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Starting Point Anchoring Effects in Choice Experiments

Jacob Ladenburg

Søren Bøye Olsen

Abstract

Anchoring is acknowledged as a potential source of considerable bias in Dichotomous Choice Contingent Valuation studies. Recently, another stated preference method known as Choice Experiments has gained in popularity as well as the number of applied studies. However, as the elicitation of preferences in Choice Experiments resembles the Dichotomous Choice format, there is reason to suspect that Choice Experiments are equally vulnerable to anchoring bias. Employing different sets of price levels in a so-called Instruction Choice Set presented prior to the actual choice sets, the present study finds that preferences elicited by Choice Experiments can be subject to starting point anchoring bias. Different price levels provoked significantly different distributions of choice in two otherwise identical choice set designs. On a more specific level, the results indicate that the anchoring subjectivity in the present study is gender dependent, pointing towards, that female respondents are prone to be affected by the price levels employed. Male respondents, on the other hand, are not sensitive towards these prices levels. Overall, this implicates that female respondents, when employing a low-priced Instruction Choice Set, tend to express lower willingness-to-pay than when higher prices are employed.

Keywords: Choice experiment, Starting point anchoring bias, Non-market valuation, Gender-specific discrepancy

Preface

Validation of economic valuation methods plays an increasingly important role when interpreting and using willingness to pay estimates from environmental economic studies. The present working paper "Starting Point Anchoring Effects in Choice Experiments" focuses on validation of Choice Experiments by testing if this method is vulnerable to "anchoring effects" as observed in Contingent Valuation studies using the Dichotomous Choice format.

The paper conveys a state-of-the-art test intended for detecting of starting point anchoring bias. To the authors' knowledge, this has not previously been tested in Choice Experiments. The results are expected to open up an array of new fields for future research.

Ph.d. Student Jacob Ladenburg and Søren Bøye Olsen have completed the paper in relation to their Ph.d. projects; Welfare Economic Valuation of Externalities of Wind Power Production - an Evaluation of Efficient Substitutions Patterns between Locations (Jacob Ladenburg) and Development and Validation of Preference Based Environmental Valuation Methods – Data Collection and Modelling (Søren Bøye Olsen). The authors would like to thank Ph.d. student Morten Mørbak and Research Director Alex Dubgaard for valuable comments.

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Contents:

Introduction

Since the mid 1980s the Contingent Valuation Method (CVM) has been one of the most important instruments for eliciting preferences for environmental non-market goods. This is achieved by setting up a hypothetical market for the good in question and then asking individuals directly about their willingness to pay for (WTP) or willingness to accept (WTA) the relevant change in the good[1].

In CVM several mechanisms for elicitation of individual WTP (or WTA) have been developed over the years. In broad terms, the respondents either express their preferences towards the proposed environmental change directly (open-ended format) or indirectly (payment ladder or dichotomous choice format (DC). A much used variant of the DC format is the *Double Bounded Dichotomous Choice* format (DBDC). In DBDC the respondents is asked two DC questions. The first DC question states a specific cost or price for the change in the good, and the respondent is asked whether or not she would accept that price. Consecutively, if the answer is positive, a similar follow-up DC question is asked where the specified price/cost is higher than in the first question. Equivalently, if the first answer is negative, the price in the follow-up question is lower.

However, since the earliest applications of the DC format in CVM surveys, the implications of presenting respondents with a specified price/value of the change in the environmental good have been in focus Mitchell and Carson (1989). More specifically, the concern has been directed at the *anchoring* or *starting point bias*, which emerges when the initial bid provides a focal point or anchor for the respondents that are uncertain about their exact, true WTP/WTA.
Due to the close interrelatedness of the two terms, only the term anchoring will be used in the remaining of this paper, even though starting point bias might be just as (or more) relevant in the specific context.

From the mid-1980s analyses of DBDC data have included tests for anchoring bias, in order to determine the scale of the problem and potentially adjust the bias in the elicit preferences (Boyle *et al.* 1985). The nature of anchoring has been analysed by testing different types of models dealing with the anchoring effects (Alberini *et al.* 2005,

[1] For comprehensive accounts of the method, see Mitchell & Carson (1989).

Chien *et al.* 2005, Herriges & Shogren 1996, Lechner *et al.* 2003, Whitehead 2002). The results generally point towards the fact that anchoring has a significant influence on the derived WTP, making WTP a function of the "response path" and not only a function of the respondent's true preferences, and thereby inconsistent from an economic point of view. Anchoring effects are consequently a severe source of bias in DBDC CVM surveys.

Anchoring effect:
"*Anchoring is most likely to occur 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:
"*Starting point bias occurs when the respondent's WTP amount is influenced by a value introduced by the scenario*"…"*Confronted with a dollar figure in a situation where he is uncertain about an amenity's value, a respondent may regard the proposed amount as conveying an approximate value of the amenity's true value and anchor his WTP around the proposed amount*".

Mitchell and Carson, pp. 240 (1989)

Recently a new array of methods known as Choice Modelling Methods has gained attention in economic environmental valuation. Arguing that especially Choice Experiment deals with some of the severe biases known in CVM[2] (Hanley *et al.* 1998) this particular method has become increasingly applied.

1. Choice Experiments

With the paper by Adamowicz *et al.* (1994) the stated preference method Choice Experiments (CE) was introduced as a tool for environmental economic valuation. CE builds on Lancaster's *consumer theory*, which describes a good as consisting of a bundle of characteristics at certain levels. Utility is not derived from the good as such, but rather from the specific attributes- total utility of the good is the sum of the attribute utilities (Lancaster 1966). Thus, the focus is on how preferences for goods or services are organised with the aim of identifying the utility that individuals derive from the attributes, which compose the good or service in question (Bennett & Adamowicz 2001).

[2] The list of proposed problems with CVM is long, but the literature mainly focus on hypothetical bias, anchoring, insensitivity to scope, embedding etc. (Bateman *et al.* 2002, Garrod & Willis 1999, Hanley *et al.* 1997).

The elicitation of preferences is accomplished by presenting respondents with a set of alternative compositions of the good. The alternatives define the good or service in terms of the key attributes. Different alternatives are described by varying the levels of the attributes. Respondents are asked to choose which alternative they prefer. By examining the trade-offs between attributes/attribute levels, that are implicit in respondents' choices, it is possible to derive an estimate of the utility associated with the different attributes (Garrod & Willis 1999). If one of the attributes is measured in *monetary units* (i.e. price), it is possible to derive estimates of respondents' WTP for the other attributes from the marginal rate of substitution between the monetary attribute and the other attributes (Louviere *et al.* 2000).

1.1. Anchoring in Choice Experiments

A priori the CE format is expected to deal with some of the problems associated with CVM (Hanley *et al.* 1998). However, CE seems to be equally prone to anchoring bias. As in DBDC, the respondents are introduced to a set of specified prices (in choice sets consisting of different alternatives). Depending on the design of the choice sets the prices are typically different between alternatives in the choice sets (Kuhfeld 2004). Just as in DBDC, there is potential risk that respondents might interpret the prices attached to the alternatives as an indicator of the "correct" value of the environmental goods. Thus, they might let this "expected correct value" rather than their own true preferences influence their choices between the alternatives.

2.1.1. Price vector anchoring effects

The exact definition of anchoring effects in CE is less obvious than in DBDC. The prices attached to the alternatives are displayed simultaneously within each choice set and not sequentially as in DBDC. So far, the only tests that have been carried out relate to the parameter estimates' sensitivity to different price vectors used in the CE[3]. More specifically, these tests have focused on a type of anchoring effect which relates to the range of the price vector employed. In other words, does employing a generally high-priced vector of prices induce high WTP values and vice versa?

In table 1 below the different studies are presented and the estimated effects of sensitivity in prices are reported.

[3] Using split samples it has been tested if the elicited preferences and willingness to pay for the good in focus depend on the range of the prices used in the survey.

Table 1. Previous studies on preference sensitivity to differences in the price vector

Study	Type of good evaluated in the survey	Area of focus	Attributes tested for range effect	Range effect of tested attributes
Ohler *et al.*(2000)	Market good	Transport economics	Price 2 non-price attributes	No significant effect
Ryan & Woodsworth (2000)	Non-market good	Health economics	Price 2 non-price attributes	No significant effect[4]
Hanley *et al.*(2005):	Non-market good	Environmental economics	Price	No significant effect[5]

The results from these previous studies indicate that across market and none-market goods, preferences are relatively insensitive to the level of the price vector used in the survey. The results consequently denote that CE might reduce/eliminate a possible anchoring bias with regards to the range of the price vector.

2.1.2. Starting point anchoring effects

In the frame of the more traditional anchoring effect, the prices used in *first* choice set might influence the perception of the prices in the following choice sets resulting in an anchoring effect bias. Cognitive psychologists argue that people, when faced with an unfamiliar situation as is the case in the present study, make estimates by starting from an initial value, which may be suggested by the formulation of the problem, and then adjust that value to yield the final answer (Kahneman *et al.* 1982). The existence of such a bias has, to the authors' knowledge, not previously been tested in CE. In the present study, a test of a possible starting point anchoring bias in CE is carried out.

Formally, the test was carried out by employing a two-split sample design. In both splits respondents were introduced to a "Instruction Choice Set" (ICS)[6]. This ICS was

[4] In their analysis of sensitivity in preferences, the data sets from the two splits are joined assuming identical scales.
[5] Though insignificant, the results strongly denote that the propensity to opt-out is sensitive to the price vector. In sample A 25% of the respondents always choose the status quo option (the respondents thus reject the environmental improvement). In sample B this proportion is 17%. Using a Chi-test, the difference is found to be significant.
[6] The LCS was introduced in the scenario description of the hypothetical market put forward in the questionnaire. The respondents were asked to look at the example and consider what they would choose. It was also emphasised that the respondents should not only focus on the non-price attributes, but that they also should take the trade-off in prices between the alternatives into consideration. Focus group interviews revealed that this approach would *indeed* be beneficial in order to minimize possible learning effects that otherwise would occur in the course of the actual choice sets and bias the results.

an example of the subsequent actual choice sets used in the survey for preference elicitation. The purpose of the ICS was to minimize a possible learning effect[7] by giving respondents the opportunity to engage in learning about their own preferences before engaging in the actual CE. Further, the aim was to get respondents acquainted with the structure of the choice sets in which those preferences were to be elicited through respondent choices.

To test for starting point anchoring bias in the present study, the prices used in the ICSs were set at different levels in the two split-samples. The questionnaires, and thus the choice set designs, were kept exactly identical except for the prices in the ICS. In split A, the ICS displayed prices of 400 DKR and 1.100 DKR for alternative 1 and 2, respectively. Split B, on the other hand, employed a lower set of prices at 100 DKR and 200 DKR for alternative 1 and 2, respectively[8]. The ICSs are available in appendix A. In other words, the hypothesis tested is that the price levels in the initial choice set, in this case the ICS, will anchor respondent preferences as expressed in the subsequent choice sets.

Ideally, and in accordance with standard preference theory assumptions, the respondents' preferences and thus WTP should not be influenced by the set of prices in the ICS. This ought to result in similar distributions of choices in the choice sets in the two splits, *ceteris paribus*.

If the price levels used in the ICS do in fact act as an anchor with regards to the preferences in the subsequent choice sets, then one would expect the distribution of choices between the two alternatives and the opt-out in each choice set to differ between the two splits. More specifically, it would be expected that split B (with the lower priced anchor) results in lower aggregate WTP estimates than split A (Bateman *et al.* 1995).

Consequently, the following main hypotheses are put forward:

H1: $\text{distribution}_{\text{split A}} = \text{distribution}_{\text{split B}}$

H2: $\text{preferences}_{\text{split A}} = \text{preferences}_{\text{split B}}$

[7] If a learning effect is present in the choice sets it would mean that preferences are not stable from choice set to choice set, thus biasing results (Braga & Starmer 2005). Bateman *et al.* (2004) find strong evidence of learning effects in a CE-study, resulting in upwards-biased WTP estimates. Bateman *et al.* (2004) further suggest that it is the later responses which should be treated with greater weight in the estimation of robust and theoretically consistent measures of preferences.

[8] In both splits, a status quo alternative with a price of 0 DKR is also included in the choice sets and in the LCS.

The first hypothesis (H1) states that the distributions of choices within each choice set are identical in the two splits, implying that the differing price levels in the ICS do not influence respondent choices. Rejection of this hypothesis thus implicates the existence of an anchoring effect conditional on the ICS price levels.

The second hypothesis (H2) denotes that preferences in general are identical in split A and B. If this is the case, data from the two splits can be pooled. Rejection of this hypothesis will also implicate an anchoring effect.

2. The survey

The analysis of sensitivity of preferences to the price levels used in the ICS is based on a survey that examines the recreational benefits associated with reducing the impact of new motorways on different types of nature by locating the new motorways through agricultural areas rather than through forest, wetland and heath/pastoral areas. A generic stretch of new motorway was used as the basis for the scenario so as not to associate the CE study with any particular ongoing motorway planning process. A brief description of the study is given below. For full accounts of the study, see Olsen *et al.* (2005).

2.1. Scenario

The scenario was defined on the basis of the past ten years of motorway building in Denmark[9]. Based on the current plans regarding future new motorways, it was loosely estimated that the next ten years will not produce as many new kilometres of motorway as the past ten. The scenario entailed the assumption that 100 kilometres of new motorways will be built over the next ten years.

In the study, the good in question comprises areas of nature that are affected by new motorways. Three different types of nature that could describe natural areas were identified and chosen as attributes in the study. The three attributes were 'forest', 'wetland', and 'heath/pastoral'[10].

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[9] According to the Danish Road Directorate, 187 kilometres of new motorways were built during the last 10 years (Vejdirektoratet 2005).

[10] It was a concern, that the mental images of the three types of nature would be heterogeneous, influencing the validity of the results. It was therefore tested in the focus groups, that mental image was similar across the focus group members. The test pointed towards that this was indeed the case.

As described, the scenario defined that a total of 100 kilometres of new motorways are to be built over the next ten years, so reducing this number is not an option. The sum of km for each alternative therefore had to sum to 100 km. A fourth supplementary attribute, 'arable land', was therefore introduced[11].

2.2. Levels of attributes

The base case levels of the attributes were assigned on the basis of the area distribution of the four nature types in Denmark in general (Danmarks Statistik 2004). The base case scenario entailed 10 kilometres of new motorway would go through forest, 5 kilometres through wetlands, 5 kilometres through heath/pastoral, and finally the remaining 80 kilometres through arable land. This composition worked as a status quo alternative in the choice sets.

For each of the three main attributes, three levels of protection of the specific nature type were used. The three levels ranged from the base case level, i.e. no protection of the affected areas, to protecting half of the affected areas, and finally to protecting the entire area[12].

Besides the above mentioned attributes and levels, a cost attribute was included to enable estimation of WTP. The payment vehicle was set as an additional yearly income tax. The cost attribute was set at six levels ranging from 100 to 1,600 DKK. The base case cost at 0 DKK could be seen as a seventh level, but this level was only used in the status quo alternative.

The attributes and their assigned levels are summed up in appendix B.

2.3. Design

Given the number of attributes and their levels a total of 162 alternatives[13] were possible. A fractional factorial design was used to generate the alternatives to be used in the survey (Louviere *et al.* 2000). The construction of the fractional factorial design used in this study was carried out in SAS using the macros '%mktruns', '%mktdes', '%choiceff' and '%mktblock'. For further explanation of these macros see Kuhfeld (2004). This resulted in the final design of the choice sets, shown in appendix C.

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[11] This attribute functioned as a sort of an accumulation attribute dependent on the other attributes
[12] In the focus groups, the range and number of levels where tested, and found to be suitable
[13] From the calculation: $3^3 \times 6^1 = 162$

2.4. Population and data collection

The aim of the CE study was to obtain WTP estimates principally transferable to any location in Denmark. The relevant target population was considered to be the entire Danish population. A sample totalling 5,354 people[14] was used to represent the population in the survey. The collection of data based on the CE questionnaire was carried out as an online Internet survey by the survey company ACNielsen AIM A/S. The collection of data took place from 3-20 June 2004. The 5,354 participants were picked from the entire panel of approximately 17,000 people on the basis of quotas regarding gender and age, based on the amount of people with Internet access in the given target group.

3. Econometric model

The respondents' preferences were described formally by use of a random utility function (Manski 1977, Marschak 1960, Thurstone 1927) in which the individual *i*'s, utility from reducing the distance of motorway through forest, wetland and heath of the *j* motorway outlay (U_{ij}) is described as a function of a deterministic part (V) and a stochastic element (ε) as follows:

$$U_{ij} = V(Z_{ij}, S_i) + \varepsilon \qquad (1)$$

where Z represents characteristics of the motorway outlay, i.e. km through nature and the cost per household; S characterises the individual, e.g. gender, income etc; i denotes the individual respondent; and j the alternative, see Maddala (1983).

The Z in the utility function represents the attributes of the alternatives evaluated by the respondents. It is with regards to the levels of these attributes that the respondents are assumed to make their choices between the different alternatives. Based on the choices, the relative weight/utility, which the respondents attach to each attribute, can be estimated. These weights are represented by the coefficients of the variables representing the attribute/attribute level; see Hensher and Johnson (1981) for further details. Based on the observed weights, the marginal rates of substitution[15] between attributes can be estimated, as illustrated in the following general example.

[14] Between 18 and 70 years of age

[15] The marginal rate of substitutions is the ratio of marginal utilities of two attributes, and thus expresses how much the individual must be compensated with attribute 1 to forgo attribute 2.

Let Z be defined by a price attribute P and a vector T representing other attributes of the alternatives For simplicity it is assumed that the preferences are homogenous across respondents, why the S in (1) cancels out. The indirect utility function can now be expressed by:

$$V_{nj} = P'\beta_P + T'\beta_T \tag{2}$$

where β_P represents the marginal utility of the price and β_T represents a vector of marginal utilities of the other attributes. Total differentiation of the indirect utility function, holding utility constant (dV/dx_{nj}=0), gives:

$$\mathrm{d}V = \beta_P \cdot dP + \beta_T \cdot dT = 0 \text{ and rearranging}$$

$$\frac{dT}{dP} = -\frac{\beta_T}{\beta_P} \tag{3}$$

The above expression is the marginal rate of substitution between the price attribute and the other attributes of the alternatives. Given that a price attribute is contained in the design, the marginal rate of substitution can be interpreted as the maximum amount the individual is willing to pay to achieve/avoid a change in one of the other attributes.

3.1. Independence of Irrelevant Alternatives

A large number of different econometric models have been formulated over the years to analyse data based on discrete choices in a random utility framework (Maddala 1983, Train 2003). A simple and easy applicable model is the logit model. The model is however limited by the restrictive assumption of proportional substitution across alternatives, also known as IIA property.

To test for IIA, the test developed by Hausman & McFadden (1984) is used, see below

$$\left(\hat{\beta}_{\tilde{C}} - \hat{\beta}_C\right)' \left(\Sigma_{\hat{\beta}_{\tilde{C}}} - \Sigma_{\hat{\beta}_C}\right)^{-1} \left(\hat{\beta}_{\tilde{C}} - \hat{\beta}_C\right) \tag{4}$$

where $\hat{\beta}_C$ and $\hat{\beta}_{\tilde{C}}$ refer to the estimated coefficient vectors for the models estimated on the full, c, and the reduced, $\tilde{c}$, data sets respectively, and where $\Sigma_{\hat{\beta}_C}$ and $\Sigma_{\hat{\beta}_{\tilde{C}}}$ refer to the associated covariance matrices. The test statistic is asymptotically χ^2-distributed with $\tilde{K}$ degrees of freedom, where $\tilde{K}$ is equal to the dimension of $\hat{\beta}_{\tilde{C}}$. Basically, the test determines the extent to which the parameter estimates from the two models are the same (Hausman & McFadden 1984). The results of the IIA test are presented in table 2 below.

Table 2. Test for violations of the IIA assumption in splits A and B

	Alternative removed			
	Alternative = Status quo* Pr<χ	Alternative = 1 Pr<χ	Alternative = 2 Pr<χ	Violation of IIA ?
Split A	0.0002	0.1511	0.0024	YES
Split B	0.1636	0.0011	0.0275	YES

The result is that the IIA assumption is violated in splits A and B. The test results in table 2 strongly indicate that a conditional logit model is not an appropriate model to use in the analysis of the discrete choice data in this study.

New types of logit models (Nested Logit, Mixed Logit) and other models (Multinomial Probit, HEV models) have been explored in an attempt to remedy the IIA problems of the logit model. In the present paper a multinomial probit model is applied.

3.2. Multinomial probit

The multinomial probit model (MNP) is an extension of the binary probit model, which can also handle multinomial choices. The multinomial probit model most importantly relaxes the IIA property. The relaxation of the IIA property is brought about by the multinomial probit model's ability to allow for correlation between the error terms for the different alternatives (Alvares & Nagler 1998).

The section below presents the theoretical properties of the model.

It is assumed that the individual is confronted with 3 alternatives (*i*, *j* and *k*). The probability of choosing alternative *i* opposed to *j* and *k* is equal to:

$$P_{ni} = P(V_{ni} - V_{nj} > \varepsilon_{nj} - \varepsilon_{ni}, V_{ni} - V_{nk} > \varepsilon_{nk} - \varepsilon_{ni}) \qquad (5)$$

where ε_{ni}, ε_{nj} and ε_{nk} are assumed to have a trivariate normal distribution. Let $f(\varepsilon_{ni}, \varepsilon_{nj}, \varepsilon_{nk}) = f_n(\varepsilon)$, with a covariance matrix given by:

$$\Omega = \begin{bmatrix} \sigma_i^2 & \sigma_{ji}^2 & \sigma_{ik}^2 \\ \sigma_{ij}^2 & \sigma_j^2 & \sigma_{kj}^2 \\ \sigma_{ik}^2 & \sigma_{jk}^2 & \sigma_k^2 \end{bmatrix} \quad (6)$$

Depending on the definition of the covariance matrix, the multinomial probit model will have different properties, see Train (2003).

Based on equation (5) the probability of choosing alternative *i* is equal to:

$$P_{ni} = \int_{-\infty}^{\infty} \int_{-\infty}^{V_{nij}+\varepsilon_{ni}} \int_{-\infty}^{V_{nik}+\varepsilon_{ni}} f(\varepsilon_{ni}, \varepsilon_{nj}, \varepsilon_{nk}) d\varepsilon_{ni} d\varepsilon_{nj} d\varepsilon_{nk} \quad (7)$$

where $V_{nij} = V_{ni} - V_{nj}$ and $V_{nik} = V_{ni} - V_{nk}$

The multinomial probit model is analysed in the statistical software package SAS by using the proc MDC procedure (SAS 2005). In proc MDC, the multinomial probit model is estimated using *simulations* of the trivariate distribution rather than solving the triple integral numerically, see Train (2003). In all of the presented models, 250 simulations were used; see (Olsen *et al.* 2005).

The multinomial probit model is fitted with regard to the definition of the structure of the covariance matrix. The structure is set by normalising with regard to one, two or all three variance elements in the covariance matrix (SAS 2005, Train 2003). Different definitions of the covariance matrix were tested using the Likelihood Ratio Test. In order to identify the most appropriate model specification, the test statistics for the main split (split A) are presented in table 3.

The nomenclature used in equation (5) is adjusted to the choice sets used in this study, where the respondent is presented with a status quo alternative *(A-sq)* and the two other alternatives represent alternative motorway layouts *(A-1 and A-2)*. Table 3 tests whether a homoscedastic model (identical variance across the three alternatives ($\sigma^2_{A-sq} = \sigma^2_{A-1} = \sigma^2_{A-2}$)) is a better model compared to heteroscedastic models (heterogeneous variances across the three alternatives ($\sigma^2_{A-sq} = \sigma^2_{A-1} \neq \sigma^2_{A-2}$, $\sigma^2_{A-sq} = \sigma^2_{A-2} \neq \sigma^2_{A-1}$ and $\sigma^2_{A-1} = \sigma^2_{A-2} \neq \sigma^2_{A-sq}$)).

Table 3. Test of appropriateness of homoscedastic model versus heteroscedastic model

	Hypothesis on the structure of the covariance matrix			
	$\sigma^2_{A\text{-}sq} = \sigma^2_{A\text{-}1} = \sigma^2_{A\text{-}2}$	$\sigma^2_{A\text{-}sq} = \sigma^2_{A\text{-}1} \neq \sigma^2_{A\text{-}2}$	$\sigma^2_{A\text{-}sq} = \sigma^2_{A\text{-}2} \neq \sigma^2_{A\text{-}1}$	$\sigma^2_{A\text{-}1} = \sigma^2_{A\text{-}2} \neq \sigma^2_{A\text{-}sq}$
LL	-1659.26	-1652.89	-1659.12	-1650.94
DF	7	8	8	8
-2LL		12.75	0.29	16.66
Test (χ^2)		0.000356	0.592666	0.000045

Looking at the test statistics (chi-square distributed), the conclusion is quite clear. The model specifying identical variances for alternatives *A-1* and *A-2* ($\sigma^2_{A\text{-}1} = \sigma^2_{A\text{-}2} \neq \sigma^2_{A\text{-}sq}$) is the model with the best fit, and will subsequently be used in the modelling of preferences in the present paper. For more comprehensive accounts, see Olsen *et al*.(2005).

4. Analysis and results

The following presents the analysis and results of the study. Firstly, the data is analysed for possible differences between demographic variables in the two splits. Secondly, a non-parametric comparison of choices is carried out, and finally choices are modelled parametrically.

4.1. Difference in demographic variables between samples

The datasets obtained in splits A and B, respectively, are based on choices from two independent population samples. Before potential differences in preferences can be assigned to anchoring effects, it is necessary to test if the two samples are identical with regards to the demographics of the respondents. If the two samples are not similar in demographic composition, it might cause differences in the elicited preferences, thus blurring the possible effects of the differing price levels in the ICS. This could lead to imprecise conclusions with regard to the acceptance/rejection of H1 and H2. In appendix D sample A and B are analysed for differences in demographics.

In general, the distributions of the different demographic variables are not significantly different from each other. There are, however, significantly different distributions of gender in the two samples, in terms of an overweight of women in sample A. This difference calls for attention in the subsequent analyses with regards to possible preference differences between male and female respondents.

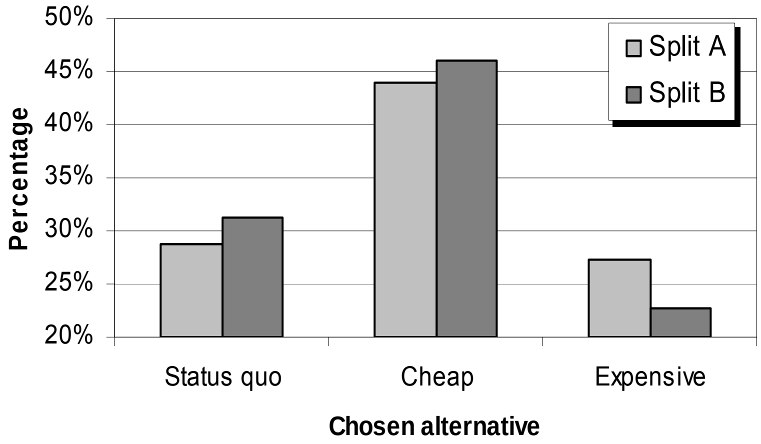
Apart from gender differences, the results generally indicate that the respondents constituting the two samples on average do not seem to be distinctively different from each other. This indicates that if a difference in preferences across the two samples is established in the following analyses, it can be ascribed to the differing price levels in the ICS used in the two samples.

In addition, to verify if potential differences in preferences can be explicated by the difference in gender-distribution in the two samples, the tests for anchoring is carried out on gender level as well as an overall level.

4.2. Comparison of choices – a non-parametric approach

The actual distributions of specific choices in each of the choice sets are displayed in figure 1 (below). More specifically, the figure depicts the share of responses in which respondents have chosen the status quo alternative, the cheap alternative and the expensive alternative, respectively. Split A reflects a total of 1764 choice sets evaluated by 294 respondents. Split B reflects a total of 1710 choice sets evaluated by 285 respondents.

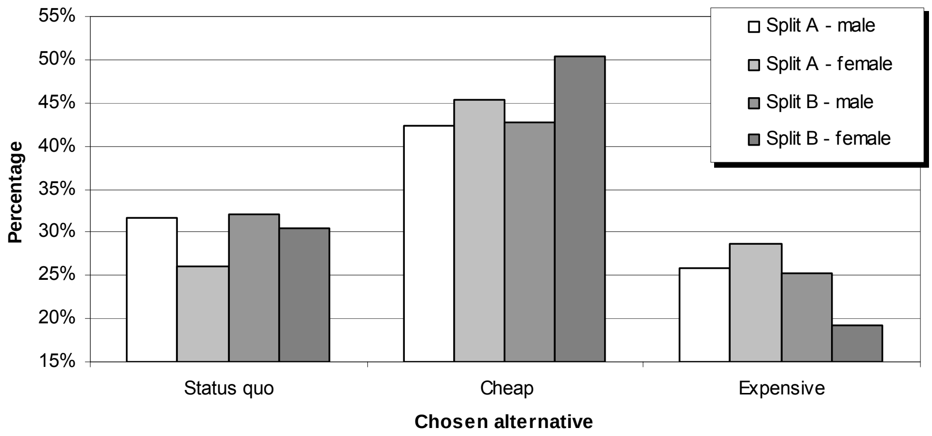
Figure 1. Distribution of choices in each choice set in the two splits



By visual inspection the distributions suggest that the different price levels in the ICS do indeed affect choices. Respondents in split A seemingly tend to choose the expensive alternative more often than respondents in split B. Recalling the fact that respondents in split B were shown a ICS with lower price levels than in the ICS shown to respondents in split A, this tendency is in keeping with the suspicion of an anchoring effect resulting in generally lower WTP in split B as compared to split A.

Employing a χ^2-test to test the hypothesis, H1, of equal distribution of chosen alternatives in the two splits returns a P-value of 0.00002, strongly rejecting the hypothesis. In other words, a significant difference between the two splits is evident.

Figure 2. Breakdown of choice distributions to gender and split



This strongly indicates that respondents' preferences, and thus WTP, are anchored in the ICS. However, there is another possible reason for the difference. The analysis of the respondents' background characteristics in appendix C revealed that the sample in split B has a significantly larger share of male respondents than the sample in split A. If male and female respondents differ in their preferences and thus choices, it might offset the identified difference in choices in the two splits. Figure 2 (below) illustrates a breakdown of choice distributions to gender in each split.

The figure suggests that male and female respondents have generally chosen differently in the choice sets. This is supported by a χ^2-test with P-value below 0.0001 (highly significant difference in distributions). Male respondents tend to choose the status quo alternative more often than female respondents. This would suggest that male respondents have lower WTP, which, combined with the overweight of male respondents in split B, could be an explanation of why WTP estimates are lower in split B, see table 4. However, when looking at the other two alternatives in figure 2, the tendency is ambiguous. In general female respondents tend to choose the cheap alternative more often, but when it comes to the expensive alternative, it is only in split A that female respondents choose the expensive alternative more often than male respondents. In split B it is the opposite case. The fact that male respondents in split B are more prone to choosing the expensive alternative than are the female respondents, would suggest that male respondents have higher WTP than female respondents thus contradicting the above explanation of the low WTP in split B.

Comparing the choices of male respondents in splits A and B, it turns out that distributions are quite similar. This is supported by a χ^2-test with P-value 0.896 (no significant difference in distributions). So, it seems that male respondents are not affected by the differing price levels in the examples in the two split.

With regards to female respondents, apparently great deviations in the choice distributions in the two splits emerge. A χ^2-test with P-value below 0.0001 reveals a statistically significant difference. By visual inspection of the figure it is evident that the difference reflects a tendency of female respondents in split B choosing the expensive alternative less often than in split A. Instead they choose the status quo or the cheap alternative. The straightforward conclusion is that women apparently *are* affected by the price levels in the ICS. The lower level of prices in the example in split B thus results in lower WTP expressed by the female respondents as compared to female respondents in split A.

Interpreted economically, female respondents in split A expressed a lower sensitivity to changes in the price than female respondents in split B. Stated differently, female respondents' marginal utility of income is lower in split A than split B:

$$\delta U_{A,\,female}/\delta Income_{A,\,female} < \delta U_{B,\,female}/\delta Income_{B,\,female} \qquad (8)$$

4.3. The parametric analysis

The non-parametric approach focuses solely on the propensity of choice as a function of the price of the alternatives, that is the positive prices for the generated alternatives and the zero price in the status quo in the choices sets. Hence, the non-parametric analysis does not take into account the information on choice related to the other attributes (protection of forest, wetland and heath) describing the environmental change associated with alternative motorway layouts. However, the observed disparity in propensity of choice could potentially be explained by differences in preferences for these attributes. To thoroughly analyse the apparent differences in preferences, the preferences of the respondents in the two samples are analysed using the multinomial probit model presented in table 4.

Table 4.

	Split A			Split B			
Parameter	Estimate	P value	WTP	Estimate	P value	WTP	ΔWTP_{AB}
forest_min	1.0347	<0.0001	895	0.8147	<0.0001	640	255 (28%)
forest_med	0.4975	<0.0001	430	0.3990	<0.0001	313	127 (30%)
wetland_min	0.8839	<0.0001	765	0.5365	<0.0001	421	344 (45%)
wetland_med	0.5073	<0.0001	439	0.3354	<0.0001	263	176 (40%)
heath_min	0.3606	<0.0001	312	0.1509	0.0203	119	193 (62%)
Status quo	0.0996	0.0994	*86*	0.1649	0.0066	130	*-44 (-147%)*
Price	-0.0012	<0.0001		-0.0013	<0.0001		
Std_1	1.6619	<0.0001		1.1082	<0.0001		
N		1764		1710			
Simulations		250		250			
LL(0)		1938.2		1879.0			
LL(b)		1650.5		1581.8			
Pseudo-R^2		0.148		0.158			

Note: Italicised WTP figures are non-significant at the 95% level. WTP figures are DKK per household per year.

The preferences in table 4 for protecting the different types of nature are significant in both sample A and B, resulting in positive WTP to avoid the level-specified amount of km of motorway to be located in forest, wetland and heath as opposed to agricultural areas. The coefficient estimates in the two models are somewhat similar. However, given the expected different scales in the two models, the coefficient estimates cannot be directly compared. However, a direct comparison *can* be made with regard to the WTP estimates, as the scale parameter cancels out (Train 2003). The differences in WTP are reported in the rightmost column. The differences strongly indicate that preferences are different in the two samples. In general the respondents in sample B have expressed a WTP, which is between 28-62% lower than the respondents in sample A[16]. The multinomial probit models consequently seem to support the results from the non-parametric analysis.

[16] The difference in WTP for the status quo variable is negative, which signifies that the respondents in sample B have connected the status quo alternative with higher utility than the respondents in sample A.

Table 5..	Test of pooling the data sets (250 simulations)			
Dataset	Loglikelihood Split A +Split B	Loglikelihood joined (μ=1.039)	LR	Significance (DF=9)
Split A-B	-1650.527-1581.796 = -3232.323	-3243. 190	21.73	0.0097

The test of pooling datasets in table 5 reveals that the preferences between sample A and B are not identical. Rescaling the data from sample B (the ratio between sample A and B = 1.039) and pooling the data sets yields a LR test statistic of 21.73. With 9 degrees of freedom[17], the test is significant on 0.0097 level. H2 is therefore rejected, indicating an anchoring effect caused by the differing price levels employed in the ICS.

As illustrated in figure 2 the preferences between sample A and B only seem to differ with regards to the female respondents' choice structure. H2 is therefore tested on gender level using the LR test.

Table 6.	Test for gender specific differences in preferences across sample A and B				
Male	Sample A	Sample B	Pooled (μ=1)	LR	Significance (DF=9)
LL	796.576	929.396	1733.104	5.95	NS (0.745)
Female	Sample A	Sample B	Pooled (μ=1.11)	LR	Significance (DF=9)
LL	847.863	644.200	1507.770	31.41	<0.001

The tests statistics in table 6 confirm the results from the non-parametric analysis with regards to gender specific preferences. In the case of the male respondents, the test statistic is only 5.95 for joining the models for sample A and B. With 9 DF, this is highly insignificant. The test size for female respondents in the two splits is however 31.40, which is very significant. It is thus affirmed that female respondents in sample A have expressed preferences different from those expressed by female respondents in sample B. Introducing female respondents to a low-priced ICS causes them to express lower WTP values than when introducing them to a higher-priced ICS. In other

[17] 8 variables and the scale parameter

words, it is established that an anchoring effect is present in this study, however only in the case of female respondents.

5. Discussion

An anchor effect is established in the present study. Using high prices in the LCE seemingly affect preference structures and drives the WTP up compared to when using low prices in the LCE. However, taken at face value, this result has fairly important implications for the validity and interpretation of CE studies as it does not conform to the standard economic theories of preference underpinning the CE method. Such inconsistencies between an individual's responses and the theory that is being used to organize the survey data are referred to as *anomalies* (Sugden 2005). But does this mean that the observed normalities make CE studies consequently worthless? Sugden (2005) argues that this is not necessarily the case. But we should at least recognise the existence and importance of anomalies, and preferably investigate strategies for dealing with these anomalies.

The Discovered Preference Hypothesis (DPH) introduced by Plott (1996) is one such strategy. DPH states that when respondents are faced with new decisions in unfamiliar environments, initially decisions will exhibit large randomness and little conformity with standard preference theory, e.g. rationality. But as choices are repeated and respondents get more familiar with the environment, decisions will progressively exhibit less randomness and greater rationality. In other words, behaviour initially deviates from, but with experience converges to, the predictions of standard theory. It is thus argued, that by "training" respondents their preferences become more stable and rational. Braga & Starmer (2005) find some, but not unequivocal, support for the DPH.

In the present study, experience from focus group interviews clearly supported the DPH. Focus group respondents expressed difficulty and uncertainty in choosing an alternative in the first couple of choice sets. But after the first couple of choice sets the general tendency was that they became more familiar with the task as well as their own preferences which made it much easier to choose.

Thus, in the final questionnaire an ICS was incorporated with the dual purpose of making respondents familiar with the task at hand and making them think about their preferences – a sort of market-like training of respondents, which, in line with Hanley & Shogren (2005), is believed to reduce irrational behaviour in the preference elicitation questions. Cherry *et al.* (2003) find that people generally gain rationality through refining values (not by changing preferences) and that their stated values become more consistent with their true preferences when choices are repeated.

Though not formally tested, it seems likely, based on the experience from focus group interviews, that the ICS has indeed reduced the extent of anomalies in the dataset. However, this paper reveals that anomalies, in terms of an anchoring effect, still exist in the dataset. An explanation for this is offered by the DPH. Even though the ICS is likely to have made the decision environment more familiar and increased respondents' awareness of own preferences, it might not be enough. It is quite possible that respondents, having seen the ICS, still experience uncertainty in the following choice set thus the choice will still exhibit some randomness. This corresponds with statements from the focus group interview respondents who needed "a couple of choice sets" to feel certain in their choices. In the survey, the respondents reported a certainty in choice (on a 1-5 scale) after each choice set evaluation. Relating this certainty in choice with the number (first, second, …, sixth) of the choice set the certainty in choice increases. Respondents become more confident in their choices as they evaluate more choice sets (everything else kept equal).

This could indicate that instead of just one, a series of two or maybe even three ICSs ought to have been introduced prior to the actual choice sets in order to make behaviour converge more towards the true preferences. However, as Braga & Starmer (2005) remarks, it is naïve to believe that DPH can take account of all anomalies, so whether including more LGSs would actually remove the anchoring effect entirely is doubtful. This issue is however worthy of further consideration and investigation in future research.

In the present study, the established anchoring effect is caused solely by the prices in the ICS. It seems reasonable to expect similar anchoring effects to be present in studies not employing an ICS. In that case, the anchoring would be caused by the price levels in the first of the actual choice sets, thus affecting choices in the subsequent choice sets. If this is so, the implication is that results from a CE study might to a certain degree depend on the design of choice sets or rather the sequence of choice sets. Starting with a relatively low-priced choice set would thus lead to low WTP.

Typically, in CE, the sequence of choice sets is identical for all respondents. This is mainly due to practical considerations such as ease of handling the questionnaire in the design phase, cost of printing, and organising and handling of data. However, in conjunction with the above findings of an anchoring effect, this implies that a study employing a low-priced first choice set will in general underestimate the true WTP of the respondents and vice versa. A solution could be to employ a sort of "random-sequenced" choice set design, changing the sequence of the choice sets from respondent to respondent. This way all possible sequences of the choice sets could be represented equally. Even though this will not remove the anchoring effect as such on an individual level, it will however minimize the bias in the overall mean WTP estimates, as the individual anchors more or less will cancel out each other. The emergence of internet based collection of data and the technical capabilities in this respect would seem to offer new possibilities for employing and testing such random-sequenced choice sets in future CE studies.

Even though the use of a random-sequenced choice set design might reduce the impact of the anchoring effect on the overall WTP estimates, it is important to remember that the anchoring effect is still present in the data. In this case, however, it will be the entire price vector which provides the anchor and not only a specific pair of prices in the first choice set. Consequently, the importance of choosing a suitable price vector must be stressed.

In practice it will often be very expensive and thus impossible to employ a random-sequenced choice set design. If this is the case, then how should the potential anchor effect be handled?

A precautionary principle would recommend the use of generally low-priced ICS or first choice sets to yield conservative estimates of WTP. However, if the price vector is carefully chosen through use of focus groups and pilot tests, it might be more correct to use a set of prices that are close to the expected WTP. Another approach would be employ a split survey (similar to the present study) in order to ascertain, firstly, whether or not an anchoring effect biases the results, and, secondly, the magnitude of the anchoring effect.

6. Conclusion

The present study finds that preferences elicited by Choice Experiments can be subject to starting point anchoring bias. Thus, employing different sets of price levels in a so-called Instruction Choice Set (ICS) presented prior to the actual choice sets, resulted in significantly different distributions of choice in two otherwise identical choice set designs. On a more specific level, the results indicate that the anchoring subjectivity in the present study is gender dependent, pointing towards, that female respondents are prone to be affected by the price levels used in an ICS displayed prior to the real choice set evaluations. Male respondents are on the other hand not sensitive towards the prices levels used in the ICS. Overall, this implicates that female respondents, when shown a low-priced ICS, tend to express lower WTP than when shown a high-priced ICS.

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Appendix A

Instruction Choice Sets (ICS) employed in the two splits

Split A

Which of the following locations for the future motorways would you prefer?

	Alternative 0	Alternative 1	Alternative 2
Number of kilometres through:			
Forest	10 km	5 km	0 km
Wetland	5 km	0 km	5 km
Heath/pastoral	5 km	5 km	0 km
Arable land	80 km	90 km	95 km
Annual extra payment	0 DKK	400 DKK	1100 DKK
I prefer …(tick one):	❑	❑	❑

Split B

Which of the following locations for the future motorways would you prefer?

	Alternative 0	Alternative 1	Alternative 2
Number of kilometres through:			
Forest	10 km	5 km	0 km
Wetland	5 km	0 km	5 km
Heath/pastoral	5 km	5 km	0 km
Arable land	80 km	90 km	95 km
Annual extra payment	0 DKK	100 DKK	200 DKK
I prefer …(tick one):	❑	❑	❑

Appendix B

Attributes and levels in the CE study

Attribute	Level
Forest	10 km
	5 km
	0 km
Wetland	5 km
	2.5 km
	0 km
Heath/pastoral	5 km
	2.5 km
	0 km
Arable land	80 km
	82.5 km
	85 km
	87.5 km
	90 km
	92.5 km
	95 km
	97.5 km
	100 km
Annual extra tax	(0 DKK)
	100 DKK
	200 DKK
	400 DKK
	700 DKK
	1100 DKK
	1600 DKK

Appendix C

The employed design

		Kilometres of motorway through type of nature				
Block	Choice set no.	Forest	Wetland	Heath/pastoral	Arable land	Price (DKK)
1	1	0	0	5	95	200
		10	5	2.5	82.5	100
	2	0	2.5	2.5	95	1100
		5	5	0	90	200
	3	5	2.5	5	87.5	100
		0	0	2.5	97.5	400
	4	10	0	2.5	87.5	700
		0	5	5	90	1600
	5	5	5	0	90	400
		10	0	5	85	1600
	6	0	0	2.5	97.5	100
		10	2.5	0	87.5	1100
2	1	5	2.5	2.5	90	700
		10	5	0	85	100
	2	0	5	5	90	400
		10	2.5	0	87.5	200
	3	5	0	5	90	100
		0	2.5	0	97.5	1600
	4	5	0	0	95	700
		10	2.5	2.5	85	400
	5	0	5	0	95	700
		5	0	5	90	1100
	6	10	2.5	5	82.5	1600
		5	5	2.5	87.5	1100
3	1	10	0	2.5	87.5	200
		0	2.5	5	92.5	700
	2	5	0	0	95	400
		0	5	2.5	92.5	200
	3	5	2.5	5	87.5	200
		10	0	0	90	1600
	4	10	2.5	5	82.5	400
		5	5	2.5	87.5	1100
	5	0	5	0	95	1100
		10	0	5	85	700
	6	0	2.5	0	97.5	100
		5	5	2.5	87.5	1600

Appendix D

Comparison of distribution of demographic variables between sample A and B

		No. of respondents		
		Sample A	Sample B	Significant
Gender				
	Male	141	163	***
	Female	153	122	
Age				
	18 – 24	29	28	NS
	25 – 34	53	56	
	35 – 44	80	75	
	45 – 54	67	67	
	55 – 64	58	46	
	65 – 70	7	12	
Personal gross income/year (DKK)				
	< 150,000	13	19	NS
	150,000 - 299,999	40	49	
	300,000 - 499,999	83	83	
	> 500,000	123	120	
Education				
	Primary school	15	11	NS
	Vocational	73	66	
	High school	15	14	
	Short academic (<3 years)	38	29	
	Middle academic (3-4 years)	75	88	
	Long academic (>4 years)	51	57	

(NS) indicates no significant difference, (*) indicates a significant difference on a 95% level, (**) indicates a significant difference on a 99% level, (***) indicates a significant difference on a 99.9% level.

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