Disentangling impacts of payment and provision consequentiality and risk attitudes on stated preferences

Ewa Zawojska, Anna Bartczak, Mikołaj Czajkowski

University of Warsaw, Faculty of Economic Sciences, Poland

Abstract: Stated preference literature suggests that to be incentivised to reveal preferences truthfully in a survey, respondents need to believe that a response in favour of a policy project of providing a public good increases chances of actual provision of the good (policy consequentiality) and that the cost of conducing the policy project stated in a survey will be actually collected upon the policy implementation (payment consequentiality). We investigate the effects of the two aspects of consequentiality beliefs on stated preferences in a field survey concerning renewable energy development in Poland. Using a hybrid choice model to capture unobservable beliefs in consequentiality, we find that latent beliefs in policy consequentiality and in payment consequentiality affect stated preferences differently: respondents believing in policy consequentiality prefer the project implementation to the status quo more than those believing in payment consequentiality; respondents believing in payment consequentiality state significantly lower willingness to pay for the project than those believing in policy consequentiality. Respondents with no clear opinion on the degree of the survey's consequentiality reveal substantially different preferences; they are much less interested in seeing the proposed project implemented. We also find that respondents' risk attitudes do not impinge neither on their self-reported perceptions over the survey's consequentiality nor on their preferences.

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

JEL codes: D12, Q40, Q48, Q51, Q55

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1. Introduction

Assessing the value of public goods is challenging as no market for them exist and, thereby, market transactions cannot inform about the value of public goods. At the same time, knowledge about the value of public goods is essential for such allocation of resources that maximises social welfare. A currently leading method for evaluating public goods is a stated preference approach. The technique infers the value of public goods from respondents' preferences disclosed in a survey. Despite long, more-than-fifty-year, history of using this methodology, concerns remain whether survey answers represent respondents' actual preferences. This contests validity of value estimates derived from stated preference data and limits their use for policy purposes. This study addresses the problem how to make survey-based value estimates reflect respondents' true preferences.

Theoretical literature (Carson and Groves, 2007; Vossler et al., 2012) identifies conditions under which a stated preference survey provides respondents with incentives to reveal their preferences truthfully (so-called conditions for incentive compatibility). These conditions refer to respondents' (unobservable) beliefs: a response in favour of a policy project of providing a public good needs to be seen to increase the probability of actual provision of the good (policy consequentiality) and the cost of the policy project realisation stated in a survey must be perceived as possible to be actually collected upon policy implementation (payment consequentiality).

Empirical research that investigates the impact of consequentiality on preference disclosure is mounting up (Zawojska and Czajkowski, 2015). Some studies define a probability with which a survey's outcome will be binding and examine the influence of this probability on respondents' behaviour (Carson et al., 2014; Cummings and Taylor, 1998; Landry and List, 2007; Mitani and Flores, 2012). Some test how respondents' stated preferences are affected by including or excluding scripts that inform about a survey's consequential character (Bulte et al., 2005; Czajkowski et al., 2015). Some ask respondents about their perceptions over survey's consequentiality and check how stated preferences differ in these perceptions (Broadbent, 2012; Broadbent et al., 2010; Czajkowski et al., 2015; Drichoutis et al., 2015; Forbes et al., 2015; Groothuis et al., 2015; Herriges et al., 2010; Hwang et al., 2014; Interis and Petrolia, 2014; Lewis et al., 2016; Li et al., 2015; Nepal et al., 2009; Oehlmann and Meyerhoff, 2016; Vossler et al., 2012; Vossler and Watson, 2013).[1] Despite the broad empirical evidence on the role of consequentiality for preference elicitation, existing research barely differentiates between the effects of policy consequentiality and payment consequentiality on stated preferences.

Two exceptions are noteworthy. Mitani and Flores (2014) show in a theoretical model how truthful preference disclosure is affected by probabilities of good provision and payment collection, and next test the theoretical predictions empirically in an induced-value lab experiment. In a field survey, Oehlmann and Meyerhoff (2016) measure respondents' beliefs over policy consequentiality and payment consequentiality separately, however, in a subsequent analysis of stated preferences they examine only the role of policy consequentiality.

In this paper, we aim at deepening the understanding of the influence of consequentiality, in particular, by distinguishing between the impacts of policy and payment consequentiality on respondents' behaviour in a survey. We inquire this problem in a field study. Our research contributes to the existing literature by addressing following two issues.

First, we consider how respondents' unobserved beliefs about consequentiality can be captured. Data on these beliefs is typically collected through respondents' self-reports to a question such as how strongly they believe that the survey's outcome will be used for future policy purposes. Respondents indicate the strength of their belief in consequentiality on a Likert scale ranging from two (Broadbent, 2012; Broadbent et al., 2010) to several levels (for example, Czajkowski et al., 2015; Herriges et al., 2010; Vossler et al., 2012). A general question as the one mentioned does not, however,

[1] We note that incentive compatibility conditions actually refer to respondents' perceptions over consequentiality and not to survey's consequentiality stated by a researcher in a survey's script. This distinction is especially important given mixed evidence on whether respondents' consequentiality beliefs can be affected by consequentiality scripts (see, for example, Czajkowski et al., 2015; Oehlmann and Meyerhoff, 2016).

allow a researcher to distinguish between self-perceived policy consequentiality and payment consequentiality, while the impact of each of these perceptions on stated preferences may be different. A researcher does not know how a respondent interprets the question: whether her answer indicates rather a belief in actual provision of the good or rather a belief in actual collection of the payment. Empirical evidence on the influence of the two aspects of consequentiality could help design questions to better measure respondents' unobservable beliefs about consequentiality. Researchers raise a doubt whether the commonly used question captures these beliefs well (Czajkowski et al., 2015; Kling et al., 2012). To the best of our knowledge, none of the existing studies examines separately the effects of respondents' beliefs about the two aspects of consequentiality on stated preferences in a field context. We address this issue by including in the survey individual questions to assess respondents' perceptions over policy consequentiality and payment consequentiality, and by subsequent econometric modelling of the impacts of these perceptions.

Second, we empirically verify a claim suggested in theoretical work that for truthful preference revelation, not only the positive strength levels of the beliefs in policy consequentiality and payment consequentiality matter (a so-called knife-edge result; Carson and Groves, 2007)[2], but also the relation between the two levels, namely which belief is stronger / weaker (Mitani and Flores, 2014). The impact of this relation on preference disclosure is hypothesised to vary depending on a respondent's risk attitude. 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 higher than the provision probability. We test empirically the influence of a respondent's risk attitude on preferences stated in a survey, and verify its correlation with beliefs in policy consequentiality and payment consequentiality.

The two issues are addressed in the study of preferences towards development of renewable energy infrastructure. Our base model focuses on the influence of consequentiality perceptions on stated preferences. To incorporate the self-reported measures of beliefs about consequentiality into econometric modelling of preferences, we apply a hybrid mixed logit framework (Czajkowski et al., 2015). The unobservable beliefs are modelled as latent variables. These latent variables were assessed in a survey on a five-point Likert scale. Our supplement model includes additionally a latent variable related to respondents' (unobservable) risk attitudes, which allows us to test the role of risk attitudes for stated preferences. Risk attitudes were measured in the survey through an approach suggested by Tanaka et al. (2010), in which respondents made choices in sequences of price lotteries.

We find that latent beliefs in policy consequentiality and payment consequentiality are strongly correlated with the self-reported measures of the respective beliefs and affect stated preferences significantly, but in different ways. Respondents believing in policy consequentiality prefer the project implementation to the current state (status quo) more than those believing in payment consequentiality. At the same time, the cost of the project decreases to a larger extent the utility of respondents believing in payment consequentiality than the utility of those believing in policy consequentiality. Interestingly, we also observe that preferences of respondents who do not have a definite opinion on the degree of either of the two consequentiality aspects are significantly different from the rest of the sample; these respondents appear much less interested in seeing the proposed project implemented. Finally, we find 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 paper is structured as follows. Section 2 provides details about the survey instrument applied for data collection. Section 3 outlines the econometric approach we use for modelling

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

preferences and for linking them with unobservable consequentiality perceptions and risk attitudes. Section 4 discusses results of our empirical analysis. Section 5 concludes.

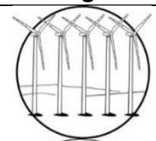
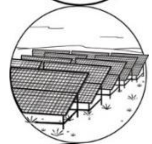
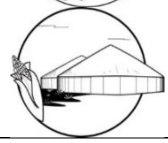
2. Empirical study

We examine the role of consequentiality beliefs on stated preferences in the context of a field survey that elicits preferences of Polish citizens towards development of renewable energy infrastructure. The survey contained five sections. The first section informed respondents about various renewable energy sources (which included wind, sun and biomass, as the survey elicited respondents' preferences towards these types of energy), and asked respondents several warm-up questions about their exposure to renewable energy and their attitudes towards it. The second section employed a discrete choice experiment to elicit respondents' preferences towards development of renewable energy infrastructure. The third section asked about respondents' beliefs in consequentiality. The fourth section measured respondents' risk attitudes. The fifth section collected socio-demographic data. Next subsections provide details about the survey's sections and the survey's implementation.

2.1. A discrete choice experiment

In the discrete choice experiment respondents were provided with a sequence of questions (choice tasks), each of which presented four variants of development of renewable energy sites. In every question 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 in each choice task 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 renewable energy development, together with pictograms used for their illustration, are shown in Table 1.

Table 1. Definitions and pictograms for the considered renewable energy sources

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 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 specified in Table 2, together with their levels used in the survey.

Table 2. Attributes (and their levels) for describing variants of renewable energy development

Attribute	Description	Levels
Distance	A minimum distance of a renewable energy site from residential areas	[in meters] 300, 600, 900 (FSQ), 1600, 2500
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	[in PLN] -20, -10, 0 (FSQ), +5, +15, +30, +50

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* was defined as 5-10 turbines, *Medium* as 18-25 turbines and *Large* as 35-50 turbines. For solar energy, each level of the attribute 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.

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.

Variants of renewable energy development were generated based on a Bayesian C-efficient design optimised for the MNL model with dominated variants 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.

Figure 1. An example of a choice task[3]

	Wind energy	**Biomass energy**	**Solar energy**	**I am indifferent**
A minimum distance of a renewable energy site from residential areas	600 m	2500 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	☐	☐	☐	☐

2.2. Measures of consequentiality perceptions

After the discrete choice experiment, information was collected about respondents' perceptions over policy consequentiality and payment consequentiality. Respondents were asked to indicate to what degree they agree with the following statements:

- "The project of development of renewable energy infrastructure will indeed be conducted in Poland in the next five years."
- "For the purpose of development of renewable energy infrastructure, the electricity bill will indeed change in the next five years."[4]

Hitherto, we refer to the first statement as a policy consequentiality question and to the second statement as a payment policy question. Each statement was assessed on a five degree Likert scale that included responses: "I definitely agree", "I agree", "I do not know", "I disagree" and "I definitely disagree". 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 introduction of changes in the electricity bill). In addition, we pay particular attention to whether "I do not know" can be treated as a continuous mid-scale response, or it represents an inherently different attitude towards the issue; we find that it is the latter.

[3] The original questionnaire was in Polish. Figure 1 presents a translated choice task.
[4] Both statements were originally in Polish. Here translations are provided.

2.3. Measures of risk attitudes

In the next section of the survey, we employed a design developed by Tanaka et al. (2010) to elicit respondents' risk attitudes. This design allows to determine individuals' preferences towards risk in a financial domain. Given that the considered project of renewable energy 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 on the basis of their choices in two series of pair-wise comparisons of lotteries.[5] The series are presented in Table 3. Every lottery was characterised by two payoffs with assigned probabilities. In every comparison, respondents faced a set of two lotteries (A and B) and 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; everything else was held fixed.

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
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.

[5] In addition, the survey contained a third series of pair-wise lottery comparisons to assess a respondent's degree of loss aversion. Here, however, we do not use this data because we do not address the issue of loss aversion.

In every comparison, the difference between the possible payoffs in lottery A is much smaller than the difference between the possible payoffs in lottery B. Simplifying, we can say 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 preferences: 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 beginning.

2.4. Survey implementation

The survey was conducted in January 2016 and, in total, 800 respondents took part in it. Data was collected through face-to-face, computer-assisted personal interviews (CAPI) administered by a professional polling agency. Quotas were implemented to match the sample with the adult population of Poland in terms of gender, age, size of the place of residence and its geographical location. The final sample used for analysis consists of 744 respondents, because we exclude those who chose the same column in all presented choice tasks and in the lottery series. Socio-demographic characteristics of the final sample are presented in Table 4.

Table 4. Socio-demographic characteristics of the sample used for analysis

	Shares / Means
Women	53%
Age	49
Education	
Primary / Elementary	37%
Secondary	35%
High / Higher	28%
Net monthly individual income in PLN (in EUR)	1,965 PLN (491.25 EUR)

Note: To calculate income in EUR, we used the exchange rate of 1 EUR = 4 PLN.

The survey was designed based on interviews and extensive pretesting with individuals representative to 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 EnergyEFFAR project[6]. Pretesting within the German project involved six focus groups and two pilot studies, one with work colleagues and another with representatives from the general population of Germany.

3. Econometric framework

In modelling respondents' preferences towards renewable energy development and variation of the preferences related to unobservable consequentiality beliefs and risk attitudes, we follow the approach used by Czajkowski et al. (2015). This approach belongs to the class of hybrid choice models (Ben-Akiva et al., 2002), which are structural models that incorporate choice and non-choice components. In our base model, the choice component comes from the discrete choice experiment, while the non-choice component is based on self-reported measures of unobservable perceptions over consequentiality. The non-choice component in our supplement model includes additionally measures of unobservable risk attitudes.

The theoretical foundation of our model is provided by a random utility framework (McFadden, 1974), which assumes that individuals derive utility from observed characteristics of a

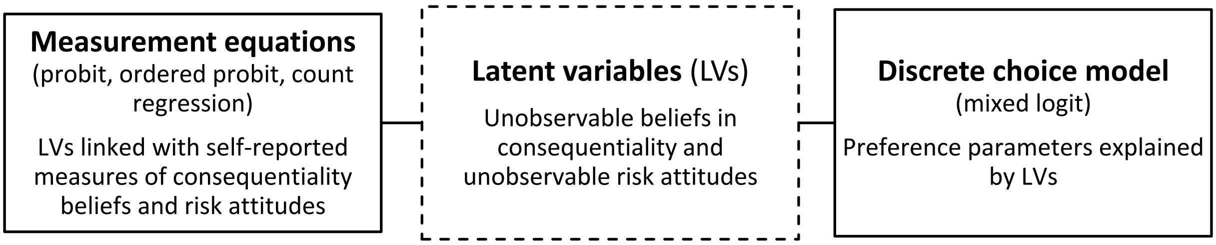
[6] Project "Efficient and fair allocation of renewable energy production at the national level" funded by the Federal Ministry of Education and Research in Germany.

good (here, features of a renewable energy project) and unobserved idiosyncrasies. Following this theory, analysts identify respondents' preferences on the basis of 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 to examine the influence of these unobservable factors on stated preferences. In our study, we consider several unobservable factors: beliefs in policy consequentiality, beliefs in payment consequentiality and attitudes towards risk. The survey provides measures of each of these factors through respondents' self-reports to consequentiality questions and their answers in lottery comparisons. Common practice is to include stated measures directly into the choice model as explanatory variables. However, this may give rise to a problem of measurement error because stated measures express imprecisely respondents' actual (inner) beliefs in consequentiality and their risk attitudes. Hybrid choice models address this issue.

In the context of our study, we assume there are several unobservable factors that affect preferences and that at the same time are measured (though imprecisely) in a survey by respondents' self-reports to consequentiality questions and their answers in lottery comparisons. These factors are captured in the model by separate latent variables. Our hybrid choice model consists of two part: 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.[7]

Figure 2. Components of our econometric modelling approach



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

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

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 project's characteristics; and the stochastic element ε captures factors unobserved by the econometrician that influence the individual's utility (choices). The expression in 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 to capture heterogeneity of respondents' preferences towards the characteristics of the considered project, and results in a mixed

[7] The software codes for the model have been developed in Matlab and are available at github.com/czaj/DCE under Creative Commons BY 4.0 license.

logit specification.[8] Instead of separately estimating the parameters for each individual, we follow 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 risk attitudes). We denote a vector of individual-specific latent variables by $\mathbf{LV}_i$. Then, 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[9] 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 by 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 is of unknown, possibly heteroskedastic variance. Identification of the model typically relies on normalising its variance (Daly et al., 2012), such that the stochastic element is independent and identically distributed following the type I extreme value distribution with constant variance equal to $\pi^2/6$. This generates convenient close-form formulas for choice probabilities. We note that because of the ordinal nature of utility, this normalisation does not change the properties of the utility function: it still represents the same preferences. The estimates of the model parameters, which can now be seen as products of preference parameters and a scaling coefficient, do not have direct interpretation anyway.

3.2. Measurement equations

We define latent variables to capture respondents' beliefs in policy consequentiality and in 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, for instance, 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 these factors. Measurement equations model the self-reported measures of the beliefs (and risk attitudes) as a function the latent variables. Formally, this relationship can be expressed as

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

where $\mathbf{I}_i$ are indicator variables (self-reported measures of unobservable factors), $\boldsymbol{\Gamma}$ is a matrix of coefficients 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 mean of each latent variable in $\mathbf{LV}_i$ is normalised to zero, and to assure identification, the variance of every latent variable is 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 measurement equations and in interactions with preference parameters) can easily be assessed.

Respondents' beliefs in policy consequentiality and in payment consequentiality were self-reported on five-point Likert scales. Risk attitudes were measured through the number of safe or risky

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

[9] The number of columns in Λ is equal to the number of latent variables and the number of rows in Λ is equal to the number of non-monetary attributes.

lotteries chosen. Therefore, we use different functional forms in the measurement component of the hybrid choice model: stated consequentiality beliefs are modelled using ordered probit, while choices expressing risk attitudes are modelled through Poisson regressions. Additionally, observing that the survey behaviour of the respondents who did not express their consequentiality perceptions unambiguously (that is, those who answered "I do not know" to any of the two consequentiality questions) differed significantly from the rest of the sample, we include separate latent variables to capture indefinite beliefs in policy consequentiality and in payment consequentiality. Self-reported measures of these beliefs are modelled through binary probit regressions.

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 in policy consequentiality and in 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 Sections 4.1 and 4.2, respectively.

4.1. Impact of policy and payment consequentiality on stated preferences

Our main model specification includes four latent variables: a belief in policy consequentiality (strength of the belief that the considered project will be actually conducted; LV_{pol}), a belief in payment consequentiality (strength of the belief that the payment will be actually collected upon implementing the project; LV_{pay}), lack of opinion on policy consequentiality (LV_{pol-dk}) and lack of opinion on payment consequentiality (LV_{pay-dk}). Table 5 presents survey-based measures of the latent variables and defines the variables used in the model that express the observed measures.

Table 5. Survey-based measures of the latent variables

Latent variable	Measure based on survey responses	Variable expressing the observed measure
LV_{pol}	Five-level Likert-scale responses to the policy consequentiality question	A five-level, ordered variable pol, where 1 is associated with a lack of / weak policy consequentiality belief and 5 with a strong policy consequentiality belief
LV_{pay}	Five-level Likert-scale responses to the payment consequentiality question	A five-level, ordered variable pay, where 1 is associated with a lack of / weak payment consequentiality belief and 5 with a strong payment consequentiality belief
LV_{pol_dk}	An answer "I do not know" to the policy consequentiality question	A binary variable pol_dk, where 1 indicates a lack of opinion on policy consequentiality (the answer "I do not know")
LV_{pay_dk}	An answer "I do not know" to the payment consequentiality question	A binary variable pay_dk, where 1 indicates a lack of opinion on payment consequentiality (the answer "I do not know")

The estimation results are shown in Table 6. We present the discrete choice component in Part A of the table and the measurement component in Part B. Part C contains the model characteristics. When interpreting the model results, we often refer to willingness to pay. The willingness-to-pay value expresses respondent's preferences in monetary terms. Marginal willingness to pay for each of the considered attributes is calculated as a ratio of the coefficient of a given non-monetary attribute to a negative of the coefficient of a monetary attribute.

Table 6. Results of the hybrid choice model depicting impacts of policy and payment consequentiality

Part A: Discrete choice component

	Means	**Standard Deviations**	**Means interacted with** LV_{pol}	**Means interacted with** LV_{pay}	**Means interacted with** LV_{pol_dk}	**Means interacted with** LV_{pay_dk}
	Coefficients (Standard Errors)					
Wind	1.842*** (0.332)	2.013*** (0.210)	2.666*** (0.585)	-0.058 (0.378)	-1.969*** (0.414)	-3.300*** (0.539)
Solar	3.764*** (0.331)	1.791*** (0.250)	2.165*** (0.620)	-0.152 (0.364)	-1.992*** (0.433)	-3.868*** (0.525)
Biomass	0.770** (0.341)	1.270*** (0.295)	3.062*** (0.549)	-0.096 (0.371)	-0.938** (0.381)	-2.874*** (0.521)
Distance (km)	0.326*** (0.054)	0.430*** (0.094)	0.175** (0.082)	-0.109 (0.080)	0.027 (0.102)	-0.061 (0.099)
Size	-0.033 (0.071)	0.012 (0.204)	-0.149 (0.101)	0.243** (0.099)	0.169 (0.109)	-0.003 (0.120)
Number	-0.007 (0.040)	0.033 (0.121)	0.039 (0.061)	0.107* (0.058)	0.088 (0.065)	0.027 (0.069)
Protected area	0.686** (0.300)	0.198 (1.091)	-0.081 (0.498)	0.705 (0.528)	1.348*** (0.512)	-0.266 (0.550)
Lines – Underground	0.212** (0.088)	0.199 (0.504)	0.117 (0.133)	-0.204 (0.129)	0.147 (0.167)	-0.343** (0.168)
(A negative of) Cost per month (EUR)	-1.720*** (0.085)	0.867*** (0.131)	-0.565*** (0.147)	0.479*** (0.140)	0.313* (0.176)	-0.408*** (0.141)

Part B: Measurement component

	Measurement Equation 1 (ordered probit) Dependent variable: pol
	Coefficients (Standard Errors)
LV_{pol}	0.340*** (0.093)
Cutoff 1	-1.390*** (0.076)
Cutoff 2	-0.104 (0.286)
Cutoff 3	0.031 (0.287)
Cutoff 4	1.640*** (0.318)
	Measurement Equation 2 (ordered probit) Dependent variable: pay
	Coefficients (Standard Errors)
LV_{pay}	0.681** (0.343)
Cutoff 1	-1.452*** (0.238)
Cutoff 2	-0.165 (0.453)

Cutoff 3	-0.034 (0.452)
Cutoff 4	1.471*** (0.549)
	Measurement Equation 3 (probit) Dependent variable: pol_dk
	Coefficients (Standard Errors)
LV_{pol_dk}	1.930** (0.860)
Constant	-4.328*** (1.061)
	Measurement Equation 4 (probit) Dependent variable: pay_dk
	Coefficients (Standard Errors)
LV_{pay_dk}	1.236*** (0.325)
Constant	-3.759*** (0.371)

Part C: Model characteristics	
Log-likelihood (constants only)	-7,914.5
Log-likelihood	-5,925.1
McFadden's pseudo R^2	0.251
AIC/n	2.685
n (number of observations)	4,464
k (number of parameters)	68

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* (future status quo) and 1 for *Large*. The attribute *Lines* is coded as a binary variable, where 1 stays for *Underground*. 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*, which is converted into EUR based on the exchange rate of 1 EUR = 4 PLN.

Means reported in Part A imply that, on average, respondents prefer implementation of a new project of renewable energy development to the future status quo (they want to see changes in the policy of renewable energy development being currently realised). Respondents prefer solar energy infrastructure extended most, while biomass energy is of least interest 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 more for having larger areas not used for renewable energy expansion and for transmitting energy through underground lines. As expected, more expensive projects reduce respondents' utility. Significant standard deviations with respect to some of the attributes indicate preference heterogeneity, which justifies the use of a mixed logit specification.

We now turn to the discussion of unobservable consequentiality perceptions. Measurement equations show that the latent variables indeed capture intrinsic, unobservable beliefs in consequentiality. High values of LV_{pol} are associated with strong stated beliefs in policy consequentiality, and high values of LV_{pay} are related to strong stated beliefs in payment consequentiality. LV_{pol_dk} and LV_{pay_dk} are correlated with do-not-know answers to policy and payment consequentiality questions, respectively, thus representing unobservable factors that cause respondents to be unsure about the survey's consequentiality or inconsequentiality. Given substantial differences in stated preferences of respondents having no definite opinion about consequentiality in comparison with the rest of the interviewed sample, as discussed below, we conclude that the do-not-know answers do not fit the ordered, Likert scale of consequentiality assessment and, therefore, they should be treated separately.

The influence of unobserved consequentiality beliefs on stated preferences is revealed by interactions of the latent variables with means of the preference parameters. Two essential differences emerge in the effects of LV_{pol} and LV_{pay} on respondents' choices. First, the significant and positive coefficients of *Wind*, *Solar* and *Biomass*[10] in interactions with LV_{pol} indicate that respondents strongly believing in policy consequentiality are willing to pay more for having a project implemented. Interestingly, this effect is not observed for those who strongly believe in payment consequentiality; the coefficients of *Wind*, *Solar* and *Biomass* in interactions with LV_{pay} are not significantly different from zero. The second important difference between the impacts of LV_{pol} and LV_{pay} is how the coefficient of the *Cost* attribute is affected by these latent perceptions.[11] For respondents with stronger beliefs about policy consequentiality, the *Cost* coefficient takes lower values, which translates into higher overall willingness to pay.[12] In contrast, for respondents believing in payment consequentiality, the *Cost* coefficient takes higher values, which translates into lower willingness to pay. In addition, the results of the interactions with LV_{pol} and LV_{pay} suggest some differences in preferences: respondents believing in policy consequentiality are willing to pay more for locating renewable energy sites far from residential areas; respondents convinced about payment consequentiality are more interested in projects involving large and numerous renewable energy sites.

Interactions of LV_{pol_dk} and LV_{pay_dk} with the means evidence that preferences stated by respondents with no clear opinion about the survey's consequentiality are substantially different. As indicated by the negative coefficients of the variant specific constants, these respondents reveal much weaker interest in any of the proposed projects of wind, solar or biomass energy development (that is, they reveal stronger preferences for the future status quo). This 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. This result suggests a need for modelling their preferences separately from the rest of the interviewed sample. And the same time, it undermines common approaches how do-not-know observations are treated. In typical practise, these observations are either excluded from a research sample or are assigned a mean value, which means that in our setting these respondents would be placed in the middle of a Likert scale (between those believing in consequentiality and those not believing in consequentiality). Our result reveals that employing such approaches may bias the results. This mirrors findings of Schafer and Graham (2002). 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.

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[10] Note that each of the three variant specific 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.

[11] By referring to the *Cost* coefficient, we mean the coefficient by the variable: *a negative of Cost per month*.

[12] *Cost* is assumed to be log-normally distributed. Thereby, the actual effect of this attribute is calculated as a value of a natural exponential function for the *Cost* coefficient. For large LV_{pol}, a natural exponent of the *Cost* coefficient becomes small (and positive) and, thus, willingness to pay becomes high.

4.2. Impact of risk attitude on stated preferences

To answer the second research question, namely whether risk attitudes affect self-reported measures of consequentiality beliefs and stated preferences, we augment the model with a fifth latent variable, LV_{risk}, which captures unobservable risk attitudes. Risk attitudes were assessed in the survey through the design proposed by Tanaka et al. (2010). The survey provides two measures of this latent variable: a number of choices of (safe) lottery A in Series 1 and in Series 2, which we denote by $risk\_1$ and $risk\_2$, respectively. Estimation results of the model including LV_{risk} are presented in Table A1 in the Appendix. LV_{risk} enters the discrete choice component of the model through interactions with preference parameters; is used in Measurement Equations 5 and 6 to explain the variables $risk\_1$ and $risk\_2$; and is incorporated into Measurement Equations 1, 2, 3 and 4 to verify its impact on self-reported measures of consequentiality. Including the variable LV_{risk} in the model does not change our conclusions made in the preceding subsection, which provides evidence of robustness of the results.

Measurement Equations 5 and 6 show that the latent variable capturing risk preferences correlates negatively with the number of safe lotteries chosen in Series 1 and 2, respectively. Hence, low values of LV_{risk} express high risk aversion (and vice versa). From Measurement Equations 1, 2, 3 and 4 it follows that respondents' risk attitudes are generally not significant in explaining perceptions regarding policy or payment consequentiality. This implies that the self-reported measures of consequentiality beliefs are not related to preferences towards risk. This contradicts the hypothesis following from the theoretical model of Mitani and Flores (2014)[13].

Regarding the influence of risk attitudes on stated preferences, the discrete choice component reveals that risk attitudes mainly affect marginal utility associated with the monetary attribute (*Cost*). High risk aversion is related to low willingness-to-pay values. This evidence adds to the scant literature on the impact of risk attitudes on willingness to pay. Our finding overlaps with previous research. Bartczak et al. (2015) report that respondents' risk preferences are significantly related to the status quo variant associated with zero cost. Erdem et al. (2010) also observe that strong risk aversion translates into low willingness-to-pay values.

5. Conclusions

Our study contributes to the stated preference literature that informs about the role of respondents' perceptions over a consequential character of a survey for their behaviour in a survey. Specifically, we aim to better understand the impacts of self-perceived policy consequentiality and payment consequentiality on stated preferences and whether risk attitudes affect these perceptions and choices made by respondents.

Using discrete choice data about preferences of Polish citizens towards renewable energy development, we obtain several important insights that broaden the understanding of the influence of consequentiality perceptions on respondents' behaviour in a survey. Latent beliefs in policy consequentiality and in payment consequentiality appear to impinge on stated preferences differently: respondents believing in policy consequentiality prefer the project implementation to the status quo more than those believing in payment consequentiality; respondents believing in payment consequentiality disclose significantly lower willingness to pay for the project than respondents believing in policy consequentiality. Those with no clear opinion on the degree of the survey's consequentiality substantially differ from the rest of the sample in terms of their stated preferences; in particular, they are much less interested in seeing the proposed project of renewable energy

[13] At the same time our result reflects the empirical finding of Mitani and Flores (2014). In an induced-value experiment, they observe that the impacts of perceptions over policy and payment consequentiality on stated preferences do not differ in risk preferences.

development implemented. Risk attitudes are observed not to influence self-reported measures of consequentiality beliefs and to have a negligible impact on stated preferences.

Overall, our empirical findings (i) evidence importance of assessing respondents' beliefs in policy consequentiality and payment consequentiality separately; (ii) suggest the need for developing questions that elicit beliefs in consequentiality more precisely; (iii) question the presumption from the theoretical literature on the impact of risk attitudes interacted with consequentiality beliefs on stated preferences.

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Appendix

Table A1. Results of the hybrid choice model depicting impact of risk attitudes

Part A: Discrete choice component							
	Means	**Standard Deviations**	**Means interacted with** LV_{pol}	**Means interacted with** LV_{pay}	**Means interacted with** LV_{pol_dk}	**Means interacted with** LV_{pay_dk}	**Means interacted with** LV_{risk}
	Coefficients (Standard Errors)						
Wind	1.906*** (0.327)	2.171*** (0.202)	3.178*** (0.408)	-0.150 (0.409)	-1.932*** (0.477)	-3.069*** (0.447)	-0.085 (0.258)
Solar	3.805*** (0.323)	1.728*** (0.269)	2.899*** (0.433)	-0.147 (0.346)	-2.425*** (0.439)	-3.459*** (0.481)	-0.296 (0.259)
Biomass	0.811** (0.337)	0.191 (0.529)	3.374*** (0.476)	0.069 (0.455)	-0.337 (0.448)	-3.203*** (0.486)	0.071 (0.269)
Distance (km)	0.324*** (0.054)	0.470*** (0.085)	0.198** (0.093)	-0.101 (0.085)	-0.017 (0.091)	-0.028 (0.108)	-0.026 (0.051)
Size	-0.058 (0.069)	0.032 (0.193)	-0.206* (0.112)	0.312*** (0.098)	0.079 (0.100)	0.010 (0.132)	0.057 (0.062)
Number	-0.009 (0.041)	0.066 (0.108)	-0.017 (0.064)	0.147*** (0.056)	0.103 (0.063)	-0.010 (0.071)	0.021 (0.038)
Protected area	0.653** (0.298)	0.327 (1.068)	-0.308 (0.487)	1.175** (0.476)	0.727 (0.484)	-0.262 (0.553)	-0.525* (0.283)
Lines – Underground	0.195** (0.086)	0.342 (0.316)	0.016 (0.143)	-0.141 (0.138)	0.032 (0.160)	-0.347* (0.192)	0.031 (0.081)
(A negative of) Cost per month (EUR)	-1.700*** (0.085)	1.043*** (0.087)	-0.383*** (0.093)	0.512*** (0.094)	-0.172* (0.093)	-0.088 (0.153)	-0.206*** (0.068)

Part B: Measurement component	
	Measurement Equation 1 (ordered probit) Dependent variable: pol
	Coefficients (Standard Errors)
LV_{pol}	0.334*** (0.100)
LV_{risk}	0.053 (0.046)
Cutoff 1	-1.388*** (0.078)
Cutoff 2	-0.103 (0.451)
Cutoff 3	0.032 (0.452)
Cutoff 4	1.639*** (0.466)
	Measurement Equation 2 (ordered probit) Dependent variable: pay
	Coefficients (Standard Errors)
LV_{pay}	0.520*** (0.158)
LV_{risk}	-0.004 (0.048)

Cutoff 1	-1.354*** (0.107)
Cutoff 2	-0.154 (0.248)
Cutoff 3	-0.032 (0.256)
Cutoff 4	1.370*** (0.393)
	Measurement Equation 3 (probit) Dependent variable: pol_dk
	Coefficients (Standard Errors)
LV_{pol_dk}	1.042*** (0.416)
LV_{risk}	0.090 (0.190)
Constant	-3.380*** (0.382)
	Measurement Equation 4 (probit) Dependent variable: pay_dk
	Coefficients (Standard Errors)
LV_{pay_dk}	1.539*** (0.452)
LV_{risk}	0.106 (0.215)
Constant	-4.068*** (0.533)
	Measurement Equation 5 (Poisson regression) Dependent variable: $risk\_1$
	Coefficients (Standard Errors)
LV_{risk}	-0.797*** (0.033)
Constant	1.609*** (0.034)
	Measurement Equation 6 (Poisson regression) Dependent variable: $risk\_2$
	Coefficients (Standard Errors)
LV_{risk}	-1.612*** (0.067)
Constant	0.587*** (0.072)

Part C: Model characteristics	
Log-likelihood (constants only)	-14,391.4
Log-likelihood	-10,420.3
McFadden's pseudo R^2	0.276
AIC/n	4.707
n (observations)	4,464
k (parameters)	85

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* (future status quo) and 1 for *Large*. The attribute *Lines* is coded as a binary variable, where 1 stays for *Underground*. 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*, which is converted into EUR based on the exchange rate of 1 EUR = 4 PLN.