Distal order effects in stated preference surveys

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1. Introduction

In stated preference (SP) surveys, order effects are said to occur when responses *to a given question* vary in a theoretically unexpected manner due to the positioning *of that question* or item relative to others (as defined by Powe and Bateman (2003), with emphasis added). A large number of SP studies have certainly found that a good's placement in a sequence of goods in a valuation exercise can have a substantial impact on people's valuation of the different goods in question (as in Carson, et al. (1998), Stewart, et al. (2002), Dupont (2003), Powe and Bateman (2003), Clark and Friesen (2008)). Goods are likely to evoke higher values if they appear earlier in a sequence, as noted by Payne, et al. (2000) or Veisten, et al. (2004).[1]

These various studies tend to focus on types of order effects which stem from the sequence of questions about different goods within the valuation portion of the survey. We will refer to these as *proximal* order effects, since the ordering issue pertains to the valuation questions themselves. However, other sources of order effects in surveys are also possible. In particular, *distal* order effects in a valuation task can be caused by the arrangement of information elsewhere in the survey, prior to the valuation questions. These order effects may be present even if just one type of good, in one amount, is to be valued by all survey respondents. Distal order effects can be created by the sequence in which information is presented or elicited during the preamble to a valuation exercise, anywhere between the beginning of the survey and the valuation task itself.

Order effects in general survey research have been studied extensively in the psychological and survey design literatures by Carpenter and Blackwood (1979), Crespi and Morris (1984), Bishop, et al. (1985), Krosnick and Alwin (1987), Mitchell and Carson (1989), Colasanto, et al. (1992), Dillman (2000), Tourangeau, et al. (2000), Bishop and Smith (2001), and Moore (2002), among others. These studies

[1] Order effects have sometimes been treated as synonymous with "embedding effects," according to Boyle, et al. (1993). The term "embedding" stems from Kahneman and Knetsch (1992), where term is used to describe a wide variety of nesting and sequencing issues, also reviewed in Dupont (2003). Since the term has been applied to distinct phenomena, it has been criticized as being ill-defined, as in Kahneman and Knetsch (1992) or Loomis, et al. (1993). Hanemann (1994) provides a useful categorization of the sequencing effect (order effect), the scope effect, and the sub-additivity effect identified in Carson and Mitchell (1995).

document a considerable amount of evidence to suggest that the order effects of some kind are likely to be the norm, rather than the exception, in most surveys.

Among economic studies, the empirical literature concerning distal order effects is rather thin. Of course, if respondents' inherent attitudes toward the good in question are already well-formed, and therefore less vulnerable to being swayed by information ordering, the problem can be ignored. However, distal order effects cannot be overlooked if respondents adjust their opinions in the later valuation portion of the survey in response to the ways in which the researcher has chosen to organize some of the prior information or attitude-elicitation questions in the survey. If respondent opinions are affected by design decisions in a survey's preamble, their modified opinions may further affect their choices in the stated preference portion of the survey and thus lead to distortions in the eventual WTP estimates.

Prior to our analysis in this paper, only Boyle, et al. (1993) seem to have specifically addressed distal order effects in a stated preference survey. Using a contingent valuation survey concerning Grand Canyon white-water rafting, they find that the sequencing of the prior elicitation questions does matter to the valuation of public goods, and inexperienced rafters are more susceptible to ordering effects than experienced rafters.[2] The scarcity of distal order effects studies in a valuation context unfortunately means that non-market valuation survey researchers tend to pay too little attention to the potential for this problem during survey design.

Using an online climate change survey, we identify significant distal order effects stemming from attitudinal questions prior to the stated choice exercise, and then examine the consequences of these effects for willingness to pay estimates. The modeling framework within which we demonstrate these effects is borrowed from Cai, et al. (2010). In that paper, we rely on the extensive randomization of all possible orderings in the survey to prevent any distortions that might have been induced by the use of just one ordering in each case. Here, however, we make use of these randomizations specifically to explore what could have been the consequences, had we relied upon just one particular ordering. Our results

[2] Their work indicates that experience and familiarity about the environmental goods in question play an important role in reducing order effects. Evidence has also been found that the magnitude of order effects differs by age and education (Hanemann (1994) and Dupont (2003)), and by type of user (active, potentially active and passive) as described in Knauper (1999).

suggest that the sequencing of information in preamble questions can alter people's apparent preferences for climate changes policies inferred from a subsequent conjoint choice task. These distortions have the potential to be non-trivial. These differences in estimated marginal utilities translate into differences in the resulting implied WTP for climate change mitigation. This sensitivity to information order suggests strongly that survey researchers should be careful to randomize the preliminary information in stated preference surveys in order to minimize inadvertent effects on the resulting valuation estimates.

2. An online climate policy survey

Our full dataset consists of 1850 responses to a comprehensive online survey about climate change mitigation policy. The sample used here consists primarily of college students—recruited by 114 different instructors from classes at 92 different colleges and universities throughout the U.S. and Canada—who responded to the survey over the internet. This survey employs a multi-campus analog to a conventional classroom convenience sample, and uses a remotely administered Web-based questionnaire (http://globalpolicysurvey.ucla.edu). The key climate policy choice question included in each dynamically randomized survey instrument is a hypothetical vote involving either one or two climate change mitigation policies versus business as usual. The survey is designed to provide conjoint choice data which will allow us to infer the size of (and systematic variation in) people's willingness to incur the potential costs of climate change mitigation and adaptation.

As in any stated preference survey, there is an automatic concern about whether respondents viewed their choices as being consequential. The "consent to participate" portion of the survey stated explicitly: "Your answers on this survey, when combined with those of other participants, will help decision-makers formulate better policies." Respondents are thus assumed to interpret the survey exercise as an advisory referendum on alternative possible climate policies. We rely on the results of Carson, et al. (2008) and Herriges, et al. (2010) which suggest that as long as there is some non-zero chance that the respondent's answers will have some bearing on outcomes they care about, they will take the choice task seriously.

Importantly, the design of the questionnaire also incorporates an unusually wide range of

dynamically randomized elicitation formats for an unusually large share of its information. In the design phase, we were especially concerned about the possibility of unintended order effects. Thus we randomly shuffled the order of almost everything for which randomization was possible. This extreme degree of randomization permits us to assess the sensitivity of respondents' stated policy preferences to different survey formats. For many SP studies, the researcher's choice between numerous information formatting alternatives may have been assumed to be arbitrary and inconsequential. Empirically, however, ordering decisions throughout a survey questionnaire may have systematic effects upon subsequent stated choices.[3]

2.1 Preliminary Attitudinal Questions

It is now widely accepted that climate change has the potential to pose major threats to agriculture, weather, human health, and ecosystems (see for example Kinnell, et al. (2002), Kelly, et al. (2005), Bosello, et al. (2006)). In our survey, we elicit respondents' subjective levels of concern about climate change impacts across five broad categories, which we label as "Agriculture&Water," "Ecosystems," "HumanHealth," "Oceans&Weather," and "Equity." We also elicit respondents' subjective ratings of the likely magnitudes of climate change impacts for each of the five categories, by thirty years in the future, if a policy of "business-as-usual" is followed. Respondents are invited to rate climate change impacts either as single values or as intervals on a simple nine-point scale (ranging from -4 for extremely negative impacts, to +4 for extremely positive impacts). In this paper, we bundle the point values (or interval midpoints) for these ratings into three categories. Ratings below -2 are classed as "severe (negative) impacts"; ratings of -2 or greater, but less than zero, are classed as "moderate (negative) impacts"; and ratings of zero or more (no effects or even positive impacts) are the omitted category.[4]

The order for the five categories of climate change impacts is constant throughout the survey instrument for any one respondent, but it is randomized across respondents (except "equity", which is

[3] If a survey has just one format, it is impossible to know the extent of either proximal or distal order effects. Information order must be varied across questionnaires to address these problems.
[4] Appendix Figure 2 depicts one version of the survey screen which elicited subjective climate change impacts.

always last in the list).[5] This order does affect respondents' stated levels of concern about each impact and their expected severity of impacts. However, to avoid confusing our respondents, we used the identical order for this list in (a.) the preliminary questions about the individual's concern about these issues and in (b.) the display of these impacts in the main conjoint choice table which summarized the policy alternatives. Thus it is not possible to discriminate between *proximal* order effects stemming from the order of climate impacts in the choice sets and *distal* order effects due to the order of climate impacts when they are first discussed prior to the choice task.

Given that full randomization was implemented for the order of climate change impact categores, we will assume that the *average* WTP for climate change mitigation is *not* biased by order effects from this source. We will concentrate, in this paper, on three cases where uniquely *distal* order effects can potentially be identified, to be discussed in the following three sections.

2.1.1 Individuals' concerns about various global issues including climate change

Individuals' stated levels of concern about climate change could play an important role in their willingness to incur the costs of prevention. Respondents were asked to rate their personal priority levels for eleven randomly ordered issues likely to be of global concern.[6] These issues included preventing climate change, improving food safety, preventing wars, reducing poverty and hunger, etc. Across respondents, the order of these issues (from first through eleventh) is completely shuffled and broader or narrower sets of answer options are offered, so that across individuals, the survey takes a wide variety of different formats. In the most extensive format, individuals could choose their response from options that include "very high priority," "high priority," "moderate priority," "low priority," "not a priority at all" and "not sure." Other randomly assigned formats included four, or three, or just two answer options (combining the two "high" and two "low" categories, dropping the "moderate" category, or both).[7] For

[5] It seemed appropriate to address the four physical impacts of climate change first, and then how these disruptions would be distributed across the world's population. These subjective ratings are then inserted dynamically, later in the survey, to summarize expected conditions under the business-as-usual "status quo" policy option.

[6] Appendix Figure 1 shows one version of this screen. This was the first substantive question on the survey, designed to lead respondents to think about a wide variety of policy problems that might compete for resources.

[7] Across respondents, we also randomly varied the left-to-right order of these answer options. In this paper, we concentrate upon

this paper, therefore we construct a binary indicator variable called $1(high)$ to signify a response of either "very high priority" or "high priority." The omitted category is the union of all answers from "moderate priority" through "not sure." [8]

2.1.2 Attitudes toward various domestic payment vehicles

Respondents are asked to indicate the extent of their agreement with the responsibility of various domestic groups to bear the costs of climate change mitigation. Six groups are proposed, and listed in random order. These include and "individual taxpayers," "consumers," "energy users," "industry (investors)," "energy producers," and "government." In the most extensive format, responses could be any one of the following: "agree strongly," "agree," "neutral," "disagree," or "disagree strongly."[9] To accommodate the random variation across respondents in the number of answer categories offered, however, we again construct a binary indicator. The variable $1(agree)$ likewise aggregates "agree" and "strongly agree" on those occasions when two levels of agreement are available. Table 1 includes a panel which describes the proportions of respondents who agree that each of these six domestic groups have a responsibility to bear the costs of climate change mitigation.[10]

2.1.3 Attitudes toward international mitigation responsibility

Seven international country groups as possible payers were also proposed and randomly ordered. These include industrialized countries, the countries of the former Soviet Union, densely populated developing countries like India and China, the United States and its major trading partners, developing countries that are beginning to pollute heavily, smaller developing countries, and "countries in proportion to their contribution to the problem" (which is the way we articulate a "polluter pays" concept). Descriptive statistics for a $1(agree)$ indicator for each of these groups are also provided in Table 1.[11]

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the order of the topics, rather than the answer options.

[8] Appendix Table A.6 provides distributional data for the display order (position) of each issue and the proportion of respondents who select either "low priority" or "not a priority at all."

[9] A less-extensive answer format is depicted in Appendix Figure 3.

[10] A $1(disagree)$ indicator aggregates "disagree" and "strongly disagree" responses. See Appendix Table A.6.

[11] More details are available in Appendix Table A.6.

2.2 Policy Alternatives

A conjoint choice question about climate change mitigation policy is the main point of the survey. In split samples, either two or three climate change mitigation policy alternatives are proposed in a single conjoint choice scenario. When two alternative policies are proposed, these include just "Maximum Prevention" (which we call complete mitigation, CM) and Business-as-Usual (BAU).[12] When three alternative policies are proposed, these include CM, BAU and an intermediate policy of "Partial Prevention" (which we refer to as partial mitigation, PM).[13]

Complete mitigation (CM) is when climate change is essentially prevented, keeping the climate much as it is at the time of the survey. However substantial costs would be incurred for this policy. Under a business-as-usual (BAU) policy, the respondent's anticipated impacts will be realized, but no additional mitigation costs will be incurred (although adaptation to climate impacts may be necessary). Those respondents who are presented with three-alternative choice sets also see an intermediate partial mitigation (PM) option, where the business-as-usual climate change impacts are scaled back (but not eliminated, as they would be under complete mitigation) and the cost of the policy is lower than for complete mitigation.[14]

Under PM and CM, overall domestic prevention costs are randomized in terms of the expected costs that the respondent's household will have to pay, subject to the constraint that the cost for PM is always less than that for CM when the PM alternative is offered. Again, there is no mitigation cost incurred for BAU. Policy costs are therefore uncorrelated with any other policy attributes, including the respondent's anticipated BAU climate change impacts and any other respondent attributes.

In our conjoint choice scenarios, we also seek to convey to individuals a sense of the *initial incidence* of the costs of each climate change mitigation policy. We explain that policy costs could be felt in a variety of different ways, according to how the policy is implemented. Domestic costs are described

[12] An example of one such two-alternative choice set is shown in Appendix Figure 4.
[13] An example of a three-alternative choice set appears as Appendix Figure 5.
[14] These policies were arranged in two ways: BAU is either on the left or on the right. The left-to-right ordering of these policies has been shown not to affect voting decisions.

as being experienced through four different payment vehicles, including increases in "consumer prices," "income taxes," "energy taxes," and decreases in "investment returns." The cost shares described for each type of payment vehicle are randomized over the range of 10% to 70%, subject to an adding-up requirement. The order of the four payment vehicles in the choice scenario is also randomized, in a manner independent from the order of the six groups in the domestic responsibility question earlier in the survey. Thus, these policy attributes are also, by design, uncorrelated with any other program features or respondent characteristics.

The international costs of each climate change mitigation policy are described as being shared across four subsets of the world's countries: "US and Japan," "other industrialized countries," "India and China," and "other developing countries." Domestic costs are thus conveyed as one component of a more-or-less coordinated international climate policy. In any given policy scenario, each group of countries needs to bear a certain percentage of the global cost. International cost shares are also randomized over the range of 10% to 70%. The "US and Japan" group is always paired with "other industrialized countries" and the "India and China" group is always paired with "other developing countries." However, the order of these two pairs is randomized, independent from the order of the seven groups in the international responsibility question earlier in the survey. These cost shares are likewise uncorrelated with other policy attributes and respondents' characteristics.

3. Distal order effects on policy choices

In the online Appendix, we explore our data for evidence of proximal order effects on answers to the preliminary attitude questions. Why these order effects exist in the form that they do is of course a complex psychological question, somewhat outside the purview of economics.[15] In this section, we outline our basic random utility models for climate policy choices which permit us to examine how a researcher, through an arbitrary single ordering of distal preliminary attitudinal questions, might unwittingly affect people's policy choices and thus their estimated WTP amounts.

[15] A classic paper on proximal order effects (choices as a function of the order of the response options in a survey) is Krosnick and Alwin (1987).

Random utility models are the most common approach to utility-theoretic analysis of choice data. Our model in this paper is a simplified version of the more complex model employed in Cai, et al. (2010). Suppose respondent *i* sees all three alternative policies: CM, PM, and BAU.[16] This respondent's anticipated indirect utility under policy *j* (where *j*= CM, PM, or BAU) can be described generically as:

$$V_i^{*j}((Y_i - C_i^j), DC^j, IC^j, B_i^j, Program^j) \quad (1)$$

where $(Y_i - C_i^j)$ denotes the usual choice-specific net income variable (after any mitigation costs) that the respondent's household will enjoy under policy j. This captures expenditures on all other goods and services. The B_i^j term represents the benefits (i.e. the reduction in climate change impacts) provided by policy j from the perspective of respondent i. However, the simple net income variable in this case is augmented by two additional sets of distributional variables, DC^j and IC^j, associated with mitigation policy j. The variables DC_h^j (h=1, 2, 3 or 4) capture the choice scenario's stated initial incidence of domestic costs under policy *j* (measured by the stated domestic cost *shares* borne via each of a set of four different payment vehicles, so that $\sum_{h=1}^{4} DC_h^j = 1$). The variables IC_g^j (g=1, 2, 3 or 4) capture the international distribution of climate change mitigation costs (measured by the stated international cost *shares* borne by each of a set of four groups of countries, so that $\sum_{g=1}^{4} IC_g^j = 1$)[17]. The variables denoted by $Program^j$ include an alternative-specific dummy variable for the CM program, $1(CM^j)$, and one for the PM program ($1(PM^j)$, when it is offered). These indicator variables allow for individuals to derive a systematically higher or lower level of utility simply for choosing CM or PM, rather than BAU, regardless of the other specified attributes of either policy.

In Cai, et al. (2010), we allow a number of attitudinal variables to serve as shifters for the basic utility parameters in our model. Here, however, we will employ "reduced form" models where the

[16] Individuals who selected the "would not vote" option are excluded from our analysis.
[17] For each set of shares, only three of the four shares will be independent.

parameters of the indirect utility from climate change policies are allowed to vary directly with the position of relevant topics in the corresponding distal preamble question. With these systematically varying utility parameters given in square brackets, the expression for indirect utility under the complete mitigation alternative can be expressed as follows (where $1(CM^{CM})=1$ and $1(PM^{CM})=0$ in this case):

$$\begin{aligned} V_i^{*CM} &= \alpha_1(Y_i - C_i^{CM}) + \sum_{h=1}^{4}\left[\theta_{h0} + \sum_{m=1}^{6}\theta_{hm} POSITION\_m_i\right] DC_{hi}^{CM} \\ &+ \sum_{g=1}^{4}\left[\theta_{g0} + \sum_{n=1}^{7}\theta_{gn} POSITION\_n_i\right] IC_{gi}^{CM} + \beta_0 B_{1i}^{CM} \\ &+ \left[\beta_{10} + \beta_{11} POSITION\_p_i\right] 1(CM^{CM}) + \left[\beta_{20} + \beta_{21} POSITION\_p_i\right] 1(PM^{CM}) + \varepsilon_i^{CM} \end{aligned} \tag{2}$$

For the randomized domestic cost shares associated with complete mitigation, DC_{hi}^{CM}, the $POSITION\_m_i$ variables describe the ordering of the preliminary attitude questions concerning responsibility for climate change mitigation costs for each of m =1,..., 6 categories of domestic payers. For the randomized international cost shares specified, IC_{gi}^{CM}; the $POSITION\_n_i$ variables record the ordering of the preliminary attitude questions concerning responsibility over each of an expanded list of *n* = 1, 2, 3…7 international country groups. For the alternative-specific constants ($1(CM)$ and $1(PM)$), which capture the lump of indirect utility associated with either policy action regardless of its other explicit benefits, $POSITION\_p_i$ describes the ordering of global issues in the preliminary question concerning policy priorities p =1,…,11.

For the partial mitigation alternative, when it is offered, the indirect utility function is analogous to equation (2), with the appropriate change of superscripts, although it will now be the case that $1(CM^{PM})=0$ and $1(PM^{PM})=1$.

Finally, under the status quo alternative (BAU), the individual will bear no mitigation costs and in this case there will be no concerns about the distribution of these costs, either domestically or

internationally (although there will of course be some distribution of climate change impacts and adaptation costs if climate change is allowed to proceed). Thus we will have $C_i^{BAU} = 0$, and all of the climate change mitigation cost shares (implicitly interacted with a dummy variable for the presence of mitigation costs) will be zero. Likewise, there will be no benefits (i.e. no "impact reductions") so we will have $B_i^{BAU} = 0$ for the explicit benefits, and $1(PM_i^{BAU}) = 1(CM_i^{BAU}) = 0$ for the alternative-specific dummy variables that we use to capture the implicit benefits of each policy alternative. Only the income term remains relevant, so that

$$V_i^{*BAU} = \alpha_1(Y_i) + \varepsilon_i^{BAU} \tag{3}$$

For random utility models (RUMs), it is customary to assume that the indirect utility *difference*, relative to a numeraire alternative (here, the BAU alternative) drives a respondent's choice among the available alternatives. In our context, there are two such utility differences. The first is for complete mitigation versus business-as-usual, where $1(CM^j) = 1$ and $1(PM^j) = 0$ have been imposed in following equation:

$$\begin{aligned}
\Delta V_i^{*CM} &= \left(V_i^{*CM} - V_i^{*BAU}\right) \\
&= \alpha_1(-C_i^{CM}) + \sum_{h=1}^{4}\left[\theta_{h0} + \sum_{m=1}^{6}\theta_{hm} POSITION_m_i\right] DC_{hi}^{CM} \\
&+ \sum_{g=1}^{4}\left[\theta_{g0} + \sum_{n=1}^{7}\theta_{gn} POSITION_n_i\right] IC_{gi}^{CM} + \beta_0 B_{1i}^{CM} \\
&+ \left[\beta_{10} + \beta_{11} POSITION_p_i\right](1) + \left(\varepsilon_i^{CM} - \varepsilon_i^{BAU}\right)
\end{aligned} \tag{4}$$

There will be an analogous indirect utility-difference for the partial mitigation alternative, where $1(CM^{PM}) = 0$ and $1(PM^{PM}) = 1$ and the appropriate substitution is made for the last substantive term in the formula. For the business-as-usual (numeraire) alternative, of course, this indirect utility-difference is simply zero.

We use a conditional logit model to estimate the basic marginal utility parameters for this model, along with the key coefficients in the systematically varying parameters enclosed in square brackets in

equation (4) that identify the distal order effects that are the focus of this paper (i.e. θ_{hm}, θ_{gn}, and β_{11}). If any of these key parameters is non-zero, then there are distal order effects in these data. Variations across individuals, and across alternatives for each individual, in the variables in equation (4) (and its analog for the partial mitigation alternative) permit the marginal utility parameters and shift coefficients to be estimated. The systematic portions of the indirect utility functions in these two expressions are commonly known as the "index" for the discrete choice problem, where the value of the index for the numeraire alternative is zero.

We can represent the systematic portions of these indirect utility-differences generically as $\gamma' W_i^j$, since they are linear-in-parameters. Then the conditional logit probabilities associated with choosing each alternative, in the three-alternative context, can be expressed as:

$$
\begin{aligned}
P_i^{CM} &= \frac{\exp(\gamma' W_i^{CM})}{\exp(\gamma' W_i^{CM}) + \exp(\gamma' W_i^{PM}) + 1} \\
P_i^{PM} &= \frac{\exp(\gamma' W_i^{PM})}{\exp(\gamma' W_i^{CM}) + \exp(\gamma' W_i^{PM}) + 1} \\
P_i^{BAU} &= \frac{1}{\exp(\gamma' W_i^{CM}) + \exp(\gamma' W_i^{PM}) + 1}
\end{aligned}
\tag{5}
$$

The log-likelihood function to be maximized with respect to the unknown parameters is then

$$
\log \mathrm{L} = \sum_{i=1}^{N} \left[y_i^{CM} \log(P_i^{CM}) + y_i^{PM} \log(P_i^{PM}) + y_i^{BAU} \log(P_i^{BAU}) \right] \tag{6}
$$

Where the y_i^j indicators take on the value of 1 if alternative j is chosen and zero otherwise.

4. Estimation Results

On the substantive question of heterogeneity in willingness to pay for climate change mitigation across this sample of mostly college students at a wide range of institutions throughout North America, the reader is referred to Cai, et al. (2010). Here, we focus attention specifically upon the issue of distal order effects. Thus we will discuss only the framework for estimation and the key parameter estimates

and refer the reader to Cai, et al. (2010) for a detailed discussion of a richer model, including the empirical distribution of fitted WTP amounts for specified climate mitigation policies and particular categories of respondents.

In the most general possible model, the potential benefit of each policy (B_i) would include all five available categories of anticipated impacts, including Agriculture&Water, Oceans&Weather, HumanHealth, Ecosystems, and Equity. In our data, however, respondents' anticipated impacts upon HumanHealth and Oceans&Weather are distributed very differently from the other three categories. Nearly 70% of respondents rated these two categories at -4, and these effects were rated each as "severe" (i.e. either -3 or -4) by 99% of respondents. With negligible independent variation in these two types of impacts, it is not possible to estimate marginal utilities, so we will not attempt to estimate distinct marginal utilities associated with avoided HumanHealth or Oceans&Weather impacts. These benefits will be subsumed by the estimated coefficients on the alternative-specific indicators $1(CM)$ and $1(PM)$.

In the body of this paper, we focus on our results for models which feature the Agriculture&Water impacts.[18] These estimation results are reported in Table 2. Model 1 in Table 2 reflects the set of variables that have been found to bear statistically significant coefficients in Cai, et al. (2010) or in other specifications explored for this paper which feature other types of climate impacts. Not all of the coefficients are individually statistically significant. Thus, in Model 2, we display results for a parsimonious specification. The variable "program cost" has an estimated coefficient that is negative and significant across specifications, which indicates that people derive a lower utility from a policy that involves higher household costs. This is consistent with our expectations. With respect to domestic cost shares, there are three statistically significant coefficients on interaction terms which allow the effects of some of the cost share variables to differ systematically with the position of different "responsibility" groups in the preliminary attitude elicitation questions. These are the key variables, the coefficients upon

[18] Agriculture&Water, Ecosystems and Equity impacts display considerable variability across people, but are highly correlated. Thus we rotate through a set of models where we "feature" just one of these three categories of impacts, recognizing that each of them, used alone, will also proxy to some extent for the others and any constant baseline will be absorbed by the alternative-specific indicators for complete and partial mitigation.

which (i.e. the θ_{hm}) capture the significant impacts of question orderings on the estimated marginal utility associated with different climate policy attributes. They are highlighted by the symbol "►" in Table 2.[19,20]

If the order of an issue or a group in the preliminary attitudinal questions has no effect on choices, we would expect these key interaction terms to have coefficients equal to zero. Obviously, this is not always the case. The coefficients on the interaction terms between the cost share paid through "increased income taxes" and the position of (a.) "individual taxpayers and (b.) "energy producers" both bear negative signs. This suggests that people derive greater utility from a policy that involves a greater share of the cost being borne through income taxes when "individual taxpayers" and/or "energy producers" are positioned earlier on the list of preliminary questions about who should bear the costs of climate change mitigation.

Likewise, the coefficient on the cost share paid through "decreased investment returns" interacted with the position of "industry (investors)" is statistically significant and bears a negative sign. This indicates that if a person saw "industry (investors)" in an earlier position on the list when attitudes were elicited about responsibility for the domestic costs of climate change mitigation, then he/she would have a higher utility from a climate change mitigation policy where more of the domestic costs are borne as "decreased investment returns."

The models for proximal order effects in the preliminary attitudinal questions in Appendix Table A.4 suggest possible reasons for distal effects such as these. For example, a higher placement of "industry (investors)" on the list in the preliminary questions (i.e. a *lower* position number for this group) seems to make respondents statistically significantly more likely to "agree" that industry should bear the cost. Cai, et al. (2010) shows if someone "agrees" that industry should bear the cost, he/she would have a higher utility from a policy wherein a higher share of the cost is paid through decreased investment returns. Thus,

[19] Appendix Table A.7 repeats the results shown in Table 2 alongside analogous results for Model 3 (which features the Ecosystem impacts), and Model 4 (which features the Equity impacts of climate change).
[20] For cost shares and their shifters, of course, we initially estimated full specifications which incorporated a very large set of position-based interaction terms. Persistently insignificant terms are dropped.

the negative sign associated with this term suggests order effects from earlier tasks can carry over to affect peoples' policy preferences in a later choice problem on the survey.

We note that the international distribution of climate change mitigation costs does not appear to have any statistically significant effect on policy choices in this rather simple specification for policy preferences. In Cai, et al. (2010), there is limited evidence that the share borne by the US and Japan, and by India and China may matter, but only for subsets of the sample. Without differentiating these subsets, the effects are not discernible, and distal order effects turn out to be difficult to identify as well.

Turning to the "Benefits" category of variables in Table 2, we find that the position of "Preventing climate change" in the early question about global policy priorities has no statistically significant order effect on the coefficient on the indicator variables for moderate or severe climate change impacts.

For the "Program type" indicator variables, the coefficient on the interaction term between the $1(CM^j)$ indicator and the order of climate change as a potential global policy problem fails to suggest a statistically significant order effect. There is likewise no robust effect implied by the interaction between $1(PM^j)$ and this order variable. The point estimates of these coefficients, however, do display the anticipated signs. If anything, a later position of the climate change issue in the list of global policy problems may be associated with a lower increment of autonomous utility attached to each of the climate change policies that involve mitigation (conveyed by the coefficients on the $1(CM)$ and $1(PM)$ variables). However, the effect never quite attains statistical significance, even at the 10% level. These global policy problems were presented at the very beginning of the survey, far in advance of the policy choice question. Thus respondents may have recovered from any temporary influence of ordering by the time the policy voting questions were presented near the end of the survey. Since these terms do not suggest significant order effects, they are dropped to produce our parsimonious Model 2.[21]

[21] An anonymous referee has suggested that since the climate change problem received the lowest average rating across the various global policy problems that perhaps it was not perceived as being important enough to excite order effects.

5. Simulated WTP bias due to order effects

Willingness to pay estimates for the complete mitigation scenario are calculated by setting to zero the utility-difference in equation (4) and solving for the value of C_i^{CM} which makes the equality true. For *any given set* of policy attributes and ordering variables, WTP can be calculated as a function of the vector of estimated utility parameters, which are assumed to be distributed asymptotically joint normal, since they are estimated by maximum likelihood. One method for summarizing the precision of the parameter estimates as they influence the resulting WTP estimate is to make 1000 random draws from the joint distribution of the parameters, using the point estimates and the parameter variance-covariance matrix. For each set of parameters, WTP can be calculated and a distribution of WTP estimates can be built up. We use this strategy here.

This paper does not seek to establish the population average of WTP for climate change mitigation. For those results, the reader is referred to Cai, et al. (2010). Here, we pick a single type of individual and a single type of climate policy to illustrate the potential magnitude of distal order effects. Based on the conditional logit estimates for Model 2 in Table 2, for someone who saw only the "complete mitigation" and "business-as-usual" alternatives, we simulate WTP amounts for a complete mitigation policy to prevent moderate impacts on Agriculture&Water, for a case where costs are arbitrarily assumed to be equally distributed among each of the four domestic payment vehicles.[22] Model 2 suggests that later placement of "industry," "energy producers," and " taxpayers" tends to decrease the utility derived from the specified climate change policy. Simulations 1 and 2 in Table 3 differ only in their orderings in the prior attitude elicitation questions which seem to influence stated preferences in the policy choice task. In Simulation 1, for a policy which prevents moderate climate impacts on Agriculture&Water, we specify a case where "individual taxpayers," "energy producers," and "industry" have been placed at the top of the domestic payer list in the preliminary attitude elicitation question (in positions 1, 2, and 3 respectively). In Simulation 2, we specify that "individual taxpayers," "energy producers," and "industry" appear at the

[22] Model 2 drops the international cost distribution variables, so the international shares are moot in this case.

bottom of the domestic payer list (in positions 4, 5, and 6 respectively).[23]

The medians of the simulated WTP distributions under each of these two alternative orderings in the domestic responsibility questions are displayed at the foot of Table 3. These imply that across these two extreme orderings, the median of the WTP distribution could differ by nearly $300 per month.[24] Recall that these arbitrary ordering decisions come into play well prior to the survey's policy choice question. Had we *not* taken care to randomize the order of appearance of these different groups at that point, it is possible that we could have unknowingly produced either the higher or the lower estimate for WTP and been none the wiser. Given that the larger number is 100% bigger than the smaller one, these seemingly innocuous survey design decisions could have had a substantial impact on the valuation results and therefore potentially upon benefit-cost analyses which might use these results. The arrangement of topics during attitude elicitation could of course be an unintentional effect, or it could be strategic, which is even more worrisome.[25]

6. Conclusion

This study reveals that there can be statistically significant *distal* order effects stemming from arbitrary researcher decisions about the presentation of preliminary information or questions in a stated preference survey. We demonstrate the potential magnitude of these distal order effects on the simulated distribution of WTP in the case of a stated preference survey designed to elicit preferences for climate change mitigation policies. Arbitrary researcher decisions about the ordering of information may inadvertently alter people's opinions or attitudes toward some attributes of the good, either temporarily or permanently, and therefore influence their responses to valuation questions. In this study, we obtain results which suggest that if the researcher arranges a set of prior attitude-elicitation questions strategically in two

[23] In Figure 6 in the online Appendix, we illustrate with a simple histogram the full range of WTP amounts calculated from the same set of parameter point estimates as we rotate through all 120 possible permutations of the order of these three groups of domestic payers among the six possible positions. Monthly policy costs for the "complete mitigation" program quoted to respondents in the survey instrument averaged $260/month (with a standard deviation of $138).

[24] Real policies may accomplish less than complete mitigation and would therefore also cost less. The WTP estimates for the complete mitigation program are not out of line with the estimates obtained in Cai, et al. (2010), in Viscusi and Zeckhauser (2006), or in a companion general population survey analyzed by Lee and Cameron (2008).

[25] We also consider (in Appendix Table A.8) another pair of scenarios. All settings for simulations 3 and 4 are the same as for simulations 1 and 2, except the expected avoided climate change impacts on Agriculture&Water are specified as "severe." The main order effects are associated only with the cost share variables, so implied WTP differs by about $300 in this case as well.

questionnaires, the simulated WTP amounts for complete prevention of moderate climate change impacts could, in the extreme, differ by as much as $300 per month (almost 100%). A distortion of this magnitude could make a real difference to the policy prescriptions drawn from a benefit-cost analysis which employed these data.

More than fifteen years ago, Boyle, et al. (1993) noted the existence of an order effect of this type. In the intervening years, however, few survey researchers have taken to heart the importance of employing as much randomization as possible throughout a survey to preclude systematic effects that may result from any single aspect of their survey design. Randomization has, of course, become dramatically easier as we move toward online survey instruments, or even when we create unique mail survey instruments for each individual respondent by using "mailmerge"-type methods. There is little excuse for failure to inoculate one's survey against distal order effects by diligent randomization of as many aspects of a survey as possible.

It is of course sobering that stated preference estimates of WTP can potentially be influenced to this extent by arbitrary contextual clues throughout a survey. As most stated preference researchers concede, not all preferences for non-market goods can be viewed as being well-formed or "crystallized." It is important to know whether preferences are being induced by a survey's format to crystallize systematically in one way rather than another.

To conclude, this paper illustrates the potential magnitude of distal order effects in a non-market valuation survey. It also supports our contention that future stated preference survey researchers should strive to randomize the information presented in *all* sections of the survey questionnaire, not just those containing the key choice scenarios. Randomization prevents any single ordering decision from influencing the empirical findings from a survey study without detection. The use of extensive randomization will also permit ex post analyses to increase our understanding of the extent of distal order effects and their potential to distort welfare analyses.

Table 1. Descriptive statistics for responses to preliminary questions; randomly assigned list positions of issues or groups across respondents; voting choices (n=1850 individuals)

Society cannot afford to fix all policy problems, so we have to decide upon priorities. What are your personal relative priorities?	Proportion 1(high)[a]
Preventing climate change	0.453
Reducing poverty and hunger	0.668
Improving education	0.817
Reducing violent crime	0.681
Protecting endangered species	0.549
Reducing nuclear threats	0.551
Improving food safety	0.478
Improving health	0.707
Reducing race/ethnic tensions	0.547
Cleaning up the environment	0.747
Preventing wars	0.622
In your own country, responsibility for prevention costs should belong to:	1(agree) [a]
Consumers	0.688
Industry (investors)	0.849
Individual taxpayers	0.432
Energy users	0.810
Energy producers	0.863
Government	0.799
Internationally, responsibility for prevention costs should belong to:	1(agree) [a]
Countries in proportion to their contribution to the problem	0.881
Industrialized countries, regardless of their responsibility	0.582
The United States and its major trading partners	0.747
Developing countries that are beginning to pollute heavily	0.763
Densely populated developing countries, like India and China	0.597
The countries of former Soviet Union	0.431
Smaller developing countries	0.278
If these were the ONLY policy alternatives, what would be your choice? I would vote for:	1(yes)
Business-as-usual (BAU)	0.275
Partial prevention (PM, if offered)	0.219
Maximum prevention (CM)	0.506

Table 2. Conditional logit models to explain policy preferences: evidence of effects on preference parameters from order of presentation of prior information; symbol "►" denotes an order-related interaction term

	Model 1	Model 2
Cost-related variables:		
Program cost	-0.145	-0.144
	(4.41)***	(4.38)***
Domestic cost shares:		
Increased income taxes	1.368	1.449
	(2.09)**	(2.29)**
► … ×position of "individual taxpayers"	-0.238	-0.237
	(2.30)**	(2.29)**
► ... ×position of "energy producers"	-0.223	-0.216
	(2.22)**	(2.15)**
Decreased investment returns	0.785	0.888
	(1.58)	(1.89)*
► ... ×position of "industry"	-0.185	-0.181
	(1.85)*	(1.81)*
Increased energy taxes	-0.214	-
	(0.66)	
International cost shares:		
US and Japan	0.315	-
	(1.12)	
India and China	0.013	-
	(0.05)	
Benefits (avoided impacts)		
1(moderate Agriculture&Water impacts)[a]	0.319	0.324
	(2.39)**	(2.43)**
1(severe Agriculture&Water impacts)	0.890	0.890
	(5.76)***	(5.77)***
Program type and elicitation format		
1(*PM*) (partial mitigation)	2.210	2.034
	(7.17)***	(11.04)***
► ... ×position of "climate change" in list of issues	-0.027	-
	(0.97)	
1(*CM*) (complete mitigation)	0.702	0.533
	(2.42)**	(2.75)***
► … ×position of "climate change" in list of issues	-0.026	-
	(1.44)	
… ×1(saw partial mitigation alternative)	0.616	0.613
	(3.96)***	(3.95)***
Number of alternatives	4377	4377
Number of two-way choices; three-way choices	677, 1173	677, 1173
Number of individuals	1850	1850

Absolute value of z statistics in parentheses ***significant at 10%; **5%; ***1%

[a] Ratings of climate change impacts are grouped for this analysis. 1(Severe) implies a substantial negative impact; 1(moderate) implies a moderate negative impact; the omitted category is interpreted as neutral or positive impact

Table 3. Simulated WTP (last row: median, 5th, 95th percentiles) for complete mitigation, based on 1000 random draws from the asymptotically normal joint distribution of the parameter estimates based on Model 4

	Settings for Simulation 1	Settings for Simulation 2
Cost shares, shifters:		
Domestic cost shares:		
Borne as increased income taxes	0.25	0.25
► …×position of "individual taxpayers"	1	4
► ...×position of "energy producers"	2	5
Borne as decreased investment returns	0.25	0.25
► …×position of "industry (investors)"	3	6
Borne as increased energy taxes	0.25	0.25
Benefits (avoided impacts)		
1(moderate Agriculture&Water impacts)	1	1
1(severe Agriculture&Water impacts)	0	0
Program type and elicitation format		
Partial mitigation	0	0
Complete mitigation	1	1
…×1(saw partial mitigation)	0	0
Willingness to pay (WTP)	$639 [506, 888]	$365[a] [259, 502]

[a] Median monthly household income in sample is approximately $5208

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