Preference uncertainty in stated choice experiments

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English Summary

This thesis addressed the extent to which individuals are willing to pay for public safety programs reducing flood risks in the Netherlands. Our interest was not so much in the actual level of willingness-to-pay, but more in the development of discrete choice models to take into account the impact of preference uncertainty, and related preference dynamics in response patterns across respondents and over the course of a stated choice experiment. This thesis addresses three related research questions having the following topics: i) heterogeneity in response patterns across respondents, ii) changes in response patterns during the course of the stated choice experiment, and iii) the use of follow-up questions to measure preference uncertainty. The developed choice models can improve the validity of derived willingness-to-pay estimates in cases where respondents are likely to experience a certain degree of preference uncertainty. The methodological contributions of this thesis are applicable in all research areas relying on the use of stated choice experiments, in particular those where respondents are presented with alternatives with which they are unfamiliar or lack experience.

Valuation of flood risks and preference uncertainty

Climate change is expected to result in a rise of sea levels, which will increase flood probabilities in the Netherlands. Existing flood defence mechanisms need to be adjusted to these changing circumstances, but the economic viability of such investments relies on the balance between the associated costs and benefits. From a theoretical perspective, as discussed in Chapter 2, stated choice experiments form a suitable tool to elicit individual willingness-to-pay estimates for public safety programs (or alternative non-market goods and services) as long as respondents know their preferences.

Stated choice experiments assume that people take their personal safety into account when making various decisions, including flood risk safety. As such, people may be inclined to spend more on a house that is less exposed to flood risks than a house with similar characteristics, but which is located in a flood prone area. By presenting respondents a set of hypothetical choices regarding their exposure to flood risks and the associated costs, researchers are able to derive the extent to which a respondent is willing to make a trade-off between safety and income. The complexity of natural hazards and the frequency at which they occur are, however, likely to be associated with aspects of ‘unfamiliarity’ and ‘limited experience’ at the level of the respondent. These aspects are not necessarily related to the properties of the natural hazards, but also to the related trade-offs between safety and income presented to respondents. Consequently, respondents may experience preference uncertainty

about appropriate risk reducing policies when being interviewed in a stated choice experiment, or when making actual trade-offs in real-world markets. More specifically, the public good nature of flood risk protection in the Netherlands can be an additional source of preference uncertainty. The degree of preference uncertainty may vary across respondents and different respondents find different ways to deal with such preference uncertainties. Therefore, this thesis analysed the impact of preference uncertainty and more general, heterogeneity in response patterns across respondents and over the choice sequence on willingness-to-pay estimates.

In Chapter 3, the concept of preference uncertainty was defined and put in the context of stated choice experiments. In stated choice experiments respondents are requested to identify the best alternative from a limited set of alternatives, which differ in terms of various characteristics (or attributes). By simultaneously making trade-offs between attributes and alternatives, preference uncertainty may also arise at both levels. As such, two complementary forms of preference uncertainty were defined, but Chapter 3 also highlighted that the empirical identification of these separate forms of preference uncertainty is hampered by the limited informational content of discrete choice type data. The empirical part of this thesis (Chapters 5-7) therefore focused on the identification of dynamics in preference and scale parameters in general and puts those into the perspective of preference uncertainty, but alternative causes of these dynamics may exist. Chapter 3 therefore also provided an extensive overview of the current state of the empirical literature and models accounting for the impact of preference uncertainty and related preference dynamics (mainly in the scale parameter) on marginal WTP estimates. This formed the basis for the development of the proposed local multinomial logit model in Chapter 6 and combining the implicit and explicit measurement of preference uncertainty in the hybrid choice model in Chapter 7.

The discrete choice experiment

The characteristics and development of the stated choice experiment and survey in general are described in detail in Chapter 4. Approximately 1,000 inhabitants of dike rings 13 and 14, situated in the provinces of North and South Holland, filled out an internet survey. The stated choice experiment embedded in the survey presented respondents with ten choice tasks each. Within each choice task two alternative public plans were presented to reduce exposure to flood risks relative to the Status Quo option. The plans varied in terms of the following four attributes: i) the probability of flooding, ii) financial compensation in case of a flood , iii) available evacuation time, and iv) an increase in the annual household tax paid to the local

water board. The respondents were requested to select the best alternative in each choice task. The Status Quo option represented the case that the current flood defence mechanisms were sufficient. Hence, there would be no increase in the tax.

We deliberately chose an area characterized by low probability – high impact flood risks where respondents are likely to experience preference uncertainty. The careful development and testing of risk communication measures helped in bringing about the required information to respondents, but is unlikely to have entirely eliminated respondents' preference uncertainty entirely. Preference uncertainty is measured in two ways in this thesis. First, preference uncertainty is elicited implicitly from the choices made by the respondents. Second, a sub-sample was presented with a follow-up question after each choice task. The follow-up question asked respondents to indicate their degree of choice certainty. In total four alternative versions of the survey were launched varying in the underlying experimental design in order to be able to answer the research questions described in Chapter 1.

Preference heterogeneity across respondents

Chapter 5 covers the first research question, which takes a broader perspective than just preference uncertainty. The chapter focuses on alternative ways to control for differences in response patterns across respondents, possible caused by preference uncertainty. The Mixed Multinomial Logit (MMNL) model is at the core of the analysis here being the most popular econometric method in the discrete choice literature to account for preference heterogeneity. In this type of models, probability density functions (or mixing densities) are used to control for the fact that not everybody has the same preferences over the attributes included in the choice experiment. In determining the shape of the mixing density, trade-offs need to be made between flexibility in shape, ease of estimation and behavioural implications. For example, it is not expected that respondents have positive preferences for paying additional taxes given that no reductions in flood risks are achieved. Increasing the flexibility of the mixing density and imposing behavioural restrictions, however, increases the complexity of estimation and frequently researchers experience identification issues in estimating these types of model specifications. In this thesis a new mixing density is applied, the asymmetric triangular distribution. Its properties can overcome the drawbacks of more common distributions by having a bounded support and ability to control for skewed distribution of marginal WTP over the population of interest. As such, the proposed distribution is flexible in its form, results in behaviourally relevant marginal WTP estimates and only slightly increases the complexity of estimation, particularly in a Bayesian framework. Moreover, Bayesian estimation methods

facilitate model comparison with model specification using more common mixing densities like the normal and lognormal distribution.

The empirical analysis in Chapter 5 showed that most mixing densities, including the asymmetric triangular distribution, have problems in approximating the true distribution of preferences over the sample of interest. A more in depth analysis using Latent Class (LC) modelling revealed that not all respondents take all policy attributes, including the cost of the policy alternative, into account when making decisions. Consequently, some respondents either have a zero marginal WTP for a specific attribute while for others marginal WTP approaches infinity. It is this aspect of behaviour that lies at the heart of the observed shape inconsistencies in our case study. The properties of the lognormal distribution can best accommodate these aspects of behaviour. Nevertheless, the asymmetric triangular distribution reveals an improvement in fit over the normal distribution. The empirical benefits of the new mixing density, however, appear to be limited from our analysis. Overall, Chapter 5 shows that heterogeneity in response patterns across respondents is important and should be taken into account. Researchers therefore need to carefully select the shape of the mixing density when applying the MMNL model. Not unexpectedly, the alternative properties of the used mixing densities have a substantial impact on marginal WTP estimates derived through the MMNL model. Appropriate selection of the mixing density is therefore quintessential to derive valid and reliable marginal WTP estimates.

Preference Dynamics

Chapter 6 addressed preference dynamics over the choice sequence. Preference dynamics imply that response patterns vary over the choice sequence, which the researcher observes by obtaining variations in preference and (or) scale parameters. The discovered preference hypothesis and the theory of coherent arbitrariness attribute such dynamics respectively to aspects of institutional and value learning, and an internal drive for consistency. In Chapter 6, two alternative theories on preference dynamics are contrasted, namely the Discovered Preference Hypothesis and the theory of Coherent Arbitrariness. Both theories predict that at the start of the choice sequence individual preferences are ill-defined, but that by the end of the choice sequence these preferences have (gradually) evolved and stabilize at a specific level. This process and therefore the stable solution, however, vary between the two theories.

In the empirical application, an attempt was made to induce a starting point bias using a split sample approach. By anchoring two groups of respondents on respectively high and low price levels for exactly the same policies in the initial choice task, we contrasted the

predictions of the discovered preference hypothesis and theory of coherent arbitrariness. First, Chapter 6 reduces the standard errors, i.e. increases efficiency, of choice task specific parameter estimates by improving the experimental design. Second, Chapter 6 argues that the most commonly applied econometric test to identify preference dynamics, i.e. the Swait and Louviere (1993) test procedure, has its limitations in testing for what we label as within and between sample preference dynamics. Its main drawback is that the obtained parameter estimates may be subject to under- and over-smoothing. That is, the Swait and Louviere (1993) test procedure either fully combines choice task specific models or analyzes them in a separate fashion, thereby neglecting that preferences may evolve gradually over the choice sequence. To this end, Chapter 6 proposes a semi-parametric model, labelled as the Local Multinomial Logit (L-MNL) model, which does take into account these possible and gradual changes in preferences by smoothing parameter estimates. In fact, the model provides an intermediate solution to fully combining responses to different choice tasks or analysing them in a completely independent fashion. As such, efficiency of choice task specific preference parameters increases on average by 54% in our case study. Overall, the results show that the initial choice task has an impact on responses to the remaining choice tasks, but this effect diminishes after a couple of choice tasks. Preference dynamics are only observed to a limited extent and by the end of the choice sequence both versions of the experiment result in comparable WTP estimates. These findings are in line with the discovered preference hypothesis and highlight that controlling for heterogeneity in preferences across respondents appears to be more important than controlling for preference dynamics over the choice sequence by individual respondents.

Implicit and explicit measurement of preference uncertainty

The limit presence of preference dynamics over the choice sequence, as identified in Chapter 6, allows us to control for the impact of preference uncertainty. Chapter 7 measures preference uncertainty in two ways. First, implicit variations in the scale parameter underlying the Random Utility Model are expected because more uncertain respondent are assumed to make more random decisions, resulting in higher variances of the utility function. Uncertain respondents therefore have a larger probability of making inconsistent decisions. The second method, explicitly asks respondents after each choice task to indicate their degree of choice certainty. Chapter 7 analyses whether the information obtained through these follow-up questions can be used to control for the impact of preference uncertainty on response patterns and therefore improve the reliability of WTP estimates.

Thus far, treatment of self-reported choice certainty responses in stated choice experiments has been limited from a methodological perspective. First, existing approaches fail to make the connection that choices in the experiment and responses to the follow-up question are both possibly affected by preference uncertainty. Second, several papers have interpreted self-reported choice certainty as a direct measure of preference uncertainty. Without controlling for possible measurement errors they have directly incorporated responses to the follow-up questions in the discrete choice model. The latter may also be associated with endogeneity bias, since choice certainty is likely to be correlated with other un-modelled factors that enter in the random component of the utility function. Chapter 7 takes both shortcomings into account by developing a hybrid choice model in which latent preference (un)certainty simultaneously affects the decision in the choice task and the response to the follow-up question. Results show that a correlation exists between the implicit and explicit measurement of preference uncertainty. Respondents who reveal a higher scale parameter also state they are more certain about their choices in the follow-up questions. Moreover, preference uncertainty is increasing in the complexity of the choice task. However, we do not find an improvement in model fit when accounting for preference uncertainty in the choice model using the proposed hybrid simultaneous choice model. Most important, marginal WTP estimates are not affected by preference uncertainty when modelling the impact of preference uncertainty either through the scale parameter or by accounting for alternative choice heuristics. Our results do indicate that the responses to the choice model may help in better explaining responses to the follow-up questions. This suggests that a sequential modelling approach is more appropriate, but even in this case the use of a hybrid sequential modelling approach does not result in an improvement in model fit compared to existing approaches. Given the complexity of the model structure, we therefore conclude that responses to the choice model and follow-up questions can best be analysed in an independent fashion or two-stage model.

Recommendations

Relative to controlling for preference heterogeneity, the topic of preference dynamics has received limited attention in the discrete choice literature. This thesis has made a contribution to this literature by improving the empirical identification of preference dynamics and offers opportunities for other researchers to analyse this topic in more detail and verify our results. The results of the stated choice experiment show that response patterns are not likely to be subject to preference dynamics over the choice sequence.

The absence of preference dynamics does not imply that preference uncertainty has no impact on individual response patterns. Respondents can still adopt alternative (or simplifying) choice heuristics and these heuristics may differ across respondents. Identification of such heterogeneity in response patterns was covered in Chapter 5 and remains an important topic for future research. However, explanations for the observed heterogeneity across respondents need to get back on the research agenda as well. Preference uncertainty can be one of the explaining factors and its explicit measurement through follow-up questions a possible way of operationalizing this.

Finally, policy makers and researchers should take preference uncertainty into account in stated choice experiments. In designing surveys, researchers can adjust the informational content and visual presentation to meet the needs of individual respondents to overcome preference uncertainty to a certain extent. Pre-test stages and group discussions can be important sources of information in this process. Policy makers need to use information about preference uncertainty, possibly embedded in follow-up questions, in evaluating the extent to which a particular choice experiment can be used to derive valid welfare measures and can therefore be used as inputs for cost-benefit analyses.