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Societal preferences for the conservation of traditional pig breeds and their agroecosystems: Addressing preference heterogeneity and protest responses through deterministic allocation and scale-extended models

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ABSTRACT

We assess preferences of inhabitants of the island of Majorca (Spain) for the conservation of traditional, extensively reared Majorcan Black Pigs and the linked agroecosystem, using a choice experiment. Up to 35% of our respondents registered protest responses. We examine alternative methods of dealing with and accounting for these protests. We find that free allocated models report better information criteria estimates but may give rise to interpretation difficulties. Our preferred model in terms of performance and interpretability is a 3-class model where protest responses are deterministically allocated to one class and random parameters are included to account for heterogeneity. Among the non-protesting classes, we find heterogeneous preferences where 40% of the respondents are mostly concerned with management and product innovation and 24% more breed-concerned respondents favour price increases in breed-based products to fund improvement of the agroecosystem.

Keywords: Scale-adjusted latent class model, random parameter latent class model, protesters, extensive systems, animal genetic diversity

JEL Classifications: C93, H41, Q29, Q51

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1 Introduction

Extensive outdoor low-intensity livestock farming systems are the principal form of management of high natural value farmland in Europe and able to satisfy demands for public goods such as landscapes and biodiversity (Beaufoy and Cooper, 2008). However,

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the opportunity costs associated with this form of land management and the insufficient recognition in markets and policies can ultimately risk the future of sustainable farming (Swinton et al., 2007), propelling these farmers towards restructuring to achieve either more profitable forms of land use or land abandonment (Cooper et al., 2009). Although grazing land intensity has declined across most of Europe (Pe'er et al., 2017), the decrease in the number of livestock units is greater than the decrease in the total number of farms with an intensification pattern (Agrosynergie 2011), as a consequence of the need to increase productivity to cope with decreasing margins (Aparicio Tovar and Vargas Giraldo, 2006). Furthermore, evidence suggests that the Common Agricultural Policy (CAP) significantly contributed to this process, linked among other factors to the decoupling payments (Pe'er et al., 2017, 2014). This contrasts with the increasing societal concerns about the carbon footprint, industrialisation of agriculture, fair trade, food security, or animal welfare (Bernués et al., 2011).

Extensive farming systems are closely linked to domestic animal diversity and animal genetic resources (AnGRs), adapted to their local conditions over thousands of years of domestication (Anderson, 2003). The conservation of farmland biodiversity and more specifically of AnGR generate a number of private and public value components (Tisdell, 2003). The roles of AnGR in supporting agroecosystem resilience (Hajjar et al., 2008) include maintaining socio-cultural traditions, local identities, and traditional knowledge (Gandini and Villa, 2003; Nautiyal et al., 2008); gene flow global option values (e.g. Bellon, 2009); cultural landscapes (Tisdell, 2003), all of which are public goods (Fisher y Kerry Turner, 2008) with a high degree of non-excludability (Narloch et al., 2011). Not accounting for these non-market values overestimates the performance of improved systems. Because rearing traditional breeds is often not profitable under present market conditions, compensation payments are necessary to make these populations viable (Zander and Drucker, 2008).

Traditional high-quality meat products from Mediterranean pigs are produced in extensive-type production systems that use native agro-sylvo-pastoral resources. This case applies to the Majorcan Black Pig (MBP), a traditional, extensive pig breed native to Mallorca island (Balearic Islands, Spain), and well adaptated to Mediterranean climatic conditions (Gonzalez et al., 2013; Tibau et al., 2019). In 1997, the Spanish Ministry of Agriculture has catalogued the MBP as a breed needing special protection and in danger of extinction.

We assess Majorca island dwellers' preferences for management options for the MBP and its agroecosystem and related products through a choice experiment. We investigate preference heterogeneity, which may help policymakers to reach specific segments of the target population and account for winners and losers in proposed policy actions (Thiene et al., 2015). We also explore the performance of different modelling approaches where we control for differences in error variance across respondents by applying scale-adjusted latent class (SALC) models (Magidson and Vermunt,2007).

2 Case study description

Land use on the island of Mallorca is similar to other areas in the Mediterranean where land use intensification through urban sprawl, increases in tourism, abandonment of rainfed arboriculture and spontaneous reforestation have occurred (Marull et al., 2015). These changes endanger the traditional heterogeneous, well-connected land use mosaics and land cover complexity endowed with a rich biocultural heritage with high biodiversity (Marull et al., 2015).

Majorcan Black Pigs (MBP) were central to the economy and Majorcan lifestyle until the mid-twentieth century and contributed to the cultural heritage of the island (Tibau et al., 2019) very well adapted to the local environment and the scarce natural resources of the island (Jaume and Alfonso, 2000). Traditional MBP farms were mixed with a variety of activities, and even today, MBP generate 20% of farm income. The MBP is always managed extensively (between 10 and 25 pigs/ha) (Gonzalez et al., 2013). The traditional feeding regime is primarily pasture, cereals (barley), and legume seeds, and the secondary food sources including figs, almonds, and carob seeds from traditional rainfed tree polyculture, and Mediterranean shrubs typical to MBP plots (Gonzalez et al., 2013; Tibau et al., 2019).

The disappearance of the biocultural landscape is closely linked to the decline in MBP numbers over the last 150 years, resulting from the effect of diseases and the more recent introduction of leaner pig breeds (Tibau et al., 2019). A group of MBP stockbreeders and meat processors favoured the recovery of the breed in the 1980s (Gonzalez et al., 2013). The latest census of the MBP (August, 2016) (FAO, 2017) registered 59 farms with less than 1000 breeding sows and 54 boars.

MBP produce the 'sobrassada de Porc Negre Mallorquí,' a specialty fat-rich cured sausage that has been PGI certified since 1994. Preservation of the traditional breed requires the development of new products to create new niche markets and improve revenues for producers. Accordingly, new products such as carpaccio (Gonzalez et al., 2013) or pork burgers (Kallas et al., 2019) have been tested that may better align with consumer demand for reduced-fat pork products.

3 Material and methods

3.1 Survey design (attributes and levels) and data collection

Following Jeanloz et al. (2016), an initial list of relevant attributes was devised through an extensive literature review, followed by an in-depth discussion and exchange with researchers on socioecological transitions in Mallorca and MBP farming. An initial pool of attributes and levels, and their graphical representation, was tested in two (urban and rual) world café sessions[2] held with islanders. A final list of attributes was selected for the construction of choice scenarios. A group valuation session was held with 15 scholars to fine-tune the questionnaire and its visual aids, followed by pilot testing with 20 people to gather parameter priors (see below).

Similar to the literature on traditional breeds, the future existence of the breed was one of the attributes considered (Zander et al., 2013). A discussion held with geneticists on the project allowed for the identification of three population threshold levels for breed survival: less than 200 sows represents a high risk of breed extinction; between 200 and 1000 sows is considered a medium risk; greater than 1000 sows is a low risk.

The management attribute considered whether animals are bred outdoors, indoors, or both (50% indoors, 50% outdoors). Outdoor management allows the pigs to follow their natural behaviour while improving the organoleptic features of the meat such as intramuscular fat (Tibau et al., 2019). Indoor–outdoor management is undertaken for sows and suckling piglets. Intensification (indoor breeding with additional feed) is often used to improve financial performance, so we included indoor breeding to obtain respondents’ preferences for this option.

[2] A world café is a structured conversational process intended to facilitate open and comfortable discussion and link ideas within a larger group to access the collective intelligence in the room. Participants move between a series of tables where they engage in discussion in response to a set of questions, which are predetermined for each table and focus on the specific goals of each world café. In our case each table gathered several attribute groups according to main relevant dimensions (breed related management, product dimension, and biodiversity-related issues). A café ambience is created to facilitate conversation.

The socioecological transition in Mallorca that reduced the presence of MBPs also entailed a loss of tree polycultures and landscape functional structure (Marull et al., 2015b). Because multifunctionality in many traditional land use systems is highest when maintained simultaneously at different levels (field, farm, and landscape) (Vos and Klijn 2000), two attributes were included to illustrate the diversity dimensions of the MBP agroecosystem. Respondents were briefed with a location map of MBP farms in the central and southern parts of the island. The tree diversity attribute considered the diversity of domestic tree species in this area (tree polycultures), namely, the almond, fig, and carob trees that have traditionally provided food for MBPs. Failure to replace dead almond, carob and fig trees has reduced the density and diversity of polycultures (Marull et al., 2015), with almond trees predominating, assisted by linked subsidies.

Respondents were told that, 'in the traditional farming system in the area, each farmer would traditionally combine three different tree species in his property. However, this is becoming less common, and we observe areas where most of the plots have two or even just one tree species (medium and low tree variety, respectively)'. Explanations and pictures of the central part of the island were provided to illustrate the three levels. Explanations were provided to convey the low level of variety, for example, *the low-variety landscapes are characterised by monocultures where most of the land plots cultivate cereals, there are few or no tree crops, and traditional stone walls are missing*. This level was linked to the predominant trend towards more uniform land covers, and the removal of landscape mosaics created and maintained by traditional farming (Marull et al., 2015).

Our MPB food product attribute reflects the extent of innovation by indicating the development of new products that may fit better with current consumer demands (Kühne, 2010) while capturing cultural and heritage values linked to traditional breeds' products (Balogh et al., 2016; Gandini and Villa, 2003). This is particularly relevant in the case of MBPs because the main food product is currently *sobrassada*, a spreadable cured sausage with limited market opportunities. MBP meat holds outstanding organoleptic features, and studies have shown high consumer acceptance of other meat preparations such as hamburgers (Kallas et al., 2019).

Finally, the monetary attribute considered six levels from €10 to €60, as the public cost of supporting the traditional breeds and associated ecosystems and products. The payment vehicle was an annual household tax payment for three years. We purposefully limited the taxation period to three years because credibility is crucial for stated preference valuation studies (Carson and Grooves, 2007) and an infinite payment vehicle would appear improbable and may thus reduce the incentive compatibility of the experiment.

Table 1. Description of attributes and levels[3]

ATTRIBUTE	VARIABLE NAME	DESCRIPTION
BREED EXISTENCE	H_RISK* M_RISK L_RISK	HIGH risk of extinction (< 200 sows) MEDIUM risk of extinction (200–1000 sows) LOW risk of extinction (1000–2000 sows)
TYPE OF MANAGEMENT	OUTDOOR* OUT-IN DOOR INDOOR	Most of the time outdoors 50% outdoors, 50% indoors Most of the time indoors
TREE CROPS	1 TSP* 2 TSP 3 TSP	1 tree species, low variety 2 tree species, medium variety 3 tree species, high variety
TYPE OF LANDSCAPE	LOW* MEDIUM HIGH	Low heterogeneity Medium heterogeneity High heterogeneity
PRODUCT VARIETY	LOW* MEDIUM HIGH	Low product variety Medium product variety High product variety
COST (€/household)	0, 10, 20, 30, 40, 50, 60	

*Base or status quo level

Each of the choice sets presented to the respondents depicted a future do-nothing or status quo situation (marked * in Table 1) plus two alternative changes that would entail a cost for the respondent household. A D-efficient experimental Bayesian design with 24 alternatives distributed in four blocks was optimised using Ngene (Choice Metrics 2012) for D-efficiency, retrieving a D-error of 0.0064. The design considered the priors obtained in a pilot survey conducted with 20 respondents.

The questionnaire also included questions on participants' knowledge of the MBP system, perception of the status quo (SQ) levels of the selected attributes, and fundraising options for a hypothetical programme to support the MBP through price increases in products and an earmarked tax increase.

To attempt to reduce the incidence of protest responses against the payment vehicle, we included a question prior to the choice cards for the respondents to express their preferred institution to manage taxpayers' money. Next, respondents were asked to make their selections while considering that this institution would manage their contributions

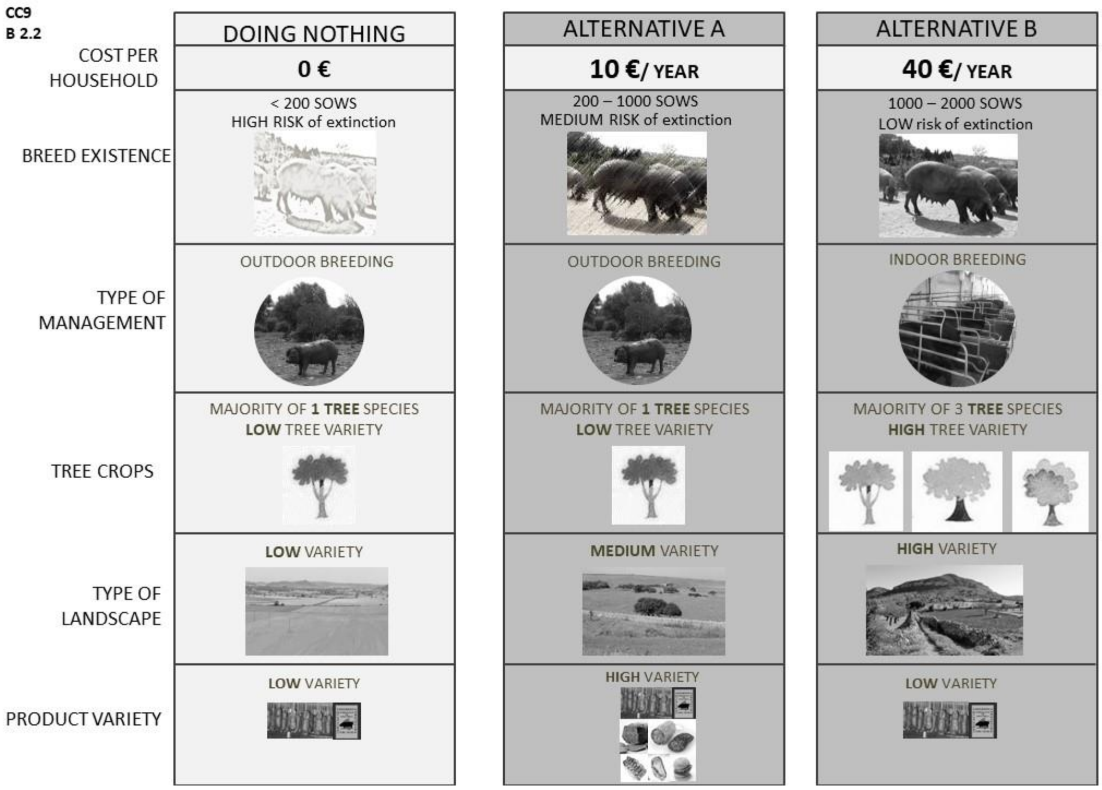
[3] Appendix 1 shows the full list of images used to convey the attributes' levels to the participants

towards their most preferred choice. Furthermore, a short, cheap-talk script was included to reduce hypothetical bias (Ladenburg et al., 2007; Varela et al., 2014c).

Because there are no established theoretical criteria or protocols to identify protest responses (Boyle and Bergstrom, 1999), we followed the usual method, where our respondents could choose the ‘status quo’ option (SQ), and were also asked a closed question to disentangle protesters from zero bidders (Meyerhoff et al., 2014a, 2014b).

Since social preferences for rural landscapes and environments often differ between urban and rural residents (Bernués et al., 2014; Hynes and Campbell, 2011), our sampling strategy attached equal weights to rural (< 20,000 inhabitants) and urban (> 20,000 inhabitants) populations. Each subsample was stratified according to population size, gender, and three age groups.

Figure 1. Example of choice cards shown to respondents



3.2 Survey details

A sample of 400 respondents with 211 and 189 respondents for rural and urban areas, respectively, were surveyed in April 2017 through face-to-face questionnaires. The urban share of the survey was undertaken in the capital city Palma de Mallorca (where 150 respondents were interviewed) and in four towns with more than 20, 000 inhabitants. The rural sampling was undertaken in seven municipalities ranging from 2,000 to 5,000 inhabitants in the central part of the island where the MBP farms are located. Potential adult respondents were approached in public places such as squares, markets or schools, considering age groups and gender quotas. The sample shows representativeness with respect to the total population in terms of gender and age distribution for rural and urban areas (Table 2).

Table 2. Percentage of gender and age representativeness of the sample

	SAMPLE	POPULATION	Chi- square
GENDER			
URBAN			
Male	49.73	48.44	P(χ^2 >0.125) =0.724
Female	50.27	51.56	
RURAL			
Male	46.44	52.2	P(χ^2 >1.19) =0.275
Female	53.56	49.8	
AGE CLASSES			
URBAN			
20–39	40.10	36.59	P(χ^2 >0.983) =0.612
40–64	41.71	44.05	
>65	18.18	19.36	
RURAL			
20–39	23.83	29.25	P(χ^2 >3.443) =0.179
40–64	45.79	44.3	
>65	30.37	26.44	

We identified 144 respondents as protesters, which is 36% of the total. Protesters were serial selectors of the SQ option who also chose one of these two options in the debriefing question: ‘I already pay enough taxes, and the government should use that money to fund this type of initiative’ or ‘I would collaborate if the method of raising funds was different’. Zero bidders (i.e. genuine zeros) were those who chose one of the following two options: ‘I do not think any of the proposed measures would have any positive effect’ or ‘Other measures should be implemented to protect the breed’.

Chi-square tests were conducted to test for differences between urban and rural subsamples and between protesters and non-protesters: 45% of the rural subsample showed protesting behaviour, and protesters in the urban subsample accounted for 25.7%. Unemployment is significantly higher among urban (9%) compared with rural respondents (6%), while there are more retired people in rural areas (27%) compared with 16.6% in urban areas. Most of the low-income group respondents belonged to rural areas (68%).

3.3 Econometric approach

Latent class (LC) models (Kamakura et al., 1989) assume that the overall preference distribution comprises a combination of unobservable latent groups or classes that differ in their utility between the groups but are similar within. Finite mixing models offer the advantage of ease of interpretation and are useful for decision making and communication (Boxall and Adamowicz, 2002; Farizo et al., 2014; Provencher and Bishop, 2004; Scarpa and Thiene, 2005), whereas some practitioners favour LC approaches over continuous specifications because of superior model fit (Bujosa et al., 2010; Soliño and Farizo, 2014; William and David, 2013; Yo and Ready, 2014). LC models impose more structure on the choice model but in exchange offer a more detailed description of segment heterogeneity in the data by using two sub-models: one for class allocation and one for within-class choice (Hess et al., 2007). Simulation procedures estimate class-specific part-worth utilities for each attribute level and assign each person a probability of belonging to each of the prespecified classes. The initial caveat of an LC that imposes homogeneity in preferences within groups is overcome by allowing random parameters within each class, which allows for another layer of preference heterogeneity within a class (Greene and Hensher, 2013). Combining LC models with random effects was initially proposed by Böckenholt (2001), and many researchers have followed this method (e.g. Bujosa et al., 2010; Justes et al., 2014; Soliño and Farizo, 2014; Varela et al., 2014).

The observed behaviour of the recurrent choice of SQ in valuation studies was addressed by Samuelson and Zeckhauser (1988) and Kahnemann et al. (1991). Although respondents may choose the SQ for different reasons, repeated choice of the SQ across a valuation survey typically hides some type of protest attitude (Adamowicz et al., 1998; Meyerhoff et al., 2014b, 2009; Thiene et al., 2012) where respondents reject (protest against) an aspect of the constructed market scenario (Meyerhoff et al., 2014). Studies such as, for example, Scarpa et al. (2005), Boxall et al. (2009), Meyerhoff et al., (2014) or Meyerhoff and Liebe (2009), have delved deeper into the variables that may be related to protest responses. Despite the common procedure of deleting protest zero responses from the sample (Morrison et al. 2000), censoring them is not necessarily justified (Jorgensen and Syme, 2000) and can lead to sample selection bias (Meyerhoff et al., 2014a).

Among the reasons explored for protesting, task complexity is suggested as one of the possible causes (Boxall et al., 2009; Thiene et al., 2012). Task complexity is closely related to higher levels of uncertainty in the responses, leading to a higher variance of parameter estimates for some respondents. Therefore, the common assumption based on equality of scale may be easily violated because respondents may display different levels of certainty when making choices, even when preferences are homogenous (Lutzeyer et al., 2018), and ignoring this may potentially imply biased estimates (Louviere and Eagle, 2006).

Until recently, LC models allowed preferences to differ from class to class, but the error variances were identical over classes (Burke et al., 2015). Modelling scale (i.e. discrimination capacity) through scale adjusted latent class (SALC) modelling was first proposed by Swait (1994). The approach introduced by Magidson and Vermunt (2007) was based on an LC model that controls for differences in the error variances across respondents by using discrete mixing distributions for scale and preference that accounts for some respondents being more consistent than others in their choices (i.e. the data exhibit different scale groups).

SALC models assume that each latent preference class may comprise subgroups of individuals that although within the same class, despite sharing the same preference structure, may display different levels of uncertainty, thereby belonging to different scale classes. In this model, respondents are probabilistically allocated to both preference and scale classes: latent segments that differ in their preference part-worth utilities, and latent subgroups that differ in their scale parameter. Scale classes (sclasses) are generally assumed to be independent of the classes, that is, the size of the sclasses is the same across latent segments. However, this assumption can be relaxed, allowing some segments to have a higher (lower) percentage of respondents belonging to a scale factor (Magidson and Vermunt, 2007).

In our study, we extended the traditional LC approach of Burton and Rigby (2009) and deterministically allocated protesters into a single class to avoid explicit consideration of these non-participants, which may have confounded the underpinning structure of other preference classes and distorted segregation into groups (Thiene et al., 2012). We tested discrete mixture distribution (random parameter LC) approaches where protesters are identified and deterministically allocated to one class. Furthermore, we explored whether protest responses were linked to significantly different scale patterns by considering whether scale is correlated to preference class.

We departed from the conditional logit model for the response probabilities (Vermunt and Magidson, 2005):

$$P(y_{it} = m|z_{it}^{att}) = \frac{\exp(\eta_{m|z_{it}})}{\sum_{m'=1}^{M} \exp(\eta_{m'|z_{it}})} \qquad (1)$$

Where $\eta_{m|z_{it}}$ is the systematic component in the utility of alternative m for individual i and choice set t; hence, z^{att} represents attribute levels.

The term $\eta_{m|z_{it}}$ is a linear function of an alternative-specific constant β_m^{con} and attribute effects β_p^{att} (Mc Fadden, 1974), that is,

$$\eta_{m|z_{it}} = \beta_m^{con} + \sum_{p=1}^{P} \beta_p^{att} z_{itmp}^{att} \qquad (2)$$

In an LC variant of the conditional logit model, we assume that individuals are probabilistically allocated to different LCs that differ with respect to the β parameters. Thus, the choice probabilities depend on class membership (x), and the logit model is in the following form:

$$P(y_{it} = m|x, z_{it}^{att}) = \frac{\exp(\eta_{m|x,z_{it}})}{\sum_{m'=1}^{M} \exp(\eta_{m'|x,z_{it}})} \qquad (3)$$

Where $\eta_{m|x,z_{it}}$ is the systematic component in the utility of alternative m at choice set t because individual i belongs to LC x. The linear model for $\eta_{m|x,z_{it}}$ is

$$\eta_{m|x,z_{it}} = \beta_{xm}^{con} + \sum_{p=1}^{P} \beta_{xp}^{att} z_{itmp}^{att} \qquad (4)$$

Thus, the logit regression coefficients are allowed to be class specific. The probability density associated with the responses of individual i has the following form:

$$P(y_i|z_i) = \sum_{x=1}^{K} P(x) \prod_{t=1}^{Ti} P(y_{it}|x, z_{it}^{att}) \qquad (5)$$

Where P(x) is the unconditional probability of belonging to class x or, equivalently, the size of LC x. The T_i repeated choices of individual i are assumed to be independent of each other on the basis of class membership.

We combine the LC with random effects continuous factors to specify the random-coefficients' conditional logit models. Continuous factor (CF) models have been proposed as an alternative to hierarchical Bayes (HB) approaches to allow for random effects, providing a more parsimonious alternative to HB estimations (Magidson et al., 2005). The CF approach superimposes a factor analytic structure on the variance–

covariance matrix, assuming the coefficients follow multivariate normal distributions. The full vector of random factor scores is denoted by F_i and F_{di} denotes the score of individual i on random effect number d. When these are included in a model, the structure for $P(y_i|z_i)$ becomes

$$P(y_i|z_i) = \sum_{x=1}^{K} \int_{Fi} f(F_i)P(x|z_i)P(y_i|x, z_i, F_i)dF_i \qquad (6)$$

Where

$$P\left(y_i\middle|x, z_{i,}F_i\right) = \prod_{t=1}^{Ti} P(y_{it}|x, z_{it}^{att}, z_{it}^{pre}, F_i) \qquad (7)$$

The F_{di} are assumed to be standard normally distributed and mutually independent and appear in the model for the choices but not in the model for the LCs. Hence, the linear predictor in the model for the choices is expanded with the following additional term where random effects are defined for the alternative-specific constant and attributes (except cost), respectively:

$$\sum_{d=1}^{D} \alpha_{xmd}^{com} \cdot F_{di} + \sum_{d=1}^{D} \sum_{p=1}^{P} \alpha_{xpd}^{att} \cdot F_{di} \cdot z_{mitp}^{att} \qquad (8)$$

Where x stands for class membership, m for alternative, and i for individual. A critical difference with the more standard specification of random effects is that here, each F_{di} can serve as a random effect for each of the model effects, which yields parsimonious random-effects covariance structures (Magidson and Vermunt, 2004).

Because class memberships are latent, we assume the probability that person i belongs to a latent preference class x is determined according to the expression:

$$Pr_{ix} = \frac{\exp(\theta_{x0} + \theta'_x Z_i)}{\sum_{k=1}^{X} \exp(\theta_{k0} + \theta'_k Z_n)}, \quad x = 1, \ldots, X \qquad (9)$$

where θ_{q0} is a scalar, Z_n is an R-dimensional vector of individual covariates, and $\theta_q = (\theta_{q1}, \ldots, \theta_{qR})$ is a vector of coefficients compatible with Z_n.

For scale-extended models, we followed Thiene et al. (2015), Lutzeyer et al. (2018), and Vermunt (2008) and refer to the interested reader to these publications for the sake of brevity. Within each x preference class and s scale class, the choice probability for alternative m in choice set t is a conditional logit:

$$Pr_{imt|x,s} = \frac{\exp(\lambda_s \beta'_x X_{imt})}{\sum_{k=1}^{M} \exp(\lambda_s \beta'_x X_{ikt})}, \quad s = 2, \ldots, S \qquad (10)$$

where β_x is a vector of utility function parameters; X_{imt} is a vector that includes characteristics of the choice alternative, often interacted with characteristics of the individual; λ_s is the scale parameter; and M the number of choice alternatives. Heterogeneity in preferences is given by the discrete range of values that β_x and λ_s can take, where λ_s is the scale parameter associated with the type I extreme value distributed random variable error term.

Respondents in each scale class have on average the same degree of determinism in their choices or the same ability to discriminate their preference using the arguments in the indirect utility function. Similarly, for each preference class x, all respondents in that class like all the MBP-related attributes with the same relative taste intensity. We also include a shared component δ_{xs} across the scale-preference class to account for potential correlation across membership probabilities of scale and classes, that is, we allow for the following: a higher scale might be positively correlated with preference classes where selected attributes have utility weights, or vice-versa. To this end, we assume that the multinomial logit membership probabilities that person i belongs to x preference class and s scale class are semi-parametric multinomial logit:

$$\Pr(i \in x, s) = \frac{\exp\,(\theta_s + \omega_x + \delta_{x,s})}{\sum_c \sum_s \exp\,(\theta_s + \omega_x + \delta_{x,s})} \qquad (11)$$

where each class has a constant for the scale value θ_s and one for the scale value ω_x. As Thiene et al. (2015) noted, in correlated scale and preference classes, an easy check is that joint membership probability for scale-preference class c, s is not the product of the marginal probabilities for membership to scale class and preference class whenever $\delta_{xs} \neq 0$.

4 Results

4.1 Econometric models: preferences and willingness to pay (WTP)

The number of protesters in the sample is high but similar to that attained in other studies (e.g. Hoyos et al., 2012; Valasiuk et al., 2017; Varela et al., 2014a). Removing these observations from econometric estimations can lead to sample selection bias and WTP estimates that are not comparable across surveys (Meyerhoff et al., 2014b).

Therefore, we applied a finite mixing approach to manage preference heterogeneity (Burton and Rigby, 2009) while also testing the impact of deterministically allocating protest responses to one class by following Thiene et al. (2012). We tested the impact of deterministic protest response allocation in LC and random parameter LC models. We assume that attributes behave randomly in two ways: a continuous random factor effect for all the classes and a specific random factor component for each class. This specification improves the accuracy of the model since isolates the common and specific random factor components. Furthermore, respondents' uncertainty would be reflected in scale differences and not only preference differences across respondents. SALC models were estimated both for uncorrelated and correlated scale and preference class sizes and for both deterministic and non-deterministic allocation of protesters to one class.

LC models considering fixed parameter effects and random parameter effects were estimated ranging from two to six classes. These models were also estimated for deterministic protester allocation. To select our best models between those specifications tested, we considered model fit along with model plausibility, the significance of the parameters' estimates and external validity (Hynes et al., 2008; Scarpa and Thiene, 2011). Information on these model fitting and scale estimates are shown in Table A1 (on-line).

The optimal number of classes was determined in an iterative procedure by comparing models on the basis of Bayesian information criterion (BIC), Akaike information criterion (AIC) and Akaike information criterion 3 (AIC3). The latter, according to Andrews and Currim (2003) is the best-performing criterion when determining the optimal number of classes in logit models, supported by the AIC and BIC. All the models adopt effects coding for all non-monetary parameters. Therefore, the magnitude of the base case level coefficient is assumed to be equal to the negative sum of the utility weights for the other estimated categories (Louviere et al., 2000; Lusk et al., 2003)[4].

In both the fixed and random parameter latent class models with free allocation of respondents, the 3-class models provide the best balance between information criteria and plausibility and this also stands for the protester-allocated versions. Based on these outcomes, the scale-adjusted (SALC) models are estimated for 3-class structure to allow for comparability. Among these, the SALC models where correlation is allowed between preference and scale classes provide better performance than where preference and scale classes remain independent and hence are selected for reporting (see tables below).

[4] Following Domínguez-Torreiro and Soliño (2011) and Varela et al. (2014), an additional column representing the adjusted marginal utility gains from the base level situation for each of the levels of the effects coded attributes has been included in Tables 3,4 and 5 increase the clarity of the interpretation of the results.

The models with deterministic protester allocation to one class show lower performance than their free-allocation counterparts. As noted by Thiene et al. (2012), imposing this type of constraint has significant implications for model performance.

The outcome of the random parameter latent class model with free protester allocation is reported in table A2, on-line. In this model roughly half of the respondents are allocated to class 1, while class 2 accounts for 27% of the respondents and the remainder 22% are found in class 3. The overall preference picture in this model shows support for the status quo situation for most attributes. Improving the conservation level for the breed is only supported by 26% of the sample while intensification is supported by half of the sampled population and low tree diversity is generally favoured. Improvement measures such as increasing landscape and product variety are supported by less than one fourth of the sampled respondents but their response pattern seems to reveal moral concerns rather than cost concerns. The results of this model show significant cost parameters for all the preference classes while in contrast, one third of the sample was identified as protest responses and accordingly non-significant estimates would be expected for them. Therefore, we argue that the share of protesters may confound the underpinning structure of other preference classes and prevent the real segregation into groups (Thiene et al., 2012). Of the 144 protestors identified, only three showed the selection of SQ in 5 of the responses. The rest selected the SQ in all six choice cards offered to them. Hence, it is unlikely that this behaviour is leading to the significance of the price attribute in the free model. Rather, by looking at the size of class 1 in the free model (around 50% of the sample allocated to it, rather than just the 33% of "real" protestors), we argue that the free model is not segregating the protestors from the rest of the respondents, but mixing them. This is the main reason that leads us to select the "allocated" model where we deliberately assign this group of preferences to one class.

Results for the deterministic protester allocation counterpart model are reported in table 3. Here, the random factor common to all the classes shows significant values, but these are common for all three classes (i.e. for the whole model) and not specific for one Class. However, for Class 1 (protesters), the continuous random factor shows no-significant values, except for the base level for landscape heterogeneity. As a consequence, we infer that these protesters do not respond significantly to the attributes and no significant randomness is found in this class, indicating that there are no significant distributional differences in preferences across these respondents.

Class 1 includes the protest responses, amounting to 35% of the sample. All the attributes show non-significant values, in accordance with the protesting behaviour of the respondents allocated to it. Respondents in this class show, as expected, no significant parameter estimates and a preference for the status quo situation as indicated by the sign and significance of the ASC.

Class 2 accounts for 41% of the sample. ASC estimates indicate that ceteris paribus, respondents in this group prefer alternative scenarios to the status quo. Improving the conservation status for the breed does not shape the preferences of respondents in this group, similarly to diversity at the (tree) species and landscape level. Combined indoor and outdoor management is supported by this group, and indoor breeding is rejected. Regarding product variety, respondents in this group significantly support high-variety options for MBP products and reject the low variety current situation. The cost attribute retrieves significant estimates and with the expected sign.

Class 3 accounts for 24% of respondents that show a significant positive willingness to select alternative scenarios, rejecting the SQ scenario. Regarding breed survival, respondents significantly support the low risk extinction option. They also demonstrate support for traditional outdoor management and reject mixed indoor-outdoor and indoor options. The high tree diversity level contributes to positively shape their preferences while landscape and product diversity retrieve non-significant estimates. Finally, the cost attribute is negative and significant.

The results for the free version of the SALC model are shown in Table 4, and those for the deterministic allocated SALC model are shown in Table 5. In both models the sclass2 accounts for the lower scale estimates (and hence higher estimate variance).

The free allocated SALC model accounts for more than half of the sample in preference class 1. Utility of individuals in this class is only shaped by the ASC, with negative and significant estimates for non-status quo scenarios. Class 2 accounts for 12% of the respondents. Utility of respondents in this group is reduced by the status quo scenario, ceteris paribus. The high risk extinction level reduces the utility of respondents while they show positive and significant estimates for medium and low risk extinction levels. The management attribute also contributes to the preferences in this group, with positive estimates for combined outdoor-indoor management. Increasing tree diversity up to three species and product availability to medium level also contribute to increase their utility.

Finally, this is the only class showing significant estimates for the cost attribute. Class 3 in this model accounts for roughly one third of the sample that would favour alternative scenarios to the status quo for breed and tree diversity. The scale structure of this model reveals that 40% of the sample belongs to sclass2, holding a lower scale parameter and hence higher estimate variance than respondents in sclass1. Most of these respondents in sclass 2 are found in preference class 3 (28% of the total sample).

The SALC model with deterministic allocation of protesters to preference class 1, distributes 28% of respondents to class 2 and the remaining 37% to class 3. Respondents in class 2 reject alternative scenarios to the status quo. Only outdoor management significantly determines their preferences together with the cost of the proposed alternatives. Class 3 shows a broader range of attributes defining respondents' preferences and an overall preference for scenarios alternative to the status quo. Low risk extinction level and improved tree and landscape diversity increase their utility. The sample is distributed approximately equally between sclass1 and 2. Respondents in sclass2 are mostly found in preference class 3, the one with a wider range of attributes determining their preferences.

Overall, the random parameter model with deterministic allocation of protesters is superior to the SALC models when considering the information criteria (see table A3) despite the considerably lower number of parameters in the SALC models (43 and 44 parameters vs. 89 in the random parameter model). This leads us to consider the 3-class allocated random parameter LC model as the superior one and hence used for ulterior reporting.

Finally, following the recommendation by Davis et al. (2019), we also report in Appendix on-line, the results of the SALC correlated models renormalised so that sclass2 takes the value of 1 for its scale parameters (tables A3 and A4).

Table 3. Random parameter latent 3-class model with deterministic protester allocation

		Class 1- protesters			Class 2			Class 3			Wald	p value
Class Size		0.35			0.41			0.24				
		Parameters	z value	Adj[a]	Parameters	z value	Adj[a]	Parameters	z value	Adj[a]		
ASC	Status Quo	**19.04**	**2.67**		**-0.77**	**-1.88**		**-4.96**	**-3.62**		28.70	0.000
	Alternative A	-5.71	-1.15	-24.74	**0.41**	**1.87**	**1.176**	**2.11**	**2.86**	**7.07**		
	Alternative B	**-13.33**	**-3.08**	**-32.36**	**0.36**	**1.59**	**1.13**	**2.85**	**4.24**	**7.80**		
EXIST	H_RISK*	4.66	0.97		-0.11	-0.45		**-5.01**	**-6.19**		41.64	0.000
	M_RISK	-1.70	-0.23	-6.35	0.06	0.33	0.17	-0.54	-1.27	4.47		
	L_RISK	-2.96	-0.60	-7.62	0.05	0.19	0.15	**5.563**	**5.90**	**10.57**		
MNG	OUTDOOR*	-0.44	-0.08		-0.03	-0.14		**4.24**	**5.35**		36.39	0.000
	OUT-IN DOOR	1.23	0.16	1.67	**0.77**	**2.84**	**0.80**	**1.46**	**1.98**	**-2.79**		
	INDOOR	-0.79	-0.17	-0.35	**-0.74**	**-3.28**	**-0.70**	**-5.70**	**-4.96**	**-9.95**		
TSP	1*	5.89	0.72		0.15	0.43		-0.60	-1.17		17.80	0.007
	2	-4.69	-0.68	-10.58	-0.54	-1.48	-0.68	-1.44	-2.58	-0.84		
	3	-1.20	-0.19	-7.09	0.39	1.53	0.25	**2.04**	**3.47**	**2.63**		
LAND	LOW*	-3.80	-0.55		-0.06	-0.18		-0.45	-0.97		3.41	0.76
	MEDIUM	0.78	0.15	4.58	0.26	1.14	0.32	0.40	0.97	0.84		
	HIGH	3.02	0.32	6.82	-0.19	-0.63	-0.13	0.05	0.10	0.49		
PROD	LOW*	-0.12	-0.03		**-0.48**	**-2.28**		0.47	1.32		10.14	0.12
	MEDIUM	1.00	0.18	1.12	-0.08	-0.35	0.40	-0.25	-0.67	-0.71		
	HIGH	-0.88	-0.12	-0.76	**0.56**	**2.72**	**1.04**	-0.2176	-0.61	-0.68		
PRICE		-0.05	-0.39		**-0.02**	**-2.61**		**-0.05**	**-2.51**		13.78	0.003
Continuous random Factor 1 (SDPD per Class)												
ASC	Status Quo	5.08	1.19		**7.87**	**6.65**		**5.66**	**3.57**		52.04	0.000
	Alternative A	-0.52	-0.16		**-3.71**	**-6.32**		**-1.46**	**-1.60**			
	Alternative B	**-4.56**	**-1.82**		**-4.16**	**-6.71**		**-4.20**	**-5.27**			
EXIST	H_RISK	2.05	0.62		**0.45**	**1.78**		**2.87**	**3.73**		44.32	0.000
	M_RISK	0.11	0.03		**0.32**	**1.62**		**3.18**	**4.56**			
	L_RISK	-2.16	-0.65		**-0.76**	**-3.18**		**-6.05**	**-5.41**			
MNG	OUTDOOR	-0.04	-0.01		0.06	0.20		-0.87	-1.27		23.72	0.001
	OUT-IN DOOR	-0.95	-0.23		**1.12**	**2.98**		-1.20	-1.14			

	INDOOR	0.98	0.30		**-1.18**	**-4.14**		**2.07**	**2.45**			
TSP	1	7.41	1.42		-0.38	-1.14		0.54	0.61		17.47	0.008
	2	-2.02	-0.49		**0.64**	**1.74**		**1.59**	**2.02**			
	3	-5.40	-1.11		-0.26	-0.82		**-2.13**	**-3.25**			
LAND	LOW	**-7.79**	**-1.76**		-0.16	-0.46		0.81	0.93		27.85	0.000
	MEDIUM	1.33	0.37		**0.77**	**2.78**		**-3.36**	**-4.22**			
	HIGH	6.47	1.09		**-0.62**	**-2.12**		**2.55**	**2.720**			
PROD	LOW	0.59	0.22		**-0.75**	**-2.99**		0.47	1.09		32.31	0.000
	MEDIUM	0.52	0.17		0.05	0.15		**2.56**	**4.10**			
	HIGH	-1.10	-0.26		**0.69**	**2.32**		**-3.02**	**-4.77**			
Continuous random Factor 2 (Common SDPD)												
ASC	Status Quo	**6.29**	**5.81**								33.82	0.000
	Alternative A	**-3.14**	**-5.66**									
	Alternative B	**-3.15**	**-5.77**									
EXIST	H_RISK	0.03	0.11								0.03	0.99
	M_RISK	0.02	0.09									
	L_RISK	-0.05	-0.16									
MNG	OUTDOOR	0.19	0.73								8.75	0.013
	OUT-IN DOOR	**0.76**	**2.15**									
	INDOOR	**-0.95**	**-2.96**									
TSP	1	**0.79**	**2.36**								6.50	0.039
	2	**-0.82**	**-2.28**									
	3	0.03	0.11									
LAND	LOW	0.12	0.36								0.94	0.63
	MEDIUM	0.13	0.59									
	HIGH	-0.25	-0.85									
PROD	LOW	-0.06	-0.26								0.15	0.93
	MEDIUM	0.11	0.38									
	HIGH	-0.04	-0.18									

[*] Base-level situation for the effects-coded attributes.

[a] Adjusted marginal utility gains from the base-level situation for the effects-coded attributes.

Table 4. Scale-adjusted latent class (SALC) model with free allocation of protesters that allows for correlated preference and class size

		CLASS 1			CLASS 2			CLASS 3			OVERALL	
Preference Class Size		0.56			0.12			0.32				
PREFERENCE CLASS MODEL PARAMETERS												
		Parameters	z value	Adj[a]	Parameters	z value	Adj[a]	Parameters	z value	Adj[a]	Wald	p-value
ASC	Status Quo*	5.40	1.60	5	**-2.90**	**-1.82**		**-34.45**	**-3.44**		13.29	0.010
	Alternative A	-1.19	-0.62	-6.592	1.21	1.16	4.12	**15.51**	**3.34**	**49.96**		
	Alternative B	**-4.22**	**-1.93**	**-9.62**	1.69	1.62	4.60	**18.94**	**3.49**	**53.40**		
EXIST	H_RISK*	2.98	1.21		**-6.83**	**-2.96**		**-6.09**	**-2.76**		12.16	0.016
	M_RISK	-5.14	-1.53	-8.11	**2.85**	**2.37**	**9.68**	-0.16	-0.18	5.93		
	L_RISK	2.15	0.64	-0.835	**3.98**	**2.52**	**10.81**	**6.26**	**3.22**	**12.35**		
MNG	OUTDOOR*	2.65	0.76		**-1.98**	**-1.90**		0.50	0.37		6.81	0.15
	OUT-IN DOOR	-4.08	-0.76	-6.73	**5.73**	**2.63**	**7.71**	-1.11	-0.64	-1.60		
	INDOOR	1.43	0.57	-1.22	**-3.75**	**-2.62**	**-1.78**	0.61	0.50	0.12		
TSP	1*	-0.14	-0.05		-0.82	-0.65		0.79	0.37		0.60	0.96
	2	-2.16	-0.90	-2.02	**-2.59**	**-1.87**	**-1.76**	-3.31	-1.49	-4.10		
	3	2.30	1.18	2.45	**3.41**	**2.44**	**4.24**	**2.52**	**1.89**	**1.73**		
LAND	LOW*	-1.87	-0.66		1.96	1.40		0.73	0.41		6.91	0.14
	MEDIUM	2.13	1.04	3.99	0.75	0.97	-1.21	**-3.22**	**-2.16**	**-3.95**		
	HIGH	-0.26	-0.08	1.61	**-2.71**	**-1.74**	**-4.67**	2.49	1.37	1.76		
PROD	LOW*	-1.56	-0.94		**-1.70**	**-1.77**		0.75	0.79		6.26	0.18
	MEDIUM	-1.46	-0.99	0.10	**2.91**	**1.89**	**4.61**	**-2.09**	**-1.65**	**1.34**		
	HIGH	3.01	1.33	4.57	-1.20	-1.41	0.5	1.34	1.20	0.60		
PRICE		-0.06	-0.36		**-0.36**	**-3.08**		-0.06	-0.80		5.10	0.078
SCALE MODEL PARAMETERS												
sClass1 (ln λ_1)		0.00									107.59	0.000
sClass2 (ln λ_2)		**-2.62**	**-10.37**									
sCLASS SIZE												
sClass1		0.60										
sClass2		0.40										
CLASS AND SCLASS												

Sclass	1	1	1	2	2	2			
Class	1	2	3	1	2	3			
ClassSize	0.52	0.05	0.03	0.05	0.07	0.28			
CLASS AND SCLASS COVARIANCES/ASSOCIATIONS									
sclass(1)<-> Class(1)	0.0000							54.00	0.000
sclass(1)<-> Class(2)	0.0000								
sclass(1)<-> Class(3)	0.0000								
sclass(2)<-> Class(1)	**-2.41**	**-6.92**							
sclass(2)<-> Class(2)	0.30	0.79							
sclass(2)<-> Class(3)	**2.11**	**5.44**							

[*] Base-level situation for the effects-coded attributes.

[a] Adjusted marginal utility gains from the base-level situation for the effects-coded attributes.

Table 5. Scale-adjusted latent class (SALC) model with deterministic allocation of protesters that allows for correlated preference and class size

		CLASS 1			CLASS 2			CLASS 3			OVERALL	
Preference Class Size		0.3549			0.2763			0.3687				
PREFERENCE CLASS MODEL PARAMETERS												
		Parameters	z value	Adj[a]	Parameters	z value	Adj[a]	Parameters	z value	Adj[a]	Wald	p-value
ASC	Status Quo*	3.5314	1.1113		3.6627	1.1405		**-35.2164**	**-3.4233**		14.7477	0.022
	Alternative A	-0.0143	-0.0060	-3.5457	-0.7506	-0.3480	-4.4133	**15.4970**	**3.2725**	**50.7134**		
	Alternative B	**-3.5171**	**-1.6217**	**-7.0485**	**-2.9122**	**-1.6664**	**-6.5749**	**19.7195**	**3.5006**	**54.9359**		
EXIST	H_RISK*	2.0939	0.6031		-2.4469	-0.8274		**-9.9121**	**-3.0943**		11.2836	0.80
	M_RISK	-1.4713	-0.3895	-3.5652	0.5189	0.2692	2.9658	0.8970	0.7365	10.8091		
	L_RISK	-0.6227	-0.2108	-2.7166	1.9279	0.9870	4.3748	**9.0151**	**3.2801**	**18.9272**		
MNG	OUTDOOR*	-0.3159	-0.1015		**3.9119**	**1.6953**		0.7506	0.4461		3.4541	0.75
	OUT-IN DOOR	0.2390	0.0552	0.5549	1.1005	0.4361	-2.8114	-0.3328	-0.1393	-1.0834		
	INDOOR	0.0769	0.0267	0.3928	-5.0124	-1.5128	-8.9243	-0.4178	-0.2582	-1.1684		
TSP	1*	1.1350	0.1976		0.8985	-0.2648		1.1546	0.4750		4.6694	0.59
	2	-2.9451	-0.5811	-4.0801	0.2725	0.1033	-0.626	**-4.6422**	**-1.7737**	**-5.7968**		
	3	1.8101	0.3287	0.6751	0.6259	0.3273	-0.2726	**3.4876**	**1.7716**	**2.333**		
LAND	LOW*	0.4331	0.1038		0.6433	0.2325		-1.3135	-0.5912		4.1942	0.65
	MEDIUM	0.9414	0.2706	0.5083	-0.7350	-0.5373	-1.3783	**-2.9138**	**-1.5612**	**-1.6003**		
	HIGH	-1.3744	-0.2017	-1.8075	0.0917	0.0299	-0.5516	**4.2274**	**1.8254**	**5.5409**		
PROD	LOW*	-0.4029	-0.2011		-0.6511	-0.3955		-0.0342	-0.0267		2.5932	0.86
	MEDIUM	0.8025	0.3679	1.2054	0.1551	0.1066	0.8062	2.4953	-1.2608	2.5295		
	HIGH	-0.3996	-0.1175	0.0033	0.4960	0.2737	1.1471	2.5295	1.4880	2.5637		
PRICE		-0.0475	-0.3097		**-0.2005**	**-2.0103**		**-0.2114**	**-2.0817**		6.7985	0.079
SCALE MODEL PARAMETERS												
sClass1 ($\ln \lambda_1$)		0.000									117.4987	0.000
sClass2 ($\ln \lambda_2$)		**-2.8026**	**-10.8397**									
sCLASS SIZE												
sClass1		0.5249										
sClass2		0.4751										

CLASS AND SCLASS SIZES								
Sclass	1	1	1	2	2	2		
Class	1	2	3	1	2	3		
ClassSize	0.3515	0.1712	0.0022	0.0035	0.1051	0.3665		
CLASS AND SCLASS COVARIANCES/ASSOCIATIONS								
sclass(1)<-> Class(1)	0.0000						29,7370	0.000
sclass(1)<-> Class(2)	0.0000							
sclass(1)<-> Class(3)	0.0000							
sclass(2)<-> Class(1)	**-4.6134**	**-5.0768**						
sclass(2)<-> Class(2)	**-0.4875**	**-2.1486**						
sclass(2)<-> Class(3)	**5.1010**	**5.4065**						

[*] Base-level situation for the effects-coded attributes.

[a] Adjusted marginal utility gains from the base-level situation for the effects-coded attributes.

The marginal WTP estimates for the deterministic model are reported in Table 6 while the estimates for the free allocation model are reported in Table A5 (on-line)Unconditional mean estimates are obtained by averaging the mean WTP estimates across classes using posterior probabilities as weights and considering significance of estimates (Hensher et al., 2015). Both class 2 and class 3 respondents experience high disutility with respect to the indoor management (-34.08 and -126.11 €/household, respectively). These estimates are extremely high among class 3 respondents that also show a high positive estimate for reducing the risk of extinction of the breed to low levels (229.70€/household) and lower values for increasing the tree crop diversity (57.22 €/household). Moving to management systems of mixed indoor and outdoor together with increasing the product variety, make a positive contribution to the utility of class 2 respondents (38.95 and 50.45 €/household, respectively).

The differences in these unconditional estimates between this selected model and its free allocated counterpart (see table A5 on-line) are wide. For example, reducing the risk of breed extinction to low levels reduces the utility of respondents in the free allocation model so that respondents on average should be compensated for achieving it (-18.35 €/household) while in the deterministic allocation model this attribute level makes the greatest contribution to respondents' utility (93.92 €/household), mostly related to the high estimate for this level by respondents in class 3. Another illustration of these differences across models are seen in the indoor management attribute estimates, reporting significant and high disutility in the deterministic allocation model (-65.09 €/household) versus positive estimates retrieved in the free allocation model. We also estimated Kernel density plots for these models (see on-line appendix figures 3-8). However, no clear differential patterns could be ascertained across unconditional marginal WTP distribution plots.

Table 6. Marginal Willingness to Pay estimates for the RLC deterministic protester allocation and the confidence interval model (€/year household)

Attributes	Levels	Class 2		Class 3		Unconditional mean estimates (considering class size and significance)
		Mean	95% CI	Mean	95% CI	Mean
EXIST	M_RISK	8.11	(-8.95; 26.73)	97.13	(32.73; 157.52)	ns
	L_RISK	7.48	(-18.51; 35.24)	**229.70***	(129.60; 325.85)	54.37
MNG	OUT-IN DOOR	**38.95****	(4.35; 75.02)	-60.52	(-83.29; -38.90)	15.90
	INDOOR	**-34.08****	(-71.97; 3.84)	**-216.11****	(-249.05; 184.62)	-65.07
TSP	2	-33.24	(-43.90; 3.63)	-18.30	(-39.39; 6.99)	ns
	3	11.92	(-27.07; 3.13)	**57.22****	(27.51; 88.36)	13.54
LAND	MEDIUM	15.57	(-10.86; 42.81)	18.36	(-31.04; 63.44)	ns
	HIGH	-6.21	(-27.15; 14.32)	10.73	(-29.98; 48.33)	ns
PROD	MEDIUM	19.59	(-2.45; 44.68)	-15.53	(-394.75; 377.23)	ns
	HIGH	**50.45****	(20.05; 82.56)	-14.85	(-57.40; 29.38)	20.60

*p < 0.10   **p < 0.05   ***p < 0.01

5 Discussion and conclusions

5.1 Insights and trade-offs of the free vs. deterministic allocation approaches

Identifying and excluding protest responses from econometric modelling is a common practice in economic valuation studies. However, this can lead to sample selection and estimation bias, especially when the number of protest responses is high. In this study we compared two approaches to deal with protesters in modelling when discrete approaches are adopted. More specifically, we investigate the impact of free versus deterministic protest responses allocation on preferences and WTP estimates across two different modelling approaches, random parameters and scale adjusted latent class (SALC) models.

Deterministic allocation of protesters to one preference class comes at the cost of the reduction in model performance with respect to information criteria. However, we argue that it provides more meaningful identification of preference profiles than the random parameter approach. In contrast, the estimates of the freely allocated random LC model may confound segregation into preference classes as indicated by Thiene et al. (2012). Free allocation models perform better in identifying serial status quo selection behaviour when scale heterogeneity is considered. The SALC model in this case retrieves patterns in preference class 1 that match with the expected protest behaviour although the share of respondents allocated to it amounts to approximately half of the sample.

The deterministic allocation of protesters provides overall better insights into preference profiles with similarities in preference patterns found between random parameters and scale-adjusted approaches, despite differences in class sizes across models. In both cases, the non-protest classes are characterized by two distinct preference patterns. Class-2 respondents in both models show a narrower range of attributes that positively define their preferences, namely support for outdoor breed management together with high product variety in the random parameters model. Class-3 respondents in both models show a more balanced utility pattern with a mix of attributes that include breed conservation, high tree crop diversity and either outdoor management (random parameters model) or landscape diversity (SALC model).

SALC models, in both free and deterministic protester allocation versions, show that the highest share of low scale (high variance) responses is found in preference segments with a wider set of attributes defining their preferences.

The disparities between estimates in the free vs. the deterministic model approach also affects the WTP estimates, leading to distinctively different policy recommendations based on these estimates. The free allocation model suggests that moderate improvement in the breed conservation status together with a shift towards indoor breeding maximize social utility. In contrast, the deterministic model suggests focusing the efforts on breed conservation followed by improving product diversity and outdoor-indoor breeding with improvements in tree crop diversity. These outcomes are also aligned with the results obtained in the world café sessions with rural and urban dwellers.

We argue that our results are aligned with the approach proposed by Thiene et al. (2012) where the allocation of protesters to a specific segment is preferred since reduction in model performance is compensated by a more plausible and balanced identification of the underlying preference structure. Accordingly, the following discussion is based on the results of our preferred model, i.e. the random parameter latent class model with deterministic allocation of protesters to one preference class.

5.2 Societal preferences for MBP farming system dimensions

Our LC analysis consideirngthe 3 class model with deterministic allocation of protesters generates two distinct classes, apart from the 36% who protest against any public support for MPBs. Class 2 (41%) exhibits clear preferences for management (against indoor) and product innovation (for a high level). New MBP products such as hamburgers have shown highly relevant sensory performance (Kallas et al., 2019), and this finding may reinforce it as a promising innovation avenue because sensory properties are not compromised but enhanced by the innovation. Class 3 (24%), while also preferring outdoor management, show greater preference for landscape and cultural aspects, and are the only respondents who value a reduction in the risk of extinction. Tree polycultures, preferred by class3, are closely linked to the management and meat quality of MBPs, where a share of the tree fruit harvest feeds MBPs and provides its meat with outstanding qualities.

It is notable that some respondents in the focus groups stated that breed extinction—for them—was unrealistic. In addition, respondents stated in debriefing questions that the outdoor option was chosen for meat quality reasons (38% of the sample), followed by animal welfare concerns (24.5%).

Although some researchers (Häfner et al., (2017), Arnberger and Eder, (2011), van Berkel and Verburg (2014)) have used virtual reality or manipulated pictures to assess social landscape preferences, we did not manipulate our pictorial representation of MPB agroecosystems. As noted by one of the reviewers, this may bias our estimates, since our pictures may represent different recreational opportunities for some people, which might generate non-significant estimates for this attribute across classes.

5.3 Policy implications for supporting extensive farming systems

Our unconditional WTP estimates signal some societal support for policies aimed at improving the status of the breed and its management systems. The highest WTP estimates in our sample, albeit for a relatively small segment, reside in securing breed low risk of extinction, increasing the product variety and in the outdoor management with some indoor sheltering.

Our results indicate some societal support for innovation in traditional product variety and may represent an opportunity to increase the value added for MBP farmers and hence contribute to the sustainability of this traditional farming system.

5.4 Limitations of our research and future pathways

Potential protest behaviour was identified in our world café focus group sessions and, although we used different payment options to try and mitigate protest, the share of protesters in our experiment remained high. While we have gone to considerable lengths in our empirical estimation to deal sensibly with these protests, a major constraint of our study is the limited perspective that our debriefing questions offer on this behaviour. Greater understanding of protest behaviour (as an aspect of hypothetical and consequential bias) is clearly needed. We also suggest that some institutional distrust may be behind a substantial share of this behaviour (Kassahun et al., 2020), but we did not test for it.

Another potential limitation on our work resides on the description of the landscape attribute and its levels, where artificially manipulated pictures or even virtual reality ones would have allowed for a more homogeneous delivery of this attribute to the respondents. The lack of significance of this attribute and its levels in almost all the models estimated may also be due to this limitation and not solely to its lack of significance in shaping people's preferences.

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