University of Warsaw
Faculty of Economic Sciences

Working Papers
No. 1/2018 (260)

Disentangling the effects of policy and payment consequentiality and risk attitudes on stated preferences

Ewa Zawojska
Anna Bartczak
Mikołaj Czajkowski

Warsaw 2018

UNIVERSITY OF WARSAW
FACULTY OF ECONOMIC SCIENCES
WORKING PAPERS

Disentangling the effects of policy and payment consequentiality and risk attitudes on stated preferences

Ewa Zawojska*, Anna Bartczak, Mikołaj Czajkowski

Faculty of Economic Sciences (Warsaw Ecological Economics Center), University of Warsaw
**Corresponding author: ezawojska@wne.uw.edu.pl*

Abstract: Incentivising respondents to truthfully reveal their preferences in stated preference surveys requires that they believe their survey responses can influence decisions related to the outcome in question (policy consequentiality) and that they will have to bear their share of coercive cost if the outcome is implemented (payment consequentiality). We investigate the effects of these two aspects of consequentiality on stated preferences in a field survey concerning renewable energy development in Poland. We find that beliefs in policy and payment consequentiality strengthen respondents' interest in having the project implemented, but policy consequentiality decreases, while payment consequentiality increases their sensitivity to the project cost, thus increasing or decreasing their willingness to pay, respectively. We conclude that the two components of consequentiality should be addressed separately in stated preference studies. Additionally, we inquire the theoretically speculated links between respondents' perceptions about policy and payment consequentiality and their risk attitudes, finding no significant relationship.

Keywords: stated preferences, discrete choice experiment, policy consequentiality, payment consequentiality, risk attitudes, renewable energy

JEL codes: Q51, Q48, D12, D81, H41

Acknowledgments: This study was carried out within the project "Valuation, fairness aspects and preferences for renewable energy sources and their location in Poland and Germany" financed by the National Science Centre in Poland (Opus 5, 2013/09/B/HS4/01493). It was also supported by the National Science Centre in Poland under the project "Importance of incentive compatibility in contingent valuation research" (Preludium 8, 2014/15/N/HS4/01328). EZ obtained funding within a doctoral stipend granted by the National Science Centre in Poland (Etiuda 4, 2016/20/T/HS4/00013). We gratefully acknowledge the support of the National Science Centre, Poland (Opus 13, project no. 2017/25/B/HS4/01076). We are grateful to Jürgen Meyerhoff from Technical University of Berlin, Germany, with whom the survey presented in this paper was jointly designed. The authors wish to thank the participants of the 2017 Summer Conference of the Association of Environmental and Resource Economists and the participants of the 19th Annual Colorado University Environmental and Resource Economics Workshop for many helpful comments.

https://doi.org.10.26405/WP/WNE/2018/260/001

1. Introduction

Designing stated preference surveys so that they are incentive compatible (that is, for rational respondents, they provide a single dominant strategy to their reveal preferences truthfully; Carson and Groves 2007) is becoming a widely suggested practice in the literature. It constitutes one of the state-of-the-art recommendations for stated preference research (Johnston et al. 2017), and has been empirically shown to improve the validity of value estimates derived from stated preference surveys, hence, pointing to the robustness of implied preference and willingness-to-pay measures when incentive compatibility of a survey is assured (Zawojska and Czajkowski 2017). Making a stated preference survey incentive compatible means satisfying a set of conditions. Out of them, the one that is presumably the least arguable is a survey consequentiality. The recent guidelines for stated preference research (Johnston et al. 2017) define consequentiality as consisting of two elements: a nonzero probability, as faced or perceived by respondents, that their responses will influence decisions related to the outcome in question (henceforth referred to as "policy consequentiality") and a nonzero probability that respondents will have to pay for that outcome if it is implemented (henceforth "payment consequentiality"). Despite broad empirical evidence on the important role of consequentiality for truthful preference elicitation, little is known about correct ways how to measure and influence respondents' beliefs over consequentiality (Kling et al. 2012). Moreover, existing research barely differentiates between the effects of policy consequentiality and payment consequentiality on stated preferences, commonly treating consequentiality as a uniform concept.

The effects of a survey consequentiality on stated preferences are inquired in various ways. Some studies define a probability with which a survey's outcome will be binding and examine the influence of this probability on respondents' behaviour (e.g., Carson et al. 2014; Mitani and Flores 2012). Some verify how respondents' stated preferences change when scripts informing about the survey's consequential character are included or excluded (e.g., Bulte et al. 2005). Other ask respondents explicitly about their beliefs over the survey consequentiality and check whether their stated preferences differ in these perceptions (e.g., Broadbent, Grandy, and Berrens 2010; Nepal et al. 2009; Vossler et al. 2012). Typically, these studies refer to consequentiality in general, without differentiating between policy and payment consequentiality.

Empirical investigations provide divergent results concerning the effects of consequentiality on stated preferences. Studies that use separate treatments characterised by different probabilities of a referendum-style survey being binding generally find that respondents faced with low levels of this probability are more likely to vote "yes" than respondents in other treatments, revealing higher willingness to pay for a considered project when the referendum has small chances of being binding (Carson et al. 2014; Cummings and Osborne Taylor 1998; Landry and List 2007). Studies that test the effects of survey scripts emphasising consequentiality usually report that stated preferences are invariant to changes in the degree of this emphasis, resulting in statistically indistinguishable willingness-to-pay values for a considered project across questionnaires accentuating the survey consequentiality to various extents (Drichoutis, Vassilopoulos et al. 2015; Oehlmann and Meyerhoff 2017). On the other hand, the research of Czajkowski et al. (2017) suggests that the degree of consequentiality communicated via survey scripts statistically matters for stated preferences (increasing marginal willingness to pay for some project attributes), but the effect appears to be very weak. Lewis et al. (2016) observe that respondents presented with the consequentiality script are significantly more likely to choose one of the product options than the "none of these" option. Studies that check how stated preferences differ in declared consequentiality perceptions often reveal that the willingness-to-pay values increase in the strength of the consequentiality belief (Forbes et al. 2015; Groothuis et al. 2017; Herriges et al. 2010; Hwang et al. 2014; Interis et al. 2014; Li et al. 2015; Vossler et al. 2017; Vossler and Holladay 2016; Vossler and Watson 2013). However, findings of the studies based on self-reported consequentiality measures are not univocal. Vossler et al. (2012) show that marginal willingness to pay for the project attributes decreases in the strength of the consequentiality belief. The results of Broadbent (2012) and Oehlmann and Meyerhoff (2017) indicate that willingness to pay does not change across various strength levels of stated consequentiality perceptions. Importantly to mention, none of the studies referred to in this paragraph distinguishes between policy and payment consequentiality, treating consequentiality as a uniform construct. Separation of the elements of consequentiality could possibly help explain the mixed findings observed in the received literature.

To the best of our knowledge, only two studies to date have investigated policy and payment consequentiality separately.[1] Mitani and Flores (2010, 2014) develop theoretical models to show that truthful preference disclosure is affected by probabilities of the provision

[1] Vossler and Holladay (2016) and Oehlmann and Meyerhoff (2017) ask respondents about their beliefs over policy and payment consequentiality separately, however, the former combine the data from the two consequentiality questions for the analysis, while the latter examine only responses to the policy-consequentiality question, leaving payment consequentiality aside.

of a good and of the payment collection in the contexts of a referendum voting and a threshold provision mechanism, respectively. Each of the studies tests the theoretical predictions in an induced-value lab experiment, in which the probabilities of provision and payment are exogenously determined by researchers. Mitani and Flores (2010, 2014) hypothesise that the impact of policy and payment consequentiality on truthfulness of stated preferences varies depending on respondents' risk attitudes. For example, a risk-averse respondent is conjectured to reveal her preferences truthfully when she believes more strongly in policy consequentiality than in payment consequentiality; in other words, when in her perception, the probability of the good provision is higher than the probability of the payment collection. A risk-averse respondent is reckoned to understate her true willingness to pay for a project when she perceives the payment probability to be equal to or higher than the provision probability.

Regarding the sole effect of policy consequentiality on stated preferences, the study of Kataria et al. (2012) provides some insights. In the field survey exploring preferences towards improving the water quality of Odense River in Denmark, the authors elicit respondents' perceptions about whether they believe that the changes described in the considered policy scenario could indeed occur. They find that more than 60% of respondents view the improvements as (rather) unlikely, and that these respondents express weaker preferences for many attributes of the considered scenario than the remaining part of the sample. They conclude that the value estimates based on stated preference data may be substantially biased because of the mistrust that changes may indeed take place (or, using the terminology of this paper, because of the lack of policy consequentiality). Their study indicates that the bias increases in the level of mistrust and of the proposed improvement.

The study of Carson et al. (2014) points out to the important role of payment consequentiality for preference elicitation. Their field experiment includes treatments in which if a referendum passes, the public good is provided with certainty but participants face either 20% or 80% probability that they will be required to pay for this provision. The results indicate that the probability of voting "yes" is statistically significantly larger in the weak (20%) payment consequential treatment than in the strong (80%) payment consequential treatment. This implies that weak payment consequentiality encourages participants to vote "yes".

Payment consequentiality is also related to credibility of the project cost presented in a survey as perceived by respondents. Studies that ask respondents whether they believe that the presented cost will be equal to the actually implemented cost reveal that substantial shares of respondents have serious doubt about it: 42% of participants in the study of Champ et al. (2002)

and 67% of participants in the study of Strong and Flores (2006). Among the participants who do not believe that the presented cost will be the actual cost, the majority think the actual cost will be higher. In their theoretical model, Flores and Strong (2007) show that such beliefs may considerably bias downward the value estimates obtained derived from stated preference data.

In this paper, we aim at deepening the understanding of the role of consequentiality in stated preference surveys, by distinguishing between the impacts of self-perceived policy and payment consequentiality on respondents' behaviour. Our study contributes to the existing literature by addressing the following two issues.

First, unlike earlier studies, in which respondents' perceptions about consequentiality are elicited through a single question such as how strongly they believe that the survey's outcome will be used for future policy purposes, we ask respondents about beliefs over policy and payment consequentiality separately. Researchers raise a doubt whether the commonly used single question captures these beliefs well (Czajkowski et al. 2017; Kling et al. 2012). In surveys, respondents are asked to indicate the strength of their consequentiality beliefs on a Likert scale ranging from two (Broadbent 2012; Broadbent et al. 2010) to several levels (e.g., Herriges et al. 2010; Vossler et al. 2012). Following this practise, we include five levels, and we additionally verify where respondents who answer "I do not know" to the consequentiality questions should be located on the scale – for example, in the middle, or at any of its ends. To the best of our knowledge, none of the existing empirical studies distinguishes the effects of respondents' beliefs over policy and payment consequentiality on stated preferences. We address this issue by including questions to separately assess respondents' perceptions about the two aspects of consequentiality and by subsequent explicit econometric modelling of the impacts of these perceptions on stated preferences.

Second, we empirically verify a claim suggested in theoretical work that for truthful preference revelation, not only the positive strength levels of the beliefs over policy and payment consequentiality matter (a so-called knife-edge result),[2] but also the relation between the two levels, namely which belief is stronger / weaker (Mitani and Flores 2014). As mentioned earlier, the impact of this relation on preference disclosure is hypothesised to vary depending on a respondent's risk attitude. We empirically test the influence of a respondent's risk attitude

[2] Herriges et al. (2010) introduce the term "knife-edge result" to refer to the conclusion of Carson and Groves (2007) that for assuring a survey's consequentiality, the probability of a survey being consequential, as faced or perceived by respondents, needs to be at least marginally larger than zero.

on preferences stated in a survey and examine the correlation of risk attitudes with beliefs over policy and payment consequentiality.

We investigate the two issues in a field study of preferences towards development of renewable energy infrastructure. Our baseline model focuses on the influence of perceptions about policy and payment consequentiality on stated preferences. To incorporate self-reported measures of the beliefs into econometric modelling of preferences, while addressing the potential measurement error problem and accounting for the ordinal nature of explanatory variables, we follow Czajkowski et al. (2017) and apply a hybrid mixed logit framework. The unobservable beliefs, which were assessed on a five-point Likert scale in the survey, are modelled as latent variables. Our supplement model includes additionally a latent variable related to respondents' (unobservable) risk attitudes, measured in the survey as a count variable related to the number of choices of risky lotteries in the Tanaka et al. (2010) approach. This allows us to test the role of risk attitudes for stated preferences and for beliefs over consequentiality.

In a recent paper, Czajkowski et al. (2017) develop an econometric framework to account for stated measures of latent (unobservable) beliefs into models of stated preferences. Their hybrid mixed logit approach allows for accommodating multiple latent factors in flexible ways that take the nature of explanatory variables into account (for example, ordered choice, multinomial choice, count data models). In addition, specifying measurement equations as functions of latent variables and error terms recognises the presence of the measurement error and, hence, avoids the measurement bias resulting from direct inclusion of imprecisely measured stated beliefs as interactions in the discrete choice component of the model. We follow this approach to inquire the effects of unobservable beliefs over policy and payment consequentiality and of unobservable risk attitudes on stated preferences.

We find that latent beliefs over policy consequentiality and payment consequentiality are strongly correlated with the self-reported measures of the respective beliefs; and that the two beliefs affect stated preferences significantly, but differently. While both beliefs strengthen respondents' interest in having the considered project implemented, policy consequentiality decreases, while payment consequentiality increases their sensitivity to the project cost. As a result, respondents with strong beliefs over policy consequentiality are willing to pay substantially more for the project than respondents with strong beliefs over payment consequentiality. This finding is of particular importance, calling into question whether consequentiality perceptions can be well measured through the usual approach of a single question. Finally, we observe that risk attitudes do not affect the self-reported measures of consequentiality beliefs and have a negligible impact on stated preferences, thus questioning predictions from the theoretical model developed by Mitani and Flores (2014).

The remainder of the paper is structured as follows. Section 2 provides details about the survey instrument employed for data collection. Section 3 outlines the econometric approach we use for modelling preferences and for linking them with unobservable consequentiality perceptions and risk attitudes. Section 4 presents results of the empirical analysis. Section 5 discusses the findings and concludes.

2. Empirical study

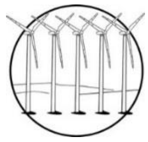
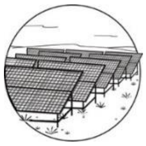
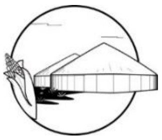
We examine the role of consequentiality beliefs on stated preferences in a field survey that elicited preferences of Polish citizens towards development of renewable energy infrastructure. Assessing the benefits of the development to the society is particularly important given that the European Union policy requires increasing the use of renewable sources for energy production. At the same time, renewable energy development can cause several external impacts that need to be taken into account to take socially optimal decisions about expansion of renewable energy infrastructure. The values of such externalities are often not directly reflected in market prices. Therefore, the nonmarket valuation methodology based on stated preferences may help evaluate these effects and provide decision-makers with necessary information for cost-benefit analysis.

Data was collected through face-to-face, computer-assisted personal interviews (CAPI) administered by a professional polling agency. The survey consisted of five parts. The first part informed respondents about various renewable energy sources, which included wind, sun and biomass, because the survey investigated preferences towards these types of energy. It also asked several warm-up questions about respondents' exposure and attitudes towards renewable energy. The second part employed a discrete choice experiment to elicit preferences towards the development of renewable energy infrastructure. The third part asked about respondents' beliefs over consequentiality, while the fourth part measured their risk attitudes. In the fifth part, socio-demographic data was collected. Next subsections provide details about the survey's parts and implementation.

2.1. Discrete choice experiment

In the discrete choice experiment, respondents were displayed a sequence of six choice tasks. Each task presented four variants of the development of renewable energy sites, out of which respondents were asked to indicate their most preferred variant. The considered expansions of renewable energy infrastructure applied to an area in a radius of 10 km from a respondent's place of residence. The variants were labelled: the first three referred to the development of wind, solar and biomass energy sites, while the last variant represented the future status quo implying that a respondent did not want to see / did not care about changes introduced in the current trend of the renewable energy development. Definitions of the labelled variants of the renewable energy development, together with pictograms used for their illustration, are shown in Table 1.

Table 1. Definitions and pictograms of the labelled variants of renewable energy development

Type	**Definition**	**Pictogram**
Wind energy	Electricity generated from single wind turbines or from wind farms located on the mainland	
Solar energy	Electricity generated from solar panels located in open areas	
Biomass energy	Electricity generated from biomass, for example, from residues from harvesting corn	

Every variant of the renewable energy development was described by six characteristics (attributes), including a monetary attribute that was defined as a change in the electricity bill. The attributes are explained in Table 2, together with their levels used in the survey.

The future status quo variant depicted the future state of renewable energy expansion assuming no interference in the current process of the development. Thus, it was related to no changes in the electricity bill. The other variants represented scenarios of renewable energy expansions that differed from the future status quo and, thereby, included changes in the electricity bill. An example of a choice task is shown in Figure 1.

Table 2. Attributes used for describing variants of renewable energy development

Attribute	Description	Levels
Distance	A minimum distance of a renewable energy site from residential areas	300; 600; 900 (FSQ); 1,600; 2,500 [meters]
Size	A size of a renewable energy site	Small, Medium (FSQ), Large
Number	A number of renewable energy sites	1; 2; 3 (FSQ); 4; 5
Protected area	A share of the area protected from renewable energy expansion	10%; 20%; 30% (FSQ); 40%; 50%
Lines	A type of energy transmission lines	Overhead (FSQ); Underground
Cost	A change in the electricity bill per month	-20; -10; 0 (FSQ); +5; +15; +30; +50 [PLN]

Notes: FSQ indicates the attribute levels of the future status quo variant. The levels of the attribute *Size* were precisely defined for every type of renewable energy. For wind energy, *Small* meant 5−10 turbines, *Medium* 18−25 turbines and *Large* 35-50 turbines. For solar energy, each attribute level was associated, respectively, with 0.5−5 hectares, 20−40 hectares and 60−100 hectares. For biomass energy, the respective levels of the attribute were related to 1−3 fermentation tanks, 5−8 fermentation tanks and 15−25 fermentation tanks.

Figure 1. An example of a choice task

	Wind energy	**Biomass energy**	**Solar energy**	**I am indifferent**
A minimum distance of a renewable energy site from residential areas	600 m	2,500 m	300 m	900 m
A size of a renewable energy site	Large (35−50 turbines)	Large (15−25 fermentation tanks)	Small (0.5−5 hectares)	Medium
A number of renewable energy sites	4	5	5	3
A share of the area protected from renewable energy expansion	20%	50%	10%	30%
A type of energy transmission lines	Underground	Underground	Overhead	Overhead
A change in the electricity bill per month (per year)	+30 PLN (+360 PLN)	-10 PLN (-120 PLN)	+30 PLN (+360 PLN)	0 PLN
My choice	□	□	□	□

Note: The original questionnaire was in Polish. The figure presents a translated choice task.

Variants of the renewable energy development were generated based on a Bayesian C-efficient design optimised for a multinomial logit model with dominated variants being excluded (Scarpa and Rose 2008). The final design comprised 24 choice tasks that were blocked into four blocks of six choice tasks, and respondents were randomly assigned one of the blocks. To control for order effects, we randomised across respondents the order of choice tasks and the order of the first three labelled variants.

2.2. Measures of consequentiality perceptions

After the discrete choice experiment, information about respondents' perceptions about policy consequentiality and payment consequentiality was collected. Respondents were asked to indicate the degrees to which they agreed with each of the statements below:[3]

– "My choices in this survey will be taken into account in decision-making about the development of renewable energy infrastructure."

– "My choices in this survey will have influence on future prices of electricity."

Hereafter, we refer to the first statement as a policy-consequentiality question and to the second statement as a payment-policy question. Each of them was assessed on a five-point Likert scale that included responses: "I definitely agree", "I agree", "I disagree", "I definitely disagree" and "I do not know". We treat a respondent's answer to the first statement as an indicator for her belief in policy consequentiality (the perceived chances of the actual provision of the public good) and the answer to the second statement as an indicator for her belief in payment consequentiality (the perceived chances of the actual changes in the electricity bill). In addition, we pay particular attention to whether the answer "I do not know" can be treated as a continuous mid-scale response, or it rather represents an inherently different attitude towards the issue.

2.3. Measures of risk attitudes

In the next part of the survey, we employed the design of Tanaka et al. (2010) to elicit respondents' risk attitudes. This approach allows for determining individuals' preferences towards risk in a financial domain. Given that the considered project of the renewable energy

[3] Both statements were originally in Polish. Here translations are provided.

development involved changes in costs of electricity, we found the approach of Tanaka et al. (2010) relevant in the context of our research.

Respondents' risk attitudes were assessed based on their choices in two series of pair-wise comparisons of lotteries.[4] The series are presented in Table 3. In every comparison, respondents faced two lotteries (A and B), which were characterised by two payoffs with assigned probabilities, and they were asked to indicate their preferred lottery out of the two. Within each series, lottery A remained unchanged throughout all the comparisons, while one of the payoffs in lottery B kept on being increased from a comparison to a comparison.

In each comparison, the difference between the possible payoffs in lottery A is much smaller than the difference between the possible payoffs in lottery B. Simplifying, it can be said that respondents chose between safe lottery A and risky lottery B. Because the expected payoff from lottery B was increasing across the comparisons, choosing the risky lottery was becoming more and more attractive from a comparison to a comparison. The point at which a respondent switched from lottery A to lottery B implied her risk attitude: the later a respondent chose lottery B, the higher her risk aversion was.

All pair-wise comparisons within a series were displayed to a respondent simultaneously. Respondents were asked to indicate in which comparison they wanted to switch from lottery A to lottery B. They were noted that they could choose lottery B since the very first comparison.

Table 3. Two series of pair-wise comparisons of lotteries used in the survey

Series 1								
Lottery A				Lottery B				EV_A-EV_B
Prob.	Payoff	Prob.	Payoff	Prob.	Payoff	Prob.	Payoff	
0.3	400	0.7	100	0.1	680	0.9	50	77
0.3	400	0.7	100	0.1	750	0.9	50	70
0.3	400	0.7	100	0.1	830	0.9	50	62
0.3	400	0.7	100	0.1	930	0.9	50	52
0.3	400	0.7	100	0.1	1,060	0.9	50	39
0.3	400	0.7	100	0.1	1,250	0.9	50	20
0.3	400	0.7	100	0.1	1,500	0.9	50	-5
0.3	400	0.7	100	0.1	1,850	0.9	50	-40
0.3	400	0.7	100	0.1	2,200	0.9	50	-75
0.3	400	0.7	100	0.1	3,000	0.9	50	-155

[4] As proposed by Tanaka et al. (2010), the survey contained three series of pair-wise lottery comparisons to assess three parameters expressing a respondent's risk attitude: a utility function concavity parameter, a probabilities' weighting parameter and a loss aversion parameter. Here, we only use data from the two first series of lotteries which informs about respondents' risk aversion; we do not inquire into the issue of loss aversion. Information obtained from all three series of lotteries was used in another study, namely in Bartczak et al. (2017).

0.3	400	0.7	100	0.1	4,000	0.9	50	-255
0.3	400	0.7	100	0.1	6,000	0.9	50	-455
0.3	400	0.7	100	0.1	10,000	0.9	50	-855
0.3	400	0.7	100	0.1	17,000	0.9	50	-1,555
Series 2								
Lottery A				Lottery B				EV_A-EV_B
Prob.	Payoff	Prob.	Payoff	Prob.	Payoff	Prob.	Payoff	
0.9	400	0.1	300	0.7	540	0.3	50	-3
0.9	400	0.1	300	0.7	560	0.3	50	-17
0.9	400	0.1	300	0.7	580	0.3	50	-31
0.9	400	0.1	300	0.7	600	0.3	50	-45
0.9	400	0.1	300	0.7	620	0.3	50	-59
0.9	400	0.1	300	0.7	650	0.3	50	-80
0.9	400	0.1	300	0.7	680	0.3	50	-101
0.9	400	0.1	300	0.7	720	0.3	50	-129
0.9	400	0.1	300	0.7	770	0.3	50	-164
0.9	400	0.1	300	0.7	830	0.3	50	-206
0.9	400	0.1	300	0.7	900	0.3	50	-255
0.9	400	0.1	300	0.7	1,000	0.3	50	-325
0.9	400	0.1	300	0.7	1,100	0.3	50	-395
0.9	400	0.1	300	0.7	1,300	0.3	50	-535

Notes: Prob. denotes the probability of the payoff that comes in the next column. EV_A-EV_B is a difference in expected values between lottery A and lottery B. All payoffs are in PLN, as it was used in the survey.

2.4. Survey implementation

The survey was conducted in January 2016 and, in total, 801 respondents took part in it. Quotas were implemented to match the interviewed sample with the adult population of Poland in terms of gender, age, size of the place of residence and its geographical location. Socio-demographic characteristics of the sample are provided in Table 4.

Table 4. Socio-demographic characteristics of the sample

	Shares / Means
Women	52.3%
Age	50.2
Education	
Primary / Elementary	38.2%
Secondary	34.6%
High / Higher	27.2%
Net monthly individual income	485.25 EUR[5]

[5] In the reminder of the paper, all monetary values were converted from PLN to EUR to facilitate interpretation. At the time of the study, 1 PLN ≈ 0.25 EUR ≈ 0.33 USD.

The survey was designed based on interviews and extensive pretesting with individuals representative of the general adult population of Poland. The discrete choice part of the survey was also tested in an earlier study conducted in Germany within the project EnergyEFFAR.[6] Pretesting within the German project involved six focus groups and two pilot studies, one with work colleagues and another with representatives of the general population of Germany.

3. Econometric framework

In modelling respondents' preferences towards the renewable energy development and variation of the preferences related to unobservable consequentiality beliefs and risk attitudes, we follow the approach proposed by Czajkowski et al. (2017). Their framework belongs to a class of hybrid choice models (Ben-Akiva et al. 2002), which are structural models that incorporate choice and non-choice components.[7] In our baseline model, the choice component comes from the discrete choice experiment and uses a mixed logit approach for modelling stated preferences, while the non-choice component provides the measurement of latent variables based on self-reported perceptions about consequentiality, which are modelled through ordered choice regressions. In addition, the non-choice (measurement) component of the supplement model includes a count data model that captures unobservable risk attitudes measured through respondents' lottery choices.

The theoretical foundation of the econometric approach comes from a random utility framework (McFadden 1974), which assumes that individuals derive utility from observed characteristics of a good (here, features of a renewable energy project) and unobserved idiosyncrasies. Following this theory, analysts identify respondents' preferences based on their discrete choices in a survey.

The hybrid choice modelling approach allows one to include unobservable perceptions and cognitive processes into the random utility framework in order to examine the influence of these unobservable factors on stated preferences. In our study, we consider several unobservable factors: beliefs over policy consequentiality, beliefs over payment consequentiality and attitudes towards risk. The survey provides measures of each of these factors through respondents' self-reports to the consequentiality questions and their answers in the lottery comparisons. Common practice is to include stated measures directly into the choice

---

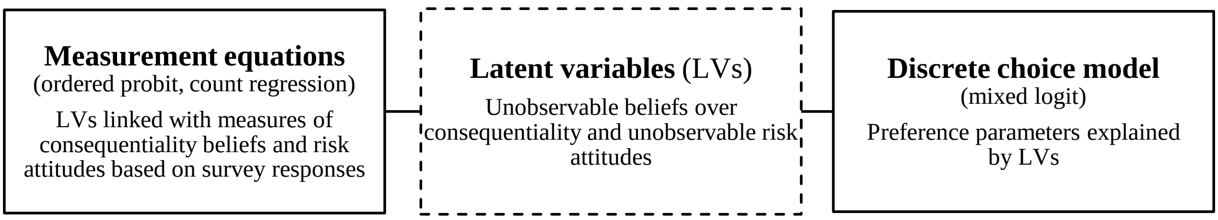
[6] Project "Efficient and fair allocation of renewable energy production at the national level" funded by the Federal Ministry of Education and Research in Germany.

[7] For other examples see Hess and Beharry-Borg (2011), Mariel and Meyerhoff (2016) and Czajkowski et al. (2017).

model as explanatory variables. However, this may give rise to a problem of measurement error because stated measures imprecisely express respondents' actual (inner) beliefs over consequentiality and their risk attitudes. Hybrid choice models address this issue (Budziński and Czajkowski 2017).

In our modelling approach, separate latent variables are used to capture the unobservable factors that are presumed to affect preferences and that at the same time are measured (though imprecisely) in the survey by respondents' self-reports to the consequentiality questions and their answers in lottery comparisons. Our hybrid choice model consists of two parts: a discrete choice component and measurement equations, and the two parts are tied through the latent variables. The measurement equations link self-reported measures of unobservable factors with the latent variables; the equations help recognise measurement error. In the discrete choice component, the latent variables are used to explain differences in respondents' stated preferences. Figure 2 illustrates our modelling approach. Two subsections that follow discuss each of the model components. The model is estimated using (full information) maximum simulated likelihood method.[8]

Figure 2. Components of the structural (hybrid choice) model



3.1. A discrete choice component

Formally, the utility that individual i derives from choosing variant j in choice task t can be expressed by

$$U_{ijt} = \mathbf{X}_{ijt}\boldsymbol{\beta}_i + \alpha_i c_{ijt} + \varepsilon_{ijt} , \tag{1}$$

where $\mathbf{X}$ represents the levels of non-monetary attributes associated with a project of renewable energy development; c_{ijt} denotes the level of the monetary attribute; $\boldsymbol{\beta}_i$ and α_i are individual-specific parameters to be estimated that express the individual's preferences towards the

[8] The software codes for estimating the hybrid choice model were developed in Matlab and are available at http://github.com/czaj/DCE under Creative Commons BY 4.0 license. The code and the data for estimating the models presented in this paper, as well as supplementary results, are available from http://czaj.org/research/supplementary-materials.

project's characteristics; and the stochastic element ε captures factors unobserved by the econometrician that influence the individual's utility (choices in the survey). The expression on the right-hand side of (1) corresponds to the random utility theory (McFadden 1974): the first two elements depict a deterministic component of the individual's utility that results from observed characteristics of the project, while the last element includes unobserved idiosyncrasies.

Three aspects of the utility specification in (1) are important to be emphasised. First, the preference parameters $\boldsymbol{\beta}_i$ and α_i are individual-specific. This allows for capturing the heterogeneity of respondents' preferences towards the characteristics of the considered project, and results in a mixed logit specification.[9] Instead of separately estimating the parameters for each individual, we follow a common practice and assume that the parameters have specific distributions: in our model, the non-monetary attributes are normally distributed and the monetary attribute is log-normally distributed.

Second, the preference parameters are assumed to depend on the latent variables that capture unobservable consequentiality beliefs (and, in the supplement model, unobservable risk attitudes). We denote a vector of individual-specific latent variables by $\mathbf{LV}_i$. The relationship between the non-monetary preference parameters and the latent variables can be illustrated by

$$\boldsymbol{\beta}_i = \boldsymbol{\Lambda}'\mathbf{LV}_i + \boldsymbol{\beta}_i^*, \tag{2}$$

where $\boldsymbol{\Lambda}$ is a matrix of coefficients to be estimated and $\boldsymbol{\beta}_i^*$ has a multivariate normal distribution with a vector of means and a covariance matrix to be estimated. Similarly, the relationship between the parameter of the monetary attribute and the latent variables is of a form

$$\alpha_i = \exp\left(\boldsymbol{\tau}'\mathbf{LV}_i + \alpha_i^*\right), \tag{3}$$

where $\boldsymbol{\tau}$ is a vector of coefficients to be estimated and α_i^* is log-normally distributed with the parameters describing its mean and its standard deviation to be estimated.

Third, the stochastic element ε in the utility function in (1) is of an unknown, possibly heteroskedastic variance. Identification of the model typically relies on normalising this variance (Daly et al. 2012), such that the stochastic element is independent and identically distributed following the type I extreme value distribution with a constant variance equal to $\pi^2/6$. This generates convenient, closed-form formulas for choice probabilities. Because of the

[9] Taking the same parameters for all respondents implies homogenous preferences and leads to a multinomial logit specification.

ordinal nature of utility, this normalisation does not change the properties of the utility function; the function still represents the same preferences. The estimates of the model parameters, which can now be seen as products of the preference parameters and a scaling coefficient, do not have direct interpretation anyway.

3.2. Measurement equations

We define latent variables to capture respondents' beliefs over policy and payment consequentiality (and their risk attitudes). The mentioned beliefs (and risk attitudes) are unobservable factors that may impinge on respondents' preferences but cannot be measured in a direct and objective way, like age or income. Instead, our survey included several indicator questions to assess these factors; responses to the indicator questions could be expected to be determined by the factors. Measurement equations model the measures of the beliefs (and of the risk attitudes) as a function the latent variables. Formally, this relationship can be expressed as

$$\mathbf{I}_i = \mathbf{\Gamma}'\mathbf{LV}_i + \boldsymbol{\eta}_i, \tag{4}$$

where $\mathbf{I}_i$ are indicator variables (the measures of the unobservable factors); $\mathbf{\Gamma}$ is a matrix of coefficients to be estimated; and $\boldsymbol{\eta}_i$ is a vector of error terms assumed to follow a multivariate normal distribution with zero means and an identity covariance matrix. To facilitate interpretation, the means of latent variables are normalised to zero, and to assure identification, their variance are normalised to one (cf. Daly et al. 2012; Raveau et al. 2012). As a result, all latent variables have the same scale and, therefore, their relative importance (for instance, in the measurement equations and in interactions with the preference parameters) can easily be assessed.

Respondents' beliefs over policy consequentiality and over payment consequentiality were self-reported on five-point Likert scales. Risk attitudes were measured through the numbers of safe or risky lotteries chosen. Therefore, we use different functional forms in the measurement component of our hybrid choice model: stated consequentiality beliefs are modelled using ordered probit, while choices expressing risk attitudes are modelled through Poisson regressions. Note that the hybrid choice framework allows us to tailor the modelling approach to the character of each explanatory variable, rather than treating them as arbitrarily classified dummy-coded variables or continuous variables (Bahamonde-Birke and Ortúzar 2017).

Additionally, in the preliminary analysis, we investigated the correct way how to treat the do-not-know responses to either of the consequentiality questions (i) by including separate latent variables modelled through binary probit regressions to capture indefinite beliefs over policy and payment consequentiality and (ii) by using a multinomial logit (rather than ordered logit) approach to model responses to the consequentiality questions.[10] As said by Manisera and Zuccolotto (2014), a do-not-know answer "informs about a specific state of mind of the respondent" and, thus, should be given appropriate attention. Using the ordered logit model, we find that the do-not-know responses fit best when treated as the outermost level of the Likert scale below the category "I definitely disagree", rather than when included as the middle level between the categories "I disagree" and "I agree". Based on this finding, we follow the former approach in the paper. The finding is interesting in itself, as it shows that respondents who answered "I do not know" to any of the consequentiality questions are inherently different from those who indicated any degree of agreement or disagreement with the statements about policy or payment consequentiality. At the same time, it undermines common practices how do-not-know observations are treated in empirical analyses; such observations are often excluded from a sample or are assigned a mean value. Our result reveals that employing such approaches may bias the results. This mirrors the findings of Schafer and Graham (2002).

4. Results

We apply the hybrid choice modelling approach, as outlined in Section 3, to address two research questions raised in the Introduction: (i) whether unobservable beliefs over policy consequentiality and over payment consequentiality affect preferences stated by respondents differently and (ii) whether risk attitudes impinge on self-reported measures of consequentiality beliefs and on stated preferences. The questions are tackled in Subsections 4.1 and 4.2, respectively.

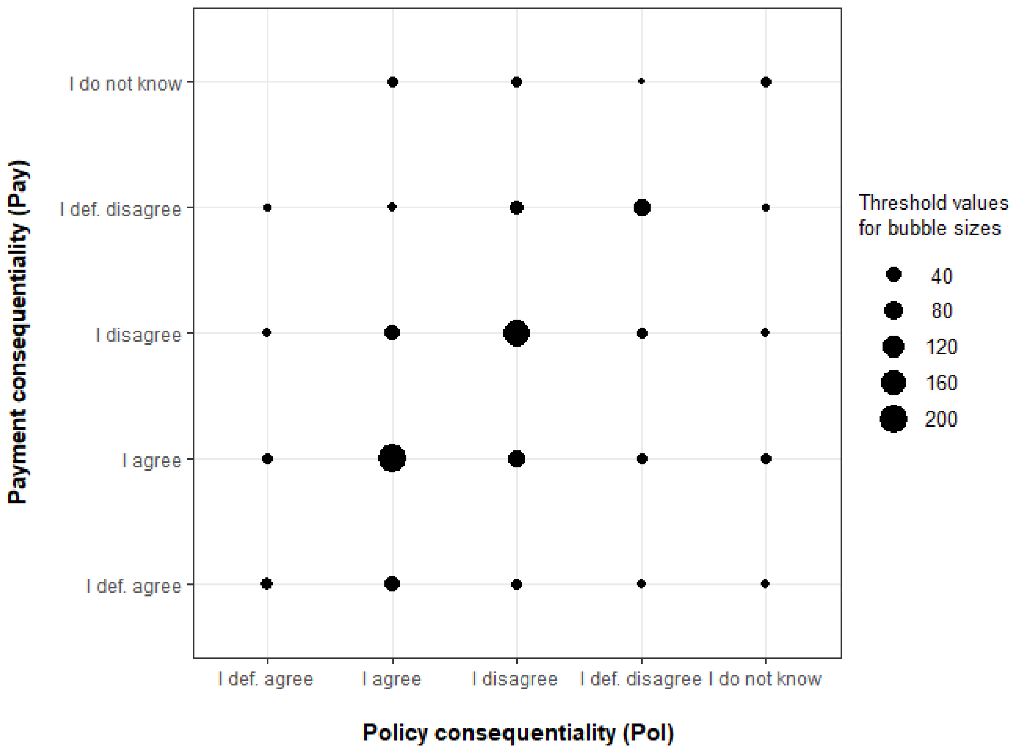
4.1. Impact of policy and payment consequentiality on stated preferences

Our baseline model includes two latent variables: a belief over policy consequentiality denoted by LV_{pol} (strength of the belief that the considered project will actually be conducted) and a belief over payment consequentiality denoted by LV_{pay} (strength of the belief that the payment related to the project implementation will actually be collected). LV_{pol} is measured through

[10] The results of the preliminary analysis are available as supplementary materials to our paper at http://czaj.org/research/supplementary-materials.

responses to the policy-consequentiality question in the survey, which we express in a five-level, ordered variable pol. LV_{pay} is assessed based on responses to the payment-consequentiality question, which we capture in a five-level, ordered variable pay. The levels of the variables pol and pay correspond to the possible answers to the consequentiality questions; specifically, 1 denotes “I do not know”, 2 – “I definitely disagree”, 3 – “I disagree”, 4 – “I agree” and 5 – “I definitely agree”. Hence, we can say that the low values of the variables are associated with a lack of / weak consequentiality beliefs, while the high values are tied to strong consequentiality beliefs. The response “I do not know” is coded as the lowest level for both pol and pay variables as suggested by the results of our preliminary analysis, which we discuss in the previous section.

Figure 3. Distribution of the responses to the policy- and payment-consequentiality questions



We start by investigating the correlation between responses to the policy- and payment-consequentiality questions; that is, the correlation between pol and pay. We present the distribution of the answers to the questions in Figure 3. The size of a bubble represents the number of respondents who chose a given set of answers to the consequentiality questions. The big bubbles on the diagonal of the matrix in Figure 3, as compared with the remaining bubbles, evidence that many respondents chose the same level of their strength of a consequentiality belief in both consequentiality questions. However, the mentioned difference in size between the bubbles on the diagonal and the other bubbles is not large, suggesting that the responses to the two consequentiality questions are not strongly correlated. Moreover, the distribution of the bubbles in Figure 3 shows that nearly all possible combinations of answers to the two consequentiality questions appear in the sample. This may also be an indication for that the responses to the two questions about consequentiality beliefs are not substantially correlated. The Pearson coefficient of correlation between the variables pol and pay is equal to 40.5%. Thus, we conclude that the two variables are not strongly correlated; we use them both in the further analysis as they do not contain the same information.

In Table 5, we present the estimation results of our baseline hybrid choice model. Results from the discrete choice component of the model are shown in Part A of the table, and results from the measurement component are included in Part B. Part C contains the model diagnostics. When interpreting the results, we often refer to willingness to pay (WTP). The WTP value expresses respondent's preferences in monetary terms. For each of the non-monetary attributes considered in the choice tasks, marginal WTP can be calculated as a ratio of the coefficient of a given (non-monetary) attribute to a negative of the coefficient of a monetary attribute.[11]

Table 5. Results of the hybrid choice model depicting the impacts of policy and payment consequentiality on stated preferences

Part A: Discrete choice component				
	Means	**Standard deviations**	**Means interacted with** LV_{pol}	**Means interacted with** LV_{pay}
	Coefficients (Standard errors)			
Wind	1.7498*** (0.3532)	2.0552*** (0.2082)	5.0508*** (0.4714)	2.3587*** (0.5512)
Biomass	0.7548** (0.3559)	1.7194*** (0.2318)	4.5136*** (0.4569)	2.0694*** (0.5152)
Solar	3.7629*** (0.3438)	2.2194*** (0.1940)	4.8275*** (0.4814)	2.6941*** (0.5325)
Distance (km)	0.3119*** (0.0531)	0.4390*** (0.0826)	0.1832** (0.0772)	-0.0371 (0.0929)
Size	-0.0288 (0.0699)	0.0093 (0.1869)	-0.2484*** (0.0924)	0.1727 (0.1120)

[11] We note, however, that the stated way of calculating WTP is an algebraic operation on multivariate random variables, which requires the means of the resulting distributions to be simulated. We do this through a two-step Krinsky and Robb simulation procedure (Krinsky and Robb 1986), drawing coefficients from the vector of estimates and the asymptotic variance-covariance matrix, and next drawing correlated random parameters from their respective distributions described by these coefficients. Each step uses 10,000 iterations. This way we are able to reliably simulate the means, other moments and quantiles of WTP, as well as the standard errors.

Number	0.0071 (0.0379)	0.0015 (0.1473)	-0.0491 (0.0539)	0.0624 (0.0651)
Protected area	0.7942*** (0.2979)	0.6437 (1.1308)	-0.6654 (0.4387)	0.8736* (0.4843)
Lines: Underground	0.1636* (0.0882)	0.3278 (0.2538)	0.2065* (0.1231)	0.1099 (0.1480)
- Cost per month (EUR)	-1.7651*** (0.0872)	0.8601*** (0.1782)	-0.5083*** (0.1524)	0.7913*** (0.1723)

Part B: Measurement component	
	Measurement Equation 1 (ordered probit) Dependent variable: *pol*
	Coefficients (Standard errors)
LV_{pol}	0.2534*** (0.0545)
Cutoff 1	-1.6755*** (0.0780)
Cutoff 2	-1.0413** (0.4382)
Cutoff 3	0.0571 (0.4464)
Cutoff 4	1.5936*** (0.4776)
	Measurement Equation 2 (ordered probit) Dependent variable: *pay*
	Coefficients (Standard errors)
LV_{pay}	0.3198*** (0.0777)
Cutoff 1	-1.7812*** (0.0885)
Cutoff 2	-1.0352* (0.5378)
Cutoff 3	-0.0197 (0.5392)
Cutoff 4	1.2476** (0.5936)

Part C: Model diagnostics	
LL at convergence	-5,982.79
LL at constant(s) only	-8,259.09
McFadden's pseudo-R^2	0.2756
Ben-Akiva-Lerman's pseudo-R^2	0.4844
AIC/*n*	2.5104
BIC/*n*	2.5725
n (the number of observations)	4,803
r (the number of respondents)	801
k (the number of parameters)	46

Notes: ***, ** and * indicate 1%, 5% and 10% significance levels, respectively. *Wind*, *Solar* and *Biomass* denote constants specific for each labelled variant. *Distance* is converted into kilometres. *Size* is treated as a continuous variable with levels -1 for *Small*, 0 for *Medium* (the future status quo) and 1 for *Large*. The attribute *Lines* is coded as a binary variable, where 1 stays for *Underground* and 0 for *Overhead*. All preference parameters are modelled as random, normally distributed except for the cost parameter, which is assumed to follow a log-normal distribution (the estimates of the underlying normal distribution are provided). We use a negative of *Cost per month*.

The means of the three variant-specific constants reported in Part A of Table 5 imply that, on average, respondents prefer implementation of a new project of renewable energy development to the future status quo. Each of these constants represents a change in utility related to the project implementation assessed against the future status quo (when no project is introduced), which is a reference level, omitted from the model. Respondents prefer most the extension of the solar energy infrastructure, while biomass energy is of least interest to them out of the three energy types considered. The further away from residential areas an energy site is, the more it is preferred. Respondents are also willing to pay for protecting some areas from renewable energy expansion and for transmitting energy through underground lines. Projects that are more expensive reduce respondents' utility. Significant standard deviations of the attributes indicate unobserved heterogeneity of respondents' preferences, which justifies the use of a mixed logit specification.[12]

We now turn to the discussion of consequentiality perceptions. Measurement equations show that the latent variables indeed capture intrinsic, unobservable beliefs over consequentiality. High values of LV_{pol} are associated with strong stated beliefs over policy consequentiality (as follows from Measurement Equation 1), and high values of LV_{pay} are related to strong stated beliefs over payment consequentiality (as implied by Measurement Equation 2). The influence of the unobserved consequentiality beliefs on stated preferences is revealed by interactions of the latent variables with the means of the preference parameters. These results are reported in the last two columns in Part A of Table 5. Several differences emerge in the effects of LV_{pol} and LV_{pay} on preferences revealed by respondents through their answers in choice tasks.

The significant and positive coefficients of the interactions of LV_{pol} with *Wind*, *Solar* and *Biomass* indicate that respondents with a strong belief over policy consequentiality have strong preferences for the implementation of a renewable energy project. A similar effect is observed for those with a strong belief over payment consequentiality. However, we note that the effect

[12] We note that because the means of the latent variables are normalised to 0, the main effects (the means in Part A of Table 5) can be readily interpreted as means for the interviewed population, without the necessity to take into account the interactions from the last two columns of Part A.

for the payment-consequential respondents is considerably weaker than for the policy-consequential respondents.[13]

The most important difference between the impacts of LV_{pol} and LV_{pay} lays in their influence on the coefficient of the *Cost* attribute. Because *Cost* is assumed to be log-normally distributed, the actual effect of this attribute is calculated as a value of a natural exponential function. For respondents with high implied values of LV_{pol}, that is, for respondents with strong beliefs over policy consequentiality, a natural exponent of the *Cost* coefficient becomes smaller. This means that the sensitivity to cost (marginal utility of money) decreases in the strength of the policy-consequentiality belief. This, in turn, implies that WTP increases in the strength of the policy-consequentiality belief. In contrast, for respondents with strong beliefs over payment consequentiality (high implies values of LV_{pay}), a natural exponent of the *Cost* coefficient increases. This means that they are characterised by increased sensitivity to cost. As a result, WTP decreases in the strength of the payment-consequentiality belief.

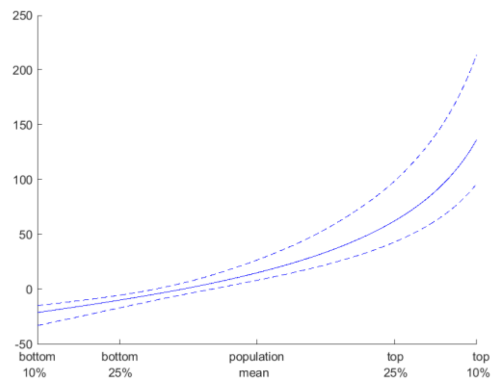
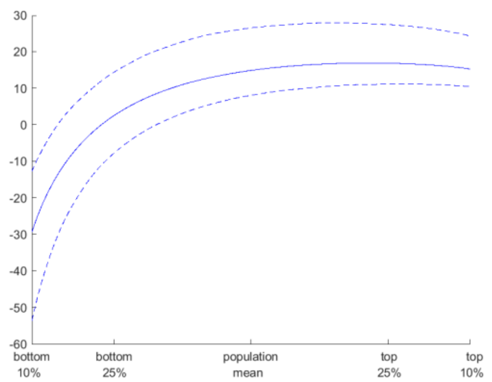
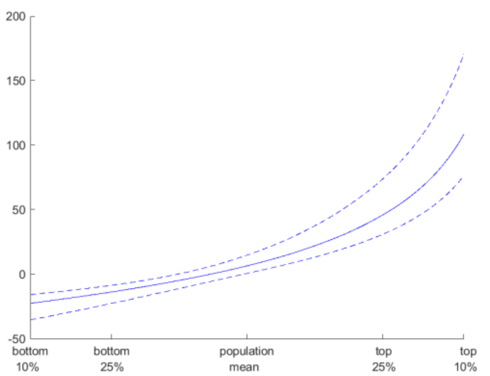
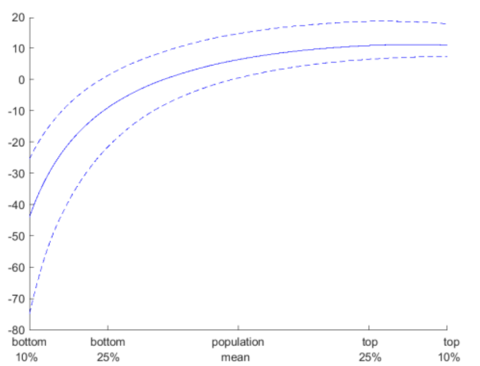
The interactions of LV_{pol} and LV_{pay} with the remaining attributes reveal that: (i) in comparison with respondents weakly believing in policy consequentiality, those strongly believing are willing to pay more for locating renewable energy sites farther from residential areas, for smaller projects and for underground transmission lines; (ii) respondents strongly believing in payment consequentiality are willing to pay more for having larger areas protected from renewable energy expansion than those weakly believing in payment consequentiality.

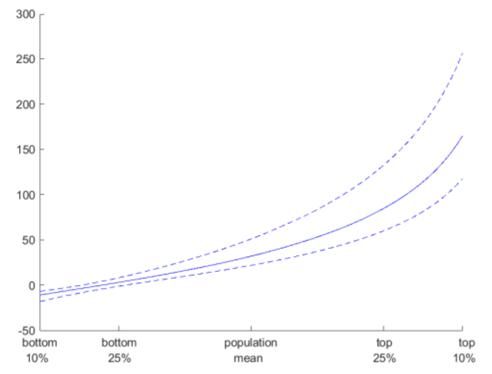
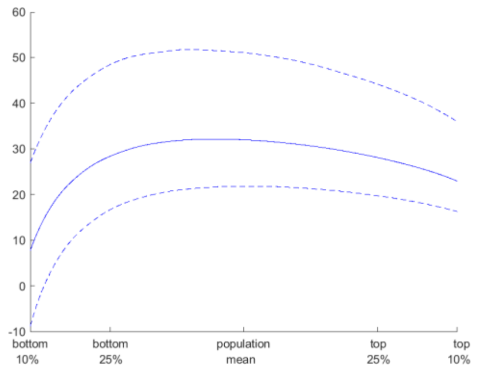
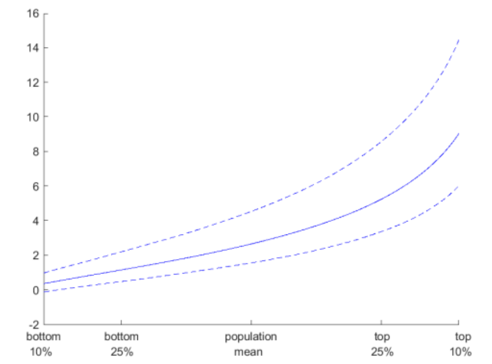
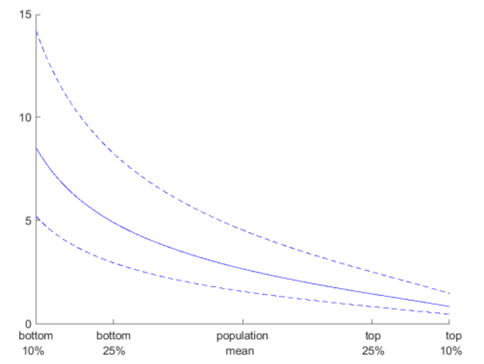
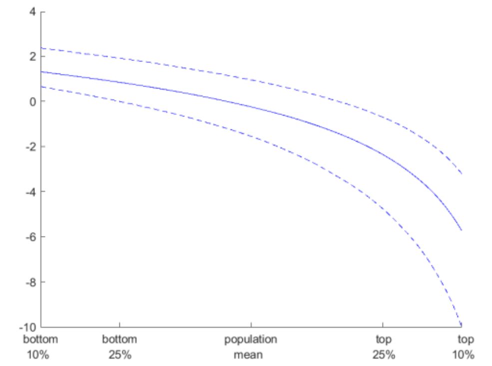
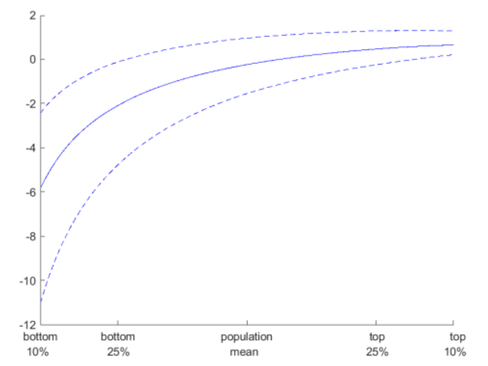
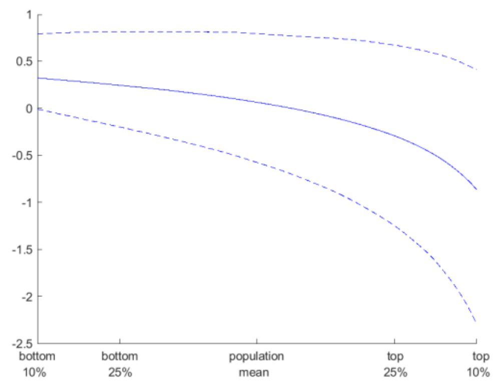
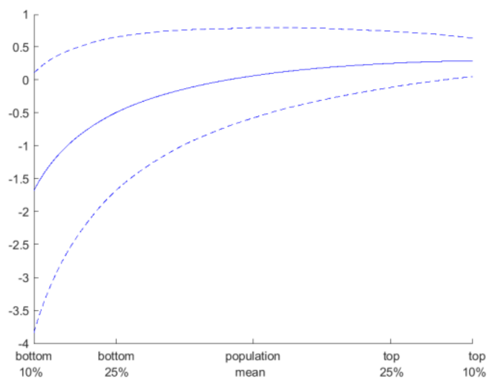
In order to facilitate the interpretation of the effects of policy and payment consequentiality for WTP, we simulate the WTP of respondents whose beliefs over consequentiality vary. Note that the effect of consequentiality perceptions for WTP is not

[13] Normalisation of each latent variable to a zero mean and a unit standard deviation allows for direct comparisons of the relative effects of different latent beliefs on stated preferences.

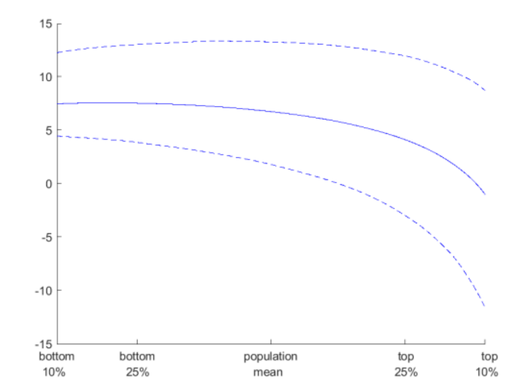
straightforward. For example, as in the case of LV_{pay}, when the coefficients of interactions of the latent variable with both the variant-specific constants and the cost are positive, it is not obvious whether the WTP for the labelled variants increases or decreases as the strength of the latent perception changes. The simulation results help identify the effects of the latent variables on WTP. The results are displayed in Figure 4. We consider respondents with such implied values of consequentiality beliefs which fall into the interval from the bottom 10% level to the top 10% level, as observed in our sample. Large WTP changes and narrow confidence intervals indicate substantial effects of policy and payment consequentiality.

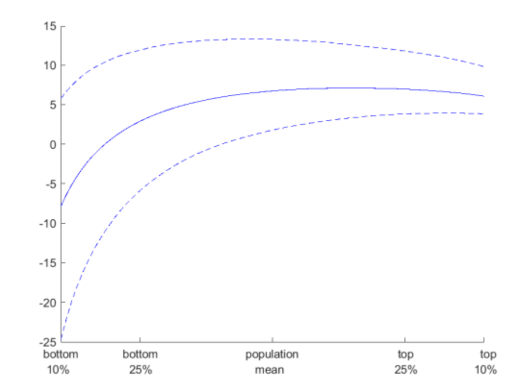
Figure 4. Marginal WTP (EUR) of respondents with varying strength of the latent beliefs over policy and payment consequentiality

<table>
<tr><th colspan="2"></th><th>Policy consequentiality</th><th>Payment consequentiality</th></tr>
<tr><td rowspan="2">Marginal WTP (EUR) for</td><td>Wind</td><td>
</td><td>
</td></tr>
<tr><td>Solar</td><td>
</td><td>
</td></tr>
</table>

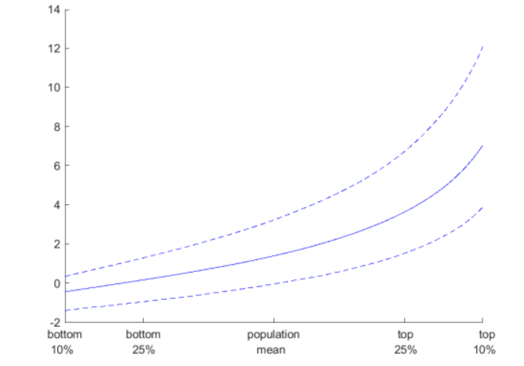
	Biomass		
	Distance (km)		
	Size		
	Number		

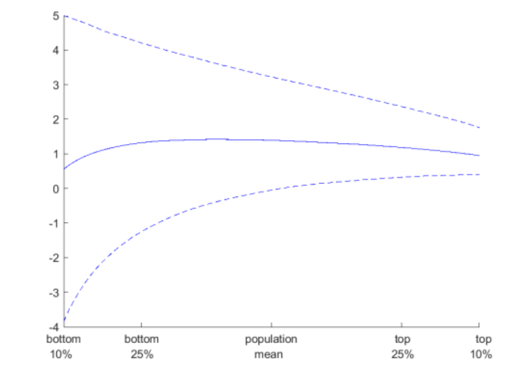
Protected area





Lines: Underground





The results in Figure 4 show that, in general, WTP significantly changes in beliefs over policy consequentiality. Increasing the strength of the policy-consequentiality belief is associated with increasing WTP for all labelled projects of renewable energy development, *Distance* and *Underground Lines*. The changes in WTP across varying strength of the policy-consequentiality belief are also statistically significant for the attribute *Size*: WTP for this attribute decreases in the strength of the belief. The effect of the payment-consequentiality belief, while significant for preferences for the project variants and cost sensitivity as concluded from the results in Part A of Table 5, does not appear to be significant for WTP. This is because the enhanced preferences for the non-monetary attributes are balanced by the increased sensitivity to cost. Hence, WTP appears not to change significantly across varying levels of the payment-consequentiality belief.

Figure 4 also evidences another difference in the impacts of the latent consequentiality beliefs on WTP. For all attributes, when the perceived policy consequentiality is very weak, WTP is close to zero. When the policy consequentiality diverges from the low levels, WTP changes substantially, becoming, in most cases, significantly different from zero. This implies that respondents believing in policy consequentiality reveal some (positive or negative) WTP for the considered project, in contrast to those not believing in policy consequentiality, whose

WTP does not differ significantly from zero for the majority of the attributes. The observed effect of the payment consequentiality is opposite. Respondents who do not believe in payment consequentiality seem often to declare some (positive or negative) WTP in the survey, while the stronger the payment-consequentiality belief gets, the closer the WTP converges to zero. In brief, policy consequentiality appears to encourage respondents to state some (positive or negative) WTP for the considered project, and payment consequentiality appears to lead to declaring zero WTP values.

4.2. Impact of risk attitude on stated preferences

Our supplement model, presented in this subsection, is used to examine whether respondents' attitudes towards risk affect their self-reported measures of consequentiality beliefs and stated preferences. We augment the baseline model from Subsection 4.1 with the third latent variable, LV_{risk}, which captures unobservable risk attitudes. The risk attitudes were elicited in the survey on the basis of the approach of Tanaka et al. (2010), as described in detail in Subsection 2.3. From their technique, we use here the number of choices of a safe lottery A in each of the two series of 14 lotteries (see Table 3 for details) as a measure of the latent variable LV_{risk}. We denote the numbers of safe lottery choices in Series 1 and Series 2 as variables $risk\_1$ and $risk\_2$, respectively. To account for the count data character of the variables $risk\_1$ and $risk\_2$ in the measurement equations, we adopt a Poisson regression approach.

Estimation results are presented in Table 6. LV_{risk} enters the discrete choice component of the model through interactions with the preference parameters. At the same time, it is informed through Measurement Equations 3 and 4 by explaining the variables $risk\_1$ and $risk\_2$. LV_{risk} is also incorporated in Measurement Equations 1 and 2 to verify its impact on self-reported measures of consequentiality. This way, LV_{pol} and LV_{pay} can be interpreted as beliefs over consequentiality net of risk attitudes (which are separately controlled for by including LV_{risk} in the measurement equations).

Table 6. Results of the hybrid choice model depicting the impact of risk attitudes on stated preferences

Part A: Discrete choice component					
	Means	**Standard deviations**	**Means interacted with** LV_{pol}	**Means interacted with** LV_{pay}	**Means interacted with** LV_{risk}
	Coefficients (Standard errors)				
Wind	1.9734*** (0.3420)	2.2338*** (0.2093)	4.9410*** (0.4525)	2.5111*** (0.4137)	-0.1828 (0.2597)
Biomass	0.9342*** (0.3532)	1.8014*** (0.2445)	4.4271*** (0.4594)	2.3155*** (0.4193)	-0.3089 (0.2455)
Solar	3.9503*** (0.3452)	2.1607*** (0.2007)	4.8556*** (0.5056)	2.7595*** (0.6334)	0.0551 (0.2730)
Distance (km)	0.3259*** (0.0531)	0.4720*** (0.0814)	0.1905** (0.0787)	-0.0846 (0.0920)	0.0248 (0.0508)
Size	-0.0544 (0.0691)	0.0138 (0.1701)	-0.2771*** (0.0940)	0.2392** (0.1042)	-0.0317 (0.0618)
Number	0.0069 (0.0378)	0.0325 (0.1386)	-0.0771 (0.0548)	0.0833 (0.0641)	-0.0143 (0.0368)
Protected area	0.7747*** (0.2916)	0.1142 (1.0140)	-0.8191* (0.4604)	1.0592** (0.4863)	0.4450 (0.2739)
Lines: Underground	0.1495* (0.0839)	0.3579* (0.2035)	0.2332* (0.1285)	0.0939 (0.1578)	-0.0413 (0.0794)
- *Cost per month (EUR)*	-1.7640*** (0.0864)	1.1223*** (0.0869)	-0.3345** (0.1412)	0.4476*** (0.0889)	0.2143*** (0.0686)

Part B: Measurement component	
	Measurement Equation 1 (ordered probit) Dependent variable: *pol*
	Coefficients (Standard errors)
LV_{pol}	0.2309*** (0.0578)
LV_{risk}	-0.0122 (0.0414)
Cutoff 1	-1.6728*** (0.0780)
Cutoff 2	-1.0416* (0.5764)
Cutoff 3	0.0523 (0.5881)
Cutoff 4	1.5807*** (0.5976)
	Measurement Equation 2 (ordered probit) Dependent variable: *pay*
	Coefficients (Standard errors)
LV_{pay}	0.3933*** (0.1085)
LV_{risk}	0.0305 (0.0429)

Cutoff 1	-1.8287*** (0.1050)
Cutoff 2	-1.0626*** (0.2077)
Cutoff 3	-0.0234 (0.3190)
Cutoff 4	1.2737*** (0.3742)
	Measurement Equation 3 (Poisson regression) Dependent variable: $risk\_1$
	Coefficients (Standard errors)
Constant	1.5706*** (0.0411)
LV_{risk}	0.8771*** (0.0376)
	Measurement Equation 4 (Poisson regression) Dependent variable: $risk\_2$
	Coefficients (Standard errors)
Constant	0.5806*** (0.0803)
LV_{risk}	1.6816*** (0.0762)

Part C: Model diagnostics	
LL at convergence	-10,794.63
LL at constant(s) only	-15,465.57
McFadden's pseudo-R^2	0.3020
Ben-Akiva-Lerman's pseudo-R^2	0.4842
AIC/*n*	4.5204
BIC/*n*	4.6026
n (the number of observations)	4,803
r (the number of respondents)	801
k (the number of parameters)	61

Note: The same notes apply as to Table 5.

Including LV_{risk} in the model does not change our earlier conclusions, which we take as evidence of their robustness. Measurement Equations 3 and 4 show that LV_{risk} correlates positively with the number of safe lotteries chosen in Series 1 and 2, respectively. Hence, high values of LV_{risk} express high risk aversion (and vice versa). From Measurement Equations 1 and 2, it follows that respondents' risk attitudes are generally not significant in explaining the self-reported measures of consequentiality beliefs: the perceptions about consequentiality appear not to be related to preferences towards risk. We, therefore, do not find support to the hypothesis following from the theoretical model of Mitani and Flores (2014). At the same time, our result are in line with their empirical findings. In an induced-value experiment, they observe that the impacts of perceptions about policy and payment consequentiality on stated preferences do not differ in risk attitudes.

Regarding the influence of risk attitudes on stated preferences, the discrete choice component reveals that risk attitudes affect statistically significantly only marginal utility associated with the monetary attribute (*Cost*). Strong aversion to risk is related to high sensitivity to cost and, hence, to low WTP values. This evidence adds to the scant literature in the field of environmental economics on the impact of risk attitudes on WTP (e.g., Faccioli et al. 2017). A similar relationship between risk attitudes and WTP to the one observed in our analysis has been found in previous studies. For example, Bartczak et al. (2015) report that respondents' risk attitudes are significantly related to choosing the status quo variant associated with zero cost, and Erdem et al. (2010) observe that strong risk aversion translates into low WTP.

5. Discussion and conclusions

We investigate the role of respondents' beliefs over a consequential character of a survey for their stated preferences. Specifically, we adopt the hybrid choice modelling framework as proposed by Czajkowski et al. (2017) to use respondents' statements about their perceptions about the survey policy and payment consequentiality as measures of their latent beliefs over these consequentiality aspects; and we analyse how the latent beliefs correlate with respondents' stated preferences. We find distinctive effects of policy and payment consequentiality. While both beliefs enhance respondents' preferences for implementing a renewable energy project (rather than sticking with the status quo), the effect of the latent belief over policy consequentiality is stronger. The latent consequentiality beliefs also appear to be significantly correlated with respondents' marginal utility of money but in opposite directions. Policy consequentiality lowers sensitivity to cost, increasing at the same time respondents' willingness to pay, while payment consequentiality enhances sensitivity to cost, reducing respondents' willingness to pay.

The observation that the latent beliefs over policy and payment consequentiality have different effects on respondents' stated preferences suggests that, while empirical studies should generally aim at designing the surveys so that they are consequential (Johnston et al. 2017), consequentiality is more complex than usually thought. Our study shows that policy and payment consequentiality can and should be measured separately. Both aspects of consequentiality may play an important role for truthful disclosure of preferences by respondents. Also, the beliefs over policy and payment consequentiality are likely to be influenced using different scripts. Disaggregating policy and payment consequentiality can possibly explain some of the mixed evidence in the literature on the effect of consequentiality on stated preferences. As discussed in more detail the Introduction, consequentiality is observed to increase respondents' interest in the project under consideration (e.g., Herriges et al. 2010; Vossler and Watson, 2013), to reduce this interest (e.g., Vossler et al. 2012), or not to affect this interest at all (e.g., Broadbent 2012; Oehlmann and Meyerhoff 2017).

In our study, we also inquire whether respondents' beliefs over policy and payment consequentiality are linked to their risk attitudes. We find no evident connection: respondents' latent risk attitudes are not significant explanatory variables of their perceptions about consequentiality. At the same time, in line with existing empirical evidence, risk attitudes are observed to significantly influence respondents' marginal utility from money, which leads to the result that strong risk aversion lowers willingness to pay for the considered project of expanding renewable energy infrastructure. Overall, our results do not support the hypothesis of Mitani and Flores (2014) derived from their theoretical model, which links the relationship between beliefs over policy and payment consequentiality with respondents' risk attitudes and stated preferences.

Several limitations of our study need to be acknowledged. First, the hybrid choice framework is able to identify latent constructs and describe their correlations with measurement variables and stated preferences. These latent constructs, however, need to be interpreted by a researcher. It is not unusual for latent variables to, for example, significantly explain stated preferences but not to be significantly linked with any of the measurement variables in the measurement equations. In such a case, the latent variables uncover additional preference heterogeneity structures, which are not necessarily related to what they are intended to capture. In our models, all latent variables are significantly correlated with the respective measurement variables, giving support to our interpretation, but the usual reservations towards the interpretation of latent variables apply. Second, the links between latent variables, stated preferences and attitudes or perceptions are correlations and, thus, caution should be exercised when inferring about causality. Because of the indefinite causality, other interpretations are possible, including external drivers of the effects reported. For example, respondents who have a more agreeable nature may be more likely to choose other variants than the status quo and, at the same time, they may be more likely to agree that the survey is consequential (Boyce et al. 2017). A carefully designed experimental study exogenously varying policy and payment consequentiality levels could possibly shed more light on the causational relationship between influencing respondents' beliefs and the effects for their preferences. Third, while respondents' risk attitudes were assessed with two measurement questions, the each of the consequentiality beliefs was measured on the basis of a single Likert-scale question. Although using a single question to elicit consequentiality perceptions is a common practice in stated preference studies, it remains unknown if the unobservable beliefs can be captured well through the single question. We acknowledge that the usual practice in other fields (e.g., psychometrics) is to use multiple measurement questions. In addition, future studies could use both direct (stated) and indirect measures of respondents' latent consequentiality perceptions, utilising such information as whether the respondents currently pay any taxes, intend to retire etc. Finally, we note that the econometric framework employed here is potentially sensitive to endogeneity problems (for example, in the case when stated beliefs are correlated with other unobserved factors that influence respondents' choices; Budziński and Czajkowski 2017), and that the specification used does not allow for correlation of the latent variables. Addressing these shortcomings requires modifying the model specification and assuring the model is identified, which, we believe, would be a valuable addition. Investigating further the correlation of the latent beliefs over policy and payment consequentiality seems especially interesting.

In summary, our study evidences the importance of separately addressing policy and payment consequentiality in stated preference surveys. We find that these two characteristics can be independently measured and influence respondents' choices in different ways. In addition, we investigate the link between respondents' risk attitudes and the latent consequentiality beliefs, and we observe that, at least in the case of our research, the two concepts are largely unrelated. Overall, our study provides new evidence for the role of survey consequentiality, as a necessary condition for incentive compatibility and truthful revelation of preferences.

References

Bahamonde-Birke, F. J., Ortúzar, J. d. D. 2017. Analyzing the continuity of attitudinal and perceptual indicators in hybrid choice models. Journal of Choice Modelling 25, 28−39. http://dx.doi.org/10.1016/j.jocm.2017.01.003

Bartczak, A., Chilton, S., Czajkowski, M., Meyerhoff, J. 2017. Gain and loss of money in a choice experiment. The impact of financial loss aversion and risk preferences on willingness to pay to avoid renewable energy externalities. Energy Economics 65, 326–334.

Bartczak, A., Mariel, P., Chilton, S., Meyerhoff, J. 2015. The impact of latent risk preferences on valuing the preservation of threatened lynx populations in Poland. Australian Journal of Agricultural and Resource Economics 60 (2), 284−306.

Ben-Akiva, M., McFadden, D., Train, K., Walker, J., Bhat, C., Bierlaire, M., . . . Munizaga, M. 2002. Hybrid Choice Models: Progress and Challenges. Marketing Letters 13 (3), 163−175. doi:10.1023/A:1020254301302

Boyce, C., Czajkowski, M., Hanley, N. 2017. Personality and Economic Choices. Working Paper 11/2017 (240). Department of Economics, University of Warsaw, Poland.

Broadbent, C.D. 2012. Hypothetical Bias, Consequentiality and Choice Experiments. Economics Bulletin 32 (3), 2490-2499.

Broadbent, C.D., Grandy, J.B., Berrens, R. 2010. Testing for Hypothetical Bias in a Choice Experiment Using a Local Public Good: Riparian Forest Restoration. International Journal of Ecological Economics and Statistics 19 (F10), 1−19.

Budziński, W., Czajkowski, M. 2017. Addressing measurement error and endogeneity in hybrid choice models. Paper presented at the 23rd Annual Conference of the European Association of Environmental and Resource Economists, April 3−5, Athens, Greece.

Bulte, E., Gerking, S., List, J. A., de Zeeuw, A. 2005. The Effect of Varying the Causes of Environmental Problems on Stated WTP Values: Evidence from a Field Study. Journal of Environmental Economics and Management 49 (2), 330−342.

Carson, R.T., Groves, T. 2007. Incentive and informational properties of preference questions. Environmental and Resource Economics 37 (1), 181−210.

Carson, R.T., Groves, T., List, J.A. 2014. Consequentiality: A Theoretical and Experimental Exploration of a Single Binary Choice. Journal of the Association of Environmental and Resource Economists 1 (1/2), 171−207.

Champ, P., Flores, N. E., Brown, T., Chivers, J. 2002. Contingent Valuation and Incentives. Land Economics 78 (4), 591–604.

Cummings, R. G., Osborne Taylor, L. 1998. Does Realism Matter in Contingent Valuation Surveys? Land Economics 74 (2), 203−215.

Czajkowski, M., Hanley, N., and Nyborg, K. 2017. Social norms, morals and self-interest as determinants of pro-environment behaviours: The case of household recycling. Environmental and Resource Economics 66 (4), 647−670.

Czajkowski, M., Vossler, C.A., Budziński, W., Wiśniewska, A., Zawojska, E. 2017. Addressing empirical challenges related to the incentive compatibility of stated preference methods. Journal of Economic Behavior and Organization 142, 47−63.

Daly, A., Hess, S., Patruni, B., Potoglou, D., Rohr, C. 2012. Using ordered attitudinal indicators in a latent variable choice model: a study of the impact of security on rail travel behaviour. Transportation 39 (2), 267−297. doi:10.1007/s11116-011-9351-z

Drichoutis, A.C., Vassilopoulos, A., Lusk, J.L., Nayga, R.M., Jr. 2015. Reference Dependence, Consequentiality and Social Desirability in Value Elicitation: A Study of Fair Labor Labeling. Paper presented at the 143rd Joint EAAE-AAEA Seminar, March 25−27, Naples, Italy.

Erdem, C., Senturk, I., Simsek, T. 2010. Identifying the factors affecting the willingness to pay for fuel-efficient vehicles in Turkey: A case of hybrids. Energy Policy 38 (6), 3038−3043.

Faccioli, M., Kuhfuss, L., Czajkowski, M. 2017. Stated preferences for conservation policies under uncertainty: Insights on individuals' risk attitudes in the environmental domain. Working Paper 7/2017 (236). Department of Economics, University of Warsaw, Poland.

Flores, N.E., Strong, A. 2007. Cost Credibility and the Stated Preference Analysis of Public Goods. Resource and Energy Economics 29 (3), 195–205.

Forbes, K., Boxall, P., Adamowicz, W., De Maio Sukic, A. 2015. Recovering Pacific Rockfish at Risk: The Economic Valuation of Management Actions. Frontiers in Marine Science 2 (71), 1−10.

Groothuis, P.A., Mohr, T.M., Whitehead, J.C., Cockerill, K. 2017. Endogenous Consequentiality in Stated Preference Referendum Data: The Influence of the Randomly Assigned Tax Amount. Land Economics 93 (2), 258−268. doi:10.3368/le.93.2.258

Herriges, J., Kling, C., Liu, C.-C., and Tobias, J. 2010. What are the consequences of consequentiality? Journal of Environmental Economics and Management 59(1), 67−81. http://dx.doi.org/10.1016/j.jeem.2009.03.004

Hess, S., Beharry-Borg, N. (2011). Accounting for Latent Attitudes in Willingness-to-Pay Studies: The Case of Coastal Water Quality Improvements in Tobago. Environmental and Resource Economics 52 (1), 109−131. doi:10.1007/s10640-011-9522-6

Hwang, J., Petrolia, D.R., Interis, M.G. (2014). Valuation, Consequentiality, and Opt-Out Responses to Stated Preference Surveys. Agricultural and Resource Economics Review 43 (3), 471−488.

Interis, M.G., Petrolia, D.R. (2014). The Effects of Consequentiality in Binary- and Multinomial-Choice Surveys. Journal of Agricultural and Resource Economics 29 (2) 201−216.

Johnston, R.J., Boyle, K.J., Adamowicz, W., Bennett, J., Brouwer, R., Cameron, T.A., . . . Vossler, C.A. 2017. Contemporary Guidance for Stated Preference Studies. Journal of the Association of Environmental and Resource Economists 4 (2), 319−405.

Kataria, M., Bateman, I., Christensen, T., Dubgaard, A., Hasler, B., Hime, S., . . . Nissen, C. 2012. Scenario Realism and Welfare Estimates in Choice Experiments – A Non-Market Valuation Study on the European Water Framework Directive. Journal of Environmental Management 94 (1), 25−33.

Kling, C.L., Phaneuf, D.J., Zhao, J. 2012. From Exxon to BP: Has Some Number Become Better than No Number? The Journal of Economic Perspectives 26 (4), 3−26. doi:10.2307/23290277

Krinsky, I., Robb, A. L. (1986). On Approximating the Sstatistical Properties of Elasticities. The Review of Economics and Statistics 68(4), 715−719.

Landry, C.E., List, J.A. 2007. Using Ex Ante Approaches to Obtain Credible Signals for Value in Contingent Markets: Evidence from the Field. American Journal of Agricultural Economics 89 (2), 420−429.

Lewis, K.E., Grebitus, C., Nayga, R.M., Jr. 2016. U.S. consumers' Preferences for Imported and Genetically Modified Sugar: Examining Policy Consequentiality in a Choice Experiment. Journal of Behavioral and Experimental Economics 65, 1−8. http://dx.doi.org/10.1016/j.socec.2016.10.001

Li, X., Jensen, K.L., Clark, C.D., Lambert, D.M. 2015. Scale Heterogeneity, Consequentiality, and Willingness-to-Pay for Public Goods: The Case of Beef Choices. Paper presented at the Agricultural and Applied Economics Association and Western Agricultural Economics Association Joint Annual Meeting, July 26−28, San Francisco, CA.

Manisera, M., Zuccolotto, P. 2014. Modeling "don't know" Responses in Rating Scales. Pattern Recognition Letters, 45, 226-234.

Mariel, P., Meyerhoff, J. 2016. Hybrid discrete choice models: Gained insights versus increasing effort. Science of The Total Environment 568, 433−443. https://doi.org/10.1016/j.scitotenv.2016.06.019

McFadden, D. (1974). Conditional Logit Analysis of Qualititative Choice Behaviour, in: P. Zarembka (Ed.), Frontiers in Econometrics. New York, NY: Academic Press, pp. 105−142.

Mitani, Y., Flores, N.E. (2010). Public goods referenda without perfectly correlated prices and quantities. Paper presented at the 4th World Congress of Environmental and Resource Economists, June 28−July 2, Montreal, Canada.

Mitani, Y., Flores, N. E. (2012). Robustness Tests of Incentive Compatible Referenda: Consequential Probability, Group Size, and Value-cost Difference. Paper presented at the 19th Annual Conference of European Association of Environmental and Resource Economists, June 27−30, Prague, Czech Rebuplic.

Mitani, Y., Flores, N. E. (2014). Hypothetical Bias Reconsidered: Payment and Provision Uncertainties in a Threshold Provision Mechanism. Environmental and Resource Economics 59(3), 433−454.

Nepal, M., Berrens, R.P., Bohara, A.K. 2009. Assessing Perceived Consequentiality: Evidence from a Contingent Valuation Survey on Global Climate Change. International Journal of Ecological Economics and Statistics 14 (P09), 14−29.

Oehlmann, M., Meyerhoff, J. 2017. Stated Preferences Towards Renewable Energy Alternatives in Germany – Do the Consequentiality of the Survey and Trust in Institutions Matter? Journal of Environmental Economics and Policy 6 (1), 1−16.

Raveau, S., Yáñez, M.F., Ortúzar, J. d. D. 2012. Practical and Empirical Identifiability of Hybrid Discrete Choice Models. Transportation Research Part B: Methodological 46 (10), 1374−1383. http://dx.doi.org/10.1016/j.trb.2012.06.006

Scarpa, R., Rose, J.M. 2008. Design Efficiency for Non-Market Valuation with Choice Modelling: How to Measure it, What to Report and Why. Australian Journal of Agricultural and Resource Economics 52 (3), 253−282.

Schafer, J.L., Graham, J. W. 2002. Missing Data: Our View of the State of the Art. Psychological Methods 7 (2), 147−177.

Strong, A., Flores, N.E. 2006. Estimating the economic benefits of the clean up of acidic rock drainage using cost shares. Working Paper. Department of Economics, University of Colorado, CO.

Tanaka, T., Camerer, C.F., Nguyen, Q. 2010. Risk and time preferences: Linking experimental and household survey data from Vietnam. American Economic Review 100 (1), 557−571.

Vossler, C.A., Bergeron, S., Doyon, M., Rondeau, D. 2017. Revisiting the gap between the willingness-to-pay and willingness-to-accept for public goods. Paper presented at the Association of Environmental and Resource Economists Summer Conference, May 31 − June 2, Pittsburgh, PA.

Vossler, C.A., Doyon, M., Rondeau, D. 2012. Truth in consequentiality: theory and field evidence on discrete choice experiments. American Economic Journal: Microeconomics 4 (4), 145−171.

Vossler, C.A., and Holladay, S. 2016. Alternative Value Elicitation Formats in Contingent Valuation: A New Hope. Paper presented at the 22'nd Annual Conference of European Association of Environmental and Resource Economists, June 22−25, Zurich, Switzerland.

Vossler, C.A., Watson, S.B. 2013. Understanding the Consequences of Consequentiality: Testing the Validity of Stated Preferences in the Field. Journal of Economic Behavior and Organization 86, 137−147. http://dx.doi.org/10.1016/j.jebo.2012.12.007

Zawojska, E., Czajkowski, M. 2017. Re-examining empirical evidence on stated preferences: Importance of incentive compatibility. Journal of Environmental Economics and Policy 6 (4), 374−403.

University of Warsaw
Faculty of Economic Sciences
44/50 Długa St.
00-241 Warsaw
www.wne.uw.edu.pl