples. Furthermore, Hanley *et al.* (2005) observed a higher proportion of respondents choosing the status quo (no cost) alternative when presented with higher cost levels. Carlsson *et al.* (2007) concluded that respondents base their choices on the *relative* range of the monetary attribute rather than the *absolute* costs proposed.

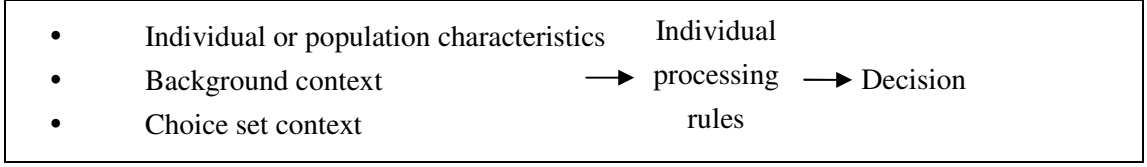
4. Framing in Choice Experiments

Framing is a critical activity in the construction of individual preferences (Hensher, 2007). Every individual will *frame* the way they see the world based on a large number of factors, and this framing process involves the *inclusion* and *exclusion* as well as *emphasis* of available information. Hence framing operates by influencing the cognitive processes of information by individuals (Hallahan 1999).

CEs can be used to estimate the values respondents hold for different non-market goods and services. This information provides an input to economic decision-making techniques such as cost benefit analyses. However, not all respondents may have pre-existing preferences for the non-market goods presented in a CE survey. Instead, preferences may be constructed based on the information provided in the survey. In that case, preferences are likely to change with the information provided and with the wording of the questionnaire (i.e. the survey frame), rather than with the nature of the good. It can be argued that framing effects are inherent to SP techniques as these are *contingent* on the information supplied in the survey. Defining the appropriate survey frame is part of all SP surveys and depends on the purpose of the survey and the requirements of respondents.

Figure 2 shows how framing may influence respondents' decisions in SP surveys. Drawing from the psychology literature, *Individual* or *population characteristics* will typically frame each respondent's preferences (Hallahan, 1999). These framing effects are generally accounted for in CEs by including socio-economic or location specific characteristics in the analysis.

Figure 2 Impacts of framing on respondents' decisions



Framing effects also arise from the way in which the *background context* is specified (Tversky and Simonson, 1993). This incorporates the amount of information provided

and its formulation, the policy and attribute description, and the presentation of the survey (see Section 4.1 and 4.2 for further discussion).

In a *choice set context*, analysts have observed impacts from varying the ways in which choice questions are framed. The number of choice sets, alternatives, attributes or number of levels[11] all affect choice set 'complexity', which has been shown to impact the way in which respondents make their choices. Varying choice set complexity may lead to attribute non-attendance when certain attributes are accentuated, while other are ignored when choosing between different alternatives (Hallahan, 1999). Whereas several studies have assessed the impacts of choice set complexity on value estimates (see, for example, Swait and Adamowicz, 2001, Breffle and Rowe, 2002, Caussade et al., 2005, and Hensher, 2006a), there are few studies on respondents' *processing rules* when assessing choice sets of varying complexity or the econometric models to account that could for different processing rules (Hensher, 2006b). An assessment of attribute non-attendance and individual processing rules is also part of this study and will be described in a future EERH report in this series.

One way to reveal that choice set context affects respondents' choices is testing for violations of the 'Independence of Irrelevant Alternatives' (IIA) assumption. This is an important property of the CL model, which states that the relative probability of choosing one alternative over the other is not influenced by the presence or absence of additional alternatives in a choice set. This assumption implies that preferences are independent of the choice set context. Many studies have detected violations of the IIA property, showing that choices are not independent of the choice set context (see, for example, Rolfe and Bennett, In Press).

4.1. Attribute scaling

Framing effects in SP surveys may arise from varying the *quantities* of the good under valuation (a **scale** effect: Rolfe *et al.*, 2008), and from varying the *dimensions* used to define the good and the tradeoffs involved (a **scope** effect; Rolfe *et al*., 2008). There is evidence that WTP estimates vary with the scale and scope of the good under valuation (Bosworth et al., 2008).

Attribute scaling effects may occur, when respondents' choices are sensitive to varying the levels of the attributes presented in each choice option. The design of CEs inherently accounts for such attribute scaling effects by specifying different quantities of the attributes provided in each choice option. Testing how the marginal tradeoffs within a CE vary with the quantities of the attributes provides an internal test for attribute scaling (see, for example, Holmes et al., 2004)[12]. A limited number of CE

[11] Note that this refers to the *number of levels* per attribute, rather than the range or height of the levels as in Section 3.

[12] Another internal scale test simply includes the significance level of the estimated β parameter. A significant parameter estimate indicates that respondents react to a change in the level of the attribute.

studies assessed the framing impacts of *geographical scale* on WTP estimates, by using split samples in which the questionnaires varied only in the size of the geographical area involved (see, for example, van Bueren and Bennett, 2004). These studies typically defined different geographic scales of the valued good, with the smaller scale typically nested within the larger geographic area (for example: a stretch of river versus the whole catchment area). The framing of the attribute and geographic scales is often intertwined, as smaller geographic scale is usually associated with smaller attribute scales. Although it may be expected that respondents' WTP is higher for changes in a local or regional context over similar changes in a national context, there is no general consensus over the impacts of geographic scaling on value estimates and more research is needed to shed light on this issue. Two research projects are currently underway within the EERH focussing specifically on differences in respondents' preferences for varying levels of geographic scales (see EERH projects 2 and 7 on http://www.crawford.anu.edu.au/research_units/eerh/).

4.2. Attribute framing

Attribute framing refers to the way attributes are described to respondents. In many CE studies, attribute levels are described as 'absolute' quantities (for example, the length of field boundaries in metres restored; Colombo and Hanley, 2007). WTP estimates can then be interpreted as the willingness to pay for a *unit change* in the attribute levels. It is also possible to describe attributes as 'relative' quantities (for example, the percentage in area of heather moorland; Colombo and Hanley, 2007). WTP estimates are then interpreted as the willingness to pay for a *percentage change* in attribute levels. The framing of attributes in terms of unit changes versus percentage changes may impact on respondents' choices, even when attribute levels are identical. No studies have been found in the SP literature that assessed the impacts of describing attribute levels in units and / or percentages.

Another source of attribute framing occurs when respondents' choices are influenced by describing alternatives in either positive or negative terms (Hallahan, 1999). Psychologically, a negatively worded impact (for example 'loss') may invoke a different response from respondents than a positively worded impact (for example 'gain'). CE studies in the transport literature have assessed the impacts of gains versus losses in the context of 'reference dependency' around a status quo scenario (Hensher, 2008, Hess et al., In press). However, no studies were found that assessed the impacts of framing attributes in positive or negative terms on respondents' answers.

4.3. Discussion

The way in which respondents' make their choices in CE surveys will be affected by the context of the survey. Whereas several studies have investigated the impacts of varying the choice set context on respondents' choices, the impacts of changing the way in which the (non-market) attributes are framed have received little attention in the CE literature. Defining attributes levels as units or as percentages may affect

respondents' choices, as may describing attribute levels in positive or negative terms. There are few studies that have explored alternative ways to frame non-market attributes in a CE and the possible impacts on value estimates.

5. Testing anchoring and framing in the George River catchment choice experiment

A study aimed at valuing changes in natural resource management in the George River catchment, Tasmania will provide insights in the way respondents' choices may be influenced by anchoring or framing in a CE survey. The questionnaire has been developed to assess Tasmanians' preferences for changes in seagrass area, rare native animal and plant species and native riverside vegetation in the George River catchment. The background to this questionnaire and its administration has been described in Kragt and Bennett (2008). The focus of the present report is on the ways anchoring and framing effects are tested in the George catchment CE.

Four different survey designs were administered in the George catchment valuation study:

1. A 'standard' (ST) design provides the base for comparing results between split samples;
2. A 'cost range' (CR) split sample questionnaire varies from the ST design in that the levels in the monetary attribute are higher (Section 5.1);
3. A 'percentage' (PC) split sample questionnaire excludes explicit references as to how the levels of native riverside vegetation and seagrass relate to total river length or total estuary area (Section 5.2);
4. A 'rare species' (RA) split sample questionnaire describes the attribute 'rare native animal and plant species' in terms of 'species lost' rather than 'species present' (used in the ST version) (Section 5.2)

Details of each split sample are provided in subsequent sections. Surveys were distributed in different locations in Tasmania (Table 5). The attribute levels of the standard survey design are presented in Table 6. Attributes and levels were assigned into choice sets using a Bayesian efficient design technique (Appendix 1). Each respondent was presented with five choice sets, with each choice set consisting of a zero-cost status-quo alternative and two alternatives which described increased protection of the environmental attributes at a certain cost (Table 6).

Table 5 Survey versions distributed in the George River catchment CE

Location	**Survey version**			
	Standard - ST	Anchoring test - CR	Framing test - PC	Framing test - RA
Hobart	*	*	*	
Launceston	*	*		*
St Helens	*		*	*

Table 6 Attributes levels used in the George River catchment questionnaire (ST – design)

Attribute	Status quo levels	Alternative levels[b]
Native riverside vegetation (km)[a]	40 (35)	56 (50), **74 (65)**, 84 (70)
Rare native animal and plant species (number of species present)	35	50, 65, **80**
Seagrass area (ha)a	420 (19)	560 (25), **690 (31)**, 815 (37)
One-off payment ($)	0	30, 60, 200, 400

[a] Numbers in parentheses are percentage of total river length with native riverside vegetation and percentage of total estuary area with healthy seagrass beds. [b] Numbers in bold are the levels of the environmental attributes currently observed in the George River catchment.

5.1. Cost anchoring effects

Until recently, there has been relatively little discussion on what attribute levels to attach to the monetary attributes in the CE literature (Carlsson and Martinsson, 2008). To test if the levels of the monetary attribute lead to respondents anchoring their answers to some proposed cost level, a split sample survey where one questionnaire version has higher levels (and a wider range) in the monetary attribute is administered. The two different cost ranges included were:

Designs ST, PC, RA: $ 30, $60, $200, $400

Design CR: $ 50, $100, $300, $600

These ranges were determined during several focus group discussions during which respondents were challenged to state their maximum WTP for natural resource management in the George River catchment. $600 was the "absolute maximum" cost mentioned by respondents. To avoid a high rate of protest responses from payment levels that would push respondents beyond their maximum cost, the levels in the ST, PC and RA design were scaled by a factor of about 2/3[13]. Note that the relative differences in cost levels are therefore similar but absolute differences are not.

A first hypothesis involves the proportion of respondents choosing the status quo or no-cost alternative. Following Hanley (2005), it is hypothesised that the propensity to choose the status quo will be higher in the CR split sample, as there will be a lower rate of acceptance of the costly alternatives (hypothesis 1a).

Economic theory predicts an income effect, which would mean that marginal WTP will be lower in the CR split sample since the disposable income for the respondent will be lower in this version (Carlsson and Martinsson, 2008). However, given observed evidence of respondents' anchoring their answers to the presented range of cost levels, estimated WTP will be higher in the split sample version when the levels

[13] Using rounded number in the cost levels was considered appropriate to reduce survey complexity and negative reactions from respondents.

of the monetary attribute are higher. In either case, the parameter and WTP estimates are expected to be different (hypothesis 1b and hypothesis 1c).

Comparing WTP estimates between subsamples is not straightforward because the standard errors for implicit prices are not directly calculated in the CL model. A bootstrapping approach will be used to simulate mean and variances for subsample WTP estimates, and non-parametric tests as proposed by Poe et al. (2005) will be used to compare estimates across subsamples.

None of the existing studies on anchoring have addressed the propensity for respondents to ignore costs under varying levels of the monetary attribute. Recent progress in CE modelling has shown that ignoring attribute non-attendance can lead to biased parameter estimates and incorrect estimates of WTP (Hensher et al., 2005, Campbell et al., 2008, Carlsson et al., 2008). A logical extension to the current study on cost anchoring is to investigate the difference in respondents' attendance to the monetary attribute under varying cost levels. It is expected that the maximum level of the cost attribute (i.e. $400 in the ST design and $600 in the CR design) will exceed the maximum WTP for most respondents. But if the maximum costs presented in a choice set are lower than an individual's maximum WTP for environmental protection, the individual will be likely to ignore the monetary attribute when deciding on their preferred alternative. It is hypothesised that the proportion of respondents ignoring the monetary attributes will be lower in the CR design (hypothesis 1d). More information on attribute (non-)attendance in CEs and formal ways to test attribute attendance will be provided in a forthcoming EERH research report in this series.

5.2. Attribute framing effects

A type of attribute framing that has not previously been assessed in the CE literature is the presentation of attributes in absolute versus relative terms. To explore possible impacts from changing the way an attribute is framed, the standard version of the George River catchment CE explicitly mentions how the kilometres of riverside vegetation relate to total river length and how the hectares of seagrass relate to the total estuary area (the bold numbers in Table 6). All survey designs describe total river length and total estuary area in the survey questionnaire but the PC version does not include the percentages of river length and estuary area explicitly in the attribute description or choice sets. Example of choice sets from the ST and PC design are provided in Appendix 2. It is expected that respondents will 'anchor' their choices on the relative levels rather than the absolute levels of the attribute. Therefore, the parameter and WTP estimates will be different between the standard and the percentage survey designs (hypothesis 2a and hypothesis 2b). In particular, it is expected that respondents' WTP for a change in attribute levels will decrease with increasing levels of that attribute (diminishing marginal utility) and that this effect will more pronounced when the percentage change is included in the attribute description.

Although the psychology literature predicts significant framing effects from describing alternatives in either positive or negative terms (Hallahan, 1999), no studies have been found that investigated this issue in a CE context. The George River catchment survey aims to fill this gap in the literature by framing the rare native animal and plant species attribute in terms of 'presence' in the ST version, versus 'loss' in the RA version (Table 7). Note that the number of rare native animal and plant species is identical across survey designs. It is expected that the 'loss' wording will trigger a stronger reaction in respondents, leading to a higher propensity of respondents to attend to the rare species attribute. Respondents' choices will therefore be impacted by the altered frame of the rare species attribute, leading to a difference in parameter and WTP estimates between the two split samples (hypothesis 3a and hypothesis 3b).

Table 7 Description of rare native animal and plant species attribute in the 'standard' and 'rare species' survey versions of the George River catchment CE

Survey design	Description of status quo	Alternative levels
ST	35 species present - Of the current 80, 35 rare species remain (45 rare species no longer live in the George catchment)	50, 65, 80
RA	45 species lost - Of the current 80 rare native species, 45 species no longer live in the George catchment	30, 15, no loss

6. Summary and discussion

Choice Experiments (CEs) have become a popular approach to valuing non-market goods. Validation of the method is important when interpreting the results of a CE. In this report, the impacts of *anchoring* and *attribute framing* in CEs are investigated. There is currently limited research on these effects in the environmental valuation CE literature.

There is some evidence that varying the (range of) levels of the monetary attributes in CEs will impact on the parameter and WTP estimates but no agreement on the magnitude or direction of these impacts. In this report, a CE survey has been described that incorporates tests of how changing the range and magnitude in cost levels for different natural resource management options in the George River catchment may impact estimated values. The questionnaire also includes tests for attribute framing effects by using different split samples that differ only in the way the non-market attributes are described to respondents. The absolute levels of the attributes are equal across survey versions.

Eight hypotheses have been developed in Section 5 about the impacts of anchoring and framing on survey results. These hypotheses are summarised below

6.1. Cost anchoring hypothesis

Hypothesis 1a:

When respondents are presented with higher levels of the monetary attribute, the proportion of respondents choosing the no-cost status quo alternative will increase.

$$H_0 : \%resp_{choice=SQ,ST} = \%resp_{choice=SQ,CR}$$
$$H_A : \%resp_{choice=SQ,ST} < \%resp_{choice=SQ,CR}$$

Hypothesis 1b:

The parameter estimates between the standard survey design and the survey split sample with higher cost levels will be different.

$$H_0 : \beta'_{ST} = \beta'_{CR}$$
$$H_A : \beta'_{ST} \neq \beta'_{CR}$$

Hypothesis 1c:

Respondents' marginal WTP for the protection of the non-market attributes will be different between the standard survey design and the 'cost range' survey design (with higher levels of the cost attribute).

$$H_0 : WTP_{non-marketattributes,ST} = WTP_{non-marketattributes,CR}$$
$$H_A : WTP_{non-marketattributes,ST} \neq WTP_{non-marketattributes,CR}$$

Hypothesis 1d:

The propensity for respondents to ignore the monetary attribute will be higher when the maximum levels of the monetary attribute are lover.

$$H_0 : Attribute\_attendance_{costs,ST} = Attribute\_attendance_{costs,CR}$$
$$H_A : Attribute\_attendance_{costs,ST} < Attribute\_attendance_{costs,CR}$$

6.2. Attribute framing hypotheses

Hypothesis 2a:

Parameter estimates will be different between the standard survey design and the percentage split sample design that does not explicitly mentions the relative river length with native riverside vegetation or relative estuary area with healthy seagrass beds.

$$H_0 : \beta'_{ST} = \beta'_{PC}$$
$$H_A : \beta'_{ST} \neq \beta'_{PC}$$

Hypothesis 2b:

Respondents' marginal WTP for the protection of the non-market attributes will be different between the standard survey version and the 'percentage' version of the survey.

$$H_0 : WTP_{non-marketattributes,ST} = WTP_{non-marketattributes,PC}$$
$$H_A : WTP_{non-marketattributes,ST} \neq WTP_{non-marketattributes,PC}$$

Hypothesis 3a:

Parameter estimates between the standard survey design (presence of species) and the 'rare species' survey design (loss of species) will be different.

$$H_0 : \beta'_{ST} = \beta'_{PC}$$
$$H_A : \beta'_{ST} \neq \beta'_{PC}$$

Hypothesis 3b:

Respondents' marginal WTP for the protection of rare native animal and plant species will be different between the standard survey design and the 'rare species' survey design.

$$H_0 : WTP_{rarespecies,ST} = WTP_{rarespecies,PC}$$
$$H_A : WTP_{rarespecies,ST} \neq WTP_{rarespecies,PC}$$

6.3. Implications for CE design

The levels of the monetary attribute may serve as a suggestion to respondents about the 'correct' payments for management changes. If respondents anchor their choices to the cost levels proposed in a CE survey, the estimated values will be biased. It is therefore vital to deliberate not only on the appropriate payment vehicle, but also on the appropriate cost levels. Cost levels should be realistic, as to avoid hypothetical bias in survey responses. But cost levels should also be adequately high enough to ensure that respondents consider the monetary attribute in making their choices. The range in levels of the cost attribute should, furthermore, be wide enough to cover the possible preferences of all respondents. Focus group discussions and careful pretesting is essential to assess respondents' reactions to different cost levels.

Reference scenarios are typically included in CEs, often in the shape of a 'status quo' scenario to provide a basis for value comparison. Several studies have assessed the impacts on value estimates of including or excluding a reference scenario. Less is known about how respondents might anchor their answers to other references described in the survey. Such references include a description of attribute levels in absolute versus relative terms.

The attribute levels presented in a CE questionnaire should be realistic and related to the policy scenarios (for example, one would expect an environmental policy to result in increased environmental quality). Furthermore, the attributes and attribute levels must be *described* in a way that is unambiguous and meaningful to respondents. Focus group discussions and pretesting can aid in reducing the ambiguity of proposed attribute descriptions. However, little is known about the effects of describing attributes in positive versus negative terms.

There is currently no agreement on how cost anchoring or attribute framing effects may impact the results of CEs. The present research aims to assess these issues using a CE survey developed to assess community preference for natural resource management in the George River catchment, Tasmania. The questionnaire has been distributed in several locations throughout Tasmania in November and December 2008. The results will provide valuable insights into the impacts of anchoring and framing on WTP estimates which will aid the design of future CE surveys.

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Appendix 1 – Experimental design for the George catchment CE survey

The following tables show the levels of the alternative choice options included in the experimental design of the George catchment choice experiment. A status-quo alternative was added to each choice set that predicted a decline in seagrass area to 420ha (19% of total estuary area), a decline in native riverside vegetation to 40km (35% of total river length) and a decline in the number of rare species observed in the catchment to 35 species. This status quo scenario involved no payments from the respondent. Four split-samples were administered: ST, PC, CR and RA. The experimental design for the ST and PC versions were identical, these versions varied in the description of the seagrass and riverside vegetation attributes.

STANDARD VERSION (ST) and PERCENTAGE VERSION (PC)

	Alternative 1				Alternative 2				
Choice set	Costs	SeaGr	RivVeg	Species	Costs	SeaGr	RivVeg	Species	Block
1	200	560	74	50	400	560	56	65	1
2	30	560	74	80	30	815	74	65	1
3	400	690	81	50	200	690	74	50	1
4	400	815	74	80	60	690	56	80	1
5	200	560	56	80	200	815	81	65	1
6	60	690	56	50	400	815	81	50	2
7	30	560	56	65	200	690	56	80	2
8	400	560	81	65	400	690	56	65	2
9	60	690	56	65	200	560	74	50	2
10	200	815	81	80	30	560	81	65	2
11	60	815	81	50	30	690	74	65	3
12	30	560	56	80	400	815	81	50	3
13	60	560	56	80	400	560	81	50	3
14	30	815	74	80	30	690	81	80	3
15	200	815	74	50	60	560	74	50	3
16	30	690	81	65	60	815	81	80	4
17	200	815	74	80	30	815	56	65	4
18	200	815	56	50	400	690	74	65	4
19	60	560	81	50	60	560	56	80	4
20	400	690	81	80	60	815	56	50	4

COST RANGE VERSION (CR)

	Alternative 1				Alternative 2				
Choice set	Costs	SeaGr	RivVeg	Species	Costs	SeaGr	RivVeg	Species	Block
1	300	560	74	50	600	560	56	65	1
2	50	560	74	80	50	815	74	65	1
3	600	690	81	50	300	690	74	50	1
4	600	815	74	80	100	690	56	80	1
5	300	560	56	80	300	815	81	65	1
6	100	690	56	50	600	815	81	50	2
7	50	560	56	65	300	690	56	80	2
8	600	560	81	65	600	690	56	65	2
9	100	690	56	65	300	560	74	50	2
10	300	815	81	80	50	560	81	65	2
11	100	815	81	50	50	690	74	65	3
12	50	560	56	80	600	815	81	50	3
13	100	560	56	80	600	560	81	50	3
14	50	815	74	80	50	690	81	80	3
15	300	815	74	50	100	560	74	50	3
16	50	690	81	65	100	815	81	80	4
17	300	815	74	80	50	815	56	65	4
18	300	815	56	50	600	690	74	65	4
19	100	560	81	50	100	560	56	80	4
20	600	690	81	80	100	815	56	50	4

RARE SPECIES VERSION (RA)

	Alternative 1				Alternative 2				
Choice set	Costs	SeaGr	RivVeg	Species	Costs	SeaGr	RivVeg	Species	Block
1	200	560	74	30	400	560	56	15	1
2	30	560	74	0	30	815	74	15	1
3	400	690	81	30	200	690	74	30	1
4	400	815	74	0	60	690	56	0	1
5	200	560	56	0	200	815	81	15	1
6	60	690	56	30	400	815	81	30	2
7	30	560	56	15	200	690	56	0	2
8	400	560	81	15	400	690	56	15	2
9	60	690	56	15	200	560	74	30	2
10	200	815	81	0	30	560	81	15	2
11	60	815	81	30	30	690	74	15	3
12	30	560	56	0	400	815	81	30	3
13	60	560	56	0	400	560	81	30	3
14	30	815	74	0	30	690	81	0	3
15	200	815	74	30	60	560	74	30	3
16	30	690	81	15	60	815	81	0	4
17	200	815	74	0	30	815	56	15	4
18	200	815	56	30	400	690	74	15	4
19	60	560	81	30	60	560	56	0	4
20	400	690	81	0	60	815	56	30	4

Appendix 2 – Choice set presentation in standard and percentage survey designs

Choice set in the ST design of the George catchment CE

Question 6

Consider each of the following three options for managing the George catchment.
Suppose options A, F and G are the **only ones** available. Which of these options would you choose?

Features	Your one-off payment	Seagrass area	Native riverside vegetation	Rare native animal and plant species	YOUR CHOICE
Condition now		690 ha (31% of total bay area)	74 km (65% of total river length)	80 rare species live in the George catchment	
Condition in 20 years					Please tick **one** box
OPTION A	$0	420 ha (19%)	40 km (35%)	35 rare species present (45 no longer live in the catchment)	☐
OPTION F	$400	560 ha (25%)	81 km (70%)	65 rare species present (15 no longer live in the catchment)	☐
OPTION G	$400	690 ha (31%)	56 km (50%)	65 rare species present (15 no longer live in the catchment)	☐

Choice set in the PC design of the George catchment CE

Question 6

Consider each of the following three options for managing the George catchment.
Suppose options A, F and G are the only ones available. Which of these options would you choose?

Features	Your one-off payment	Seagrass area	Native riverside vegetation	Rare native animal and plant species	YOUR CHOICE
Condition now		690 ha	74 km	80 rare species live in the George catchment	
Condition in 20 years					Please tick one box
OPTION A	$0	420 ha	40 km	35 rare species present (45 no longer live in the catchment)	☐
OPTION F	$400	560 ha	81 km	65 rare species present (15 no longer live in the catchment)	☐
OPTION G	$400	690 ha	56 km	65 rare species present (15 no longer live in the catchment)	☐