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Abstract

Biodiversity, landscape aesthetics and grazing livestock have significant relevance for agricultural production, however they are rarely considered in public landscape preferences research. This paper studies public preferences for pasture usage by the means of a discrete choice experiment using a sample of 449 individuals from Germany. Graphical representations of the choice sets are used to assess the preferences for the presence of livestock and typical pasture landscape elements. To account for preference heterogeneity, the paper utilises a latent-class logit model. Four different latent classes can be identified. The results show different preferences between the latent classes, not only in terms of the magnitude of the estimated parameters, but also in terms of the parameter signs. This indicates that there are multiple types of preferred pasture landscapes. Furthermore, the paper discusses the influence of sociodemographic variables on the class membership probabilities and presents the calculated willingness to pay for the landscape attributes and the livestock visibility.

1 Introduction

Land use and landscape changes are critical issues in context of agriculture and environmental protection. They are also relevant with respect to related policy issues. Within this broad field, one topic of particular interest is the development of pasture land and its utilisation by agriculture. For example, the preservation of current biodiversity levels requires the conservation of pastures (Plachter and Hampicke, 2010), as over half of the plant species in Germany have their habitat in pastures (BfN, 2018). Another important aspect of pastures is their role for climate protection. The conversion of pasture into arable land releases large amounts of CO_2, while younger pastures still have the potential to bind additional CO_2 (BfN, 2014; Poeplau et al., 2011). As rivers and brooks are often surrounded by extensive pastures, these areas also play a role in flood protection and erosion (BfN, 2014). The rooting in pastures additionally prevents soil erosion and keeps nutrients in the ground (Hampicke, 2013).

Recently, the absolute decline of the pasture area in Europe has slowed down (e.g. due to plow bans and related policy measures (BfN, 2014)). Instead, the focus of interest shifted towards the specific usage form of the pasture. Much interest is on the usage form “grazing” (enabling cattle (or other bovines) to feed themselves on pasture (Blanchet et al., 2000; Hodgson, 1990)). Under consideration of multiple perspectives, it is argued that grazing can be a preferable usage form of pastures. For example, pasture access can provide health and welfare benefits for dairy cows (Armbrecht et al., 2018; Keyserlingk et al., 2009). Given suitable conditions, the economic performance of dairy production can be improved by the implementation of grazing-practices (Knaus, 2016; Peyraud et al., 2010; Steinwidder et al., 2011; Thomet et al., 2011). With respect to the specific grazing system, it can be stated that intensive systems (e.g. rotational grazing) allow for a more efficient usage of the overgrowth than extensive systems (Hodgson, 1990). While those are generally considered to be preferable with respect to biodiversity issues (Hampicke, 2013). The implementation of grazing practices is also important with respect to landscape aesthetics with features like grazing cattle and small, mosaic agricultural plots (Plachter and Hampicke, 2010).

Notwithstanding the political relevance of pastures and positive evaluations of grazing practices, there remains little literature about public landscape preferences towards the pasture usage form “grazing”. A landscape is defined as “the outdoor environment, natural or built, which can be directly perceived by a person visiting and using that environment” (Hull IV and Revell, 1989). By letting citizens assess and valuate the aesthetic quality of landscapes, public landscape preferences can be studied (Rambonilaza and Dachary-Bernard, 2007). There exists a large body of literature on landscape preferences , e.g. reviewed for European landscapes by van Zanten et al. (2014) or Záková Kroupová et al. (2016). Next to revealed preference methods researchers often use stated preference methods (Walls et al., 2015). Within this framework, two dominant methods are the contingent valuation method and discrete choice experiments (DCE) (Hoyos, 2010). The advantage of DCEs is that they allow for the derivation of the willingness to pay (WTP) for changes of individual landscape elements (De Ayala Bilbao et al., 2012). Until today, the presence of livestock is a landscape element which has been rarely considered explicitly in public landscape preference research. According to the meta-analysis of van Zanten et al. (2014) “presence of livestock” was only used as a landscape attribute in 14 out of 345 cases, although it was among the highest preferred landscape attributes.

In reference to the agricultural production related with visible livestock, higher preferences and a WTP for milk and beef products from a grazing based production are reported for some consumer segments (Ellis et al., 2009; Kühl et al., 2018; Weinrich et al., 2014). Still, Gassler et al. (2018) showed that the purchasing intention and behaviour of consumers for grazing-based milk products are influenced by a number of different factors. It is worth noting that landscape evaluation studies typically focus on specific landscapes and often either survey inhabitants of, or tourists in a particular region of interest (van Zanten et al., 2014). When considering the previous results on consumer preferences for pasture-based products, the question arises, whether these preferences are only driven by perceived product quality differences or animal welfare benefits. It may also be the case that livestock presence itself has a value, even when the consumer does not "use" the presence (cf. the total economic value concept (Millennium Ecosystem Assessment, 2003)). Other values like existence or heritage values may also play a role in this context.

Therefore, the initial objective of the paper is to study whether preferences for livestock presence in pasture landscapes can be identified, even when there is no direct linkage with a specific product. In order to better understand this issue, a DCE with a general scenario was constructed, which did not focus on a particular region. The experiment considered the visibility of livestock in the landscape as well as other landscape attributes, e.g. linear landscape elements. In order to be able to calculate the consumers' WTP for the landscape attributes, a cost attribute is included in the DCE. Graphical representations of the choice sets were used. In order to study the public preference on a national level, a representative sample of consumers from all over Germany were surveyed. So far, studies only differentiated between presence and absence of livestock. This distinction falls short, as different grazing systems require varying livestock densities. These densities may be evaluated differently by the public. In order to address this issue the DCE includes different levels of livestock presence.

It has been shown that public landscape preferences can be heterogeneous, for example varying between regions (van Zanten et al., 2016) or with gender (Häfner et al., 2018). In context of DCEs, heterogeneity can also be modelled as a random variation among individuals (Train, 2009). Alternatively, the heterogeneity can be modelled by a mixture of a set of different groups (or classes) with homogenous preferences, using the latent class logit model (LCM) (Greene and Hensher, 2003). In this model, an individuals' assignment to the classes can be modelled by sociodemographic variables. In order to identify classes with different landscape preference patterns, we rely on the latter approach. Including individual information further allows studying factors influencing the class assignment, including the individual's regional residence.

The paper contributes to the literature in several ways. By explicitly considering the livestock density on the pasture, the paper goes beyond the simple presence or absence of cattle in the landscape and allows for different evaluations of the livestock presence were calculated. It further identifies different classes of landscape preference patterns. Lastly, by using a dataset on the national scale, it is the first to study regional differences of these patterns prevalence.

The remainder of this paper is structured as follows: In the second section, we describe the DCE, the survey design and the data collection. In section 3, the collected data is described and the econometric model and estimation procedures their analysis are outlined. The results are presented and discussed in section 4. The paper ends with conclusions (section 5).

2 Experimental design

This paper builds on the method of DCE, an approach which has gained increasing attention, especially in, but not limited to, the context of environmental evaluations (Hoyos, 2010). The basic idea of a DCE is to confront an individual with different sets of choice situations, in which he or she has to choose the preferred alternative. A number of attributes, which vary by defined levels, are used to describe the choice situations. The methodology is based on the Random Utility theory (McFadden, 1974), and allows the analysis of the stated choices under utility maximisation. As researchers are often interested in the WTP for individual attributes and levels, DCEs frequently include a cost attribute. In the following subsections, we motivate and describe the DCE and its graphical representation, the survey design and data collection are presented.

2.1 Scenario, attributes and levels

For the DCE, a suitable scenario had to be developed and appropriate attributes and their respective levels to be chosen. The attributes and levels chosen are depicted in Table 1, taking into account prior research (cf. van Zanten et al., 2014) on landscape preferences and own deliberations into account. In order to address the main concern of the paper, the attribute *presence of livestock* represents the presence and number of dairy livestock on the pasture. By taking the levels; no livestock, low livestock, medium livestock and high livestock presence, it varies the livestock density on the pasture. Additional parcelling of the grazing area by fences was used to represent the attribute *structuredness of the pasture*. The attribute levels are no additional parcels and low, medium or high number of additional parcels on the main plot. Other elements like stonewalls of hedge banks could also be used to represent additional structures of pasture. Given the broad scope of the experiment, these elements were not included in the design, in order to avoid associations with particular geographical regions. Still, two general attributes are included in the design. The first one is *point landscape elements*, including trees and individual bushes, which are either present or not present. The second attribute is *linear landscape elements* describing hedges and larger groups of bushes. They are also either present or not present. With respect to the monetary dimension, the *cost per household and year* was included as the cost attribute. It can take the values 0 €, 15 €, 30 €, 45 €, 60 €, 75 €, and 90 €.

Table 1: Attributes and levels of the Discrete Choice Experiment

Attribute	*Level*
Presence of livestock (No. of cattle)	None, low, medium, high
Structuredness of the pasture (No. of land parcels)	None, low, medium, high
Point landscape elements	Not present, Present
Linear landscape elements	Not present, Present
Cost per household and year	0 €, 15 €, 30 €, 45 €, 60 €, 75 €, 90 €

As the focus of this paper is not limited to a particular region, a general scenario for the experiment was chosen. The scenario states that ongoing developments will lead to more homogenous landscapes with fewer structural elements. It is also stated that the share of grazing cattle will continue to decrease, towards a very small share. Therefore, it is assumed that the typical landscape in the future will look like presented in the left panel of Figure 1. In order to slow down or even reverse this development, a new pasture protection program is to be implemented. In the experiment, the participants have to choose between multiple program possibilities which aim to promote different landscape structures. These programs are associated with additional costs for consumers, which are the sum of additional taxes, fees, and higher product prices, etc. (Johnston et al., 2015). The participants were informed about the structure of the choice sets (two alternative pictures representing expected outcomes of such different policies), as well as a "no policy program"-alternative. They were then asked to select the alternative to which they prefer in the different choice sets. In order to reduce the potential hypothetical bias, the scenario description includes a cheap talk-script (Carlsson et al., 2005).

2.2 Graphical representation

Based on an artificially created picture of a landscape, the attributes of the DCE (except of the cost attribute), are graphically represented (cf. van Zanten et al., 2016). The basis picture was created using photos taken in middle Lower Saxony, Germany. It was created in an unspecific way, in order to avoid potential biases which could be induced by individual associations like regional landscape particularities (like mountains) or other landscape elements.

Figure 1: left side: Basic landscape with all attributes at their lowest level; right side: Landscape with all attributes at their highest level; Source: Authors' illustration

The image portrayed in Figure 1 shows a landscape in June, which is dominated by a large pasture in the fore- and middle ground with some cultivated cropland on the sides. The pasture size is approximately 10 hectares, excluding any livestock, trees or bushes. In the right-hand corner of the background-image, a small village represents the rural character of this region. Furthermore, some trees and a forest are visible within the frame. For creating the choice sets, the attribute levels are gradually added, keeping basic conditions like light and weather conditions unchanged. This basic landscape is presented in the left panel of Figure 1. The right panel shows the landscape with all attributes at their highest level. The images were created using the software package Adobe Photoshop CS6.

2.3 Survey design and data collection

Based on the selected attributes and levels, the DCE was designed. The DCE has an unlabelled design, with two alternatives and a "no-policy"-alternative[1], which corresponds to an alternative with all attributes at the lowest level. The design of the experiment was conducted in multiple steps. First, a small pilot study was conducted, in which the participants

[1] Technically this can be understood as a status-quo-alternative, but as it represents a projected development, this term may be misleading here.

were asked to state their maximum WTP for several possible choice alternatives. These statements were used to determine realistic levels for the cost attribute. With the final levels, an efficient design with uninformative priors (Rose and Bliemer, 2009) was created. A second pilot study was conducted, which included this design. The results were used as informative priors for the determination of a Bayesian-D-efficient design (Rose and Bliemer, 2009). The final DCE consisted of 12 choice sets. Graphical representations of these choice sets were used in the survey.

The DCE was the first part of an online survey. The survey started with a welcome address and the motivation of the survey. After an introduction to the scenario of the DCE and an example choice set, a multiple-choice question followed, which assisted the understanding of the experiment's introduction for the participants. Participants who answered the control question incorrectly twice were excluded from the survey. After correctly answering the control questions, the participant's proceeded to the DCE. Participants who choose the opt-out-option at least one time were asked for their motivation.

In second part of the survey, first information regarding the participants attitudes related to the studies issues, such as the participant's attitude towards environmental issues (using the New Environmental Paradigm (NEP) – scale (Dunlap et al., 2000)) were questioned. Following previous research on preferences for cultural landscapes (Scarpa et al., 2011). The study then asked for the individual landscape usage behaviour, personal connection towards agriculture and related information like, nutritional behaviour and membership in an environmental protection Non-governmental organisation (NGO). Finally, common socio-economic variables like age and gender were asked. After completion of the survey, the participants were thanked for their participation.

The data collection was conducted by an online-sampling company in September and October of 2017. The sample contained participants from Germany. Quotas regarding the participants age, household income, federal state of residence and size of the place of residence were enforced (based on information from the German federal statistical office (Destatis, 2017a, 2017b)), in order to ensure representativeness.

Table 2: Descriptive statistics (N= 449)

	Mean	SD
Age (in years)	45.47	14.60
Farmer (0= no, 1= yes)	0.44%	
Gender (0=male, 1=female)	46.55 %	
Household income		
< 1,300 €	9.58 %	
1,300 – 1,699 €	8.24 %	
1,700 – 2,599 €	23.16 %	
2,600 – 3,599 €	18.26 %	
3,600 – 4,999 €	24.05 %	
> 5,000 €	16.07 %	
Household size	2.45	1.21
Landscape type around the place of residence		
Coast landscapes	5.12 %	
Forest landscapes and forest dominated landscapes	27.62 %	
Richly structured cultural landscapes	13.14 %	
Open cultural landscapes	22.72 %	
Mining landscapes	1.11 %	
Urban agglomeration	30.29%	
Marital status (not married = 0, married = 1)	44.95 %	
Member of an environmental NGO (0= no, 1= yes)	4.68%	
Municipality size		
< 1,000 inhabitants	2.67%	
1,000 – 5,000 inhabitants	8.91%	
5,001 – 10,000 inhabitants	10.91%	
10,001 – 100,000 inhabitants	44.32%	
100,001 – 500,000 inhabitants	16.04%	
> 500,000 inhabitants	17.15%	
NEP-score	4.02	0.48
Personal relationship towards agriculture (0= no, 1= yes)	35.41 %	

Notes: Authors‘ calculation

3 Material and Methods

3.1 Sample description

The survey was completed by 475 participants, of which 449 were included in the study sample. Participants were excluded if their data indicated protest answers and related answering behaviour. Descriptive statistics of the sociodemographic characteristics are presented in Table 2. The participants are on average 45.5 years of age. This is below the overall German mean, but corresponds with the mean of the group of the 18-69 year old, the age span which was offered by the sampling company. Nearly half of the participants were female, 45 % of the participants being married. As previously mentioned, the household income and municipality size are representative of the German population. The household size ranges from 1 to 9 persons, with an average is 2.5. Only 2 participants were actual farmers, while 35.4 % of the participants stated a personal relationship towards agriculture (e.g. growing up on a farm, or having farming relatives). The residence’s local surrounding was identified either as an area of urban agglomeration or a forest (or forest dominated) landscape by the majority of the participants (Gharadjedaghi et al., 2004). Over all participants, the average of the average NEP-score is close to 4 (on a 5-point Likert scale)[2].

Table 3 presents additional information about the participant's federal state of residence. Northern Germany refers to the federal states Berlin, Brandenburg, Bremen, Hamburg, Lower Saxony, Mecklenburg-Vorpommern, Saxony-Anhalt and Schleswig-Holstein; Middle Germany to Hesse, North Rhine-Westphalia, Thuringia and Saxony. Finally, Southern Germany refers to Baden-Württemberg, Bavaria, Rhineland-Palatinate and Saarland. Further, the share of participants living in federal states on the area of the former German Democratic Republic ("Former GDR", also often referred to as "new federal states") and in the three German city-states (Berlin, Hamburg and Bremen) are presented.

Table 3: Descriptive statistics: Federal State of residence (N= 449)

	Percentage
Northern Germany	28.06 %
Middle Germany	38.08 %
Southern Germany	33.85 %
Former GDR	16.93 %
City State	7.80 %

Notes: Author's calculations

3.2 The latent class logit model

As highlighted in the introduction, analysis relies on the LCM, an extension of the multinomial logit model (MNL) based on the introduction of latent classes, also referred to as latent segments or groups. In this section, we only briefly outline its properties. Detailed discussions of the model are e.g. given by Greene and Hensher (2003) or Train (2009).

Like most models for the analysis of observed choice behaviour, the LCM is based on the Random Utility Theory (McFadden, 1974). The person i's random utility for alternative j and choice situation t is given by

$$U_{ijt} = \boldsymbol{x}_{ijt}^{\top}\boldsymbol{\beta}_i + \epsilon_{ijt}, \tag{1}$$

with $i = 1, \dots, N; j = 1, \dots, J$ and $t = 1, \dots, T_i$. The observed alternative attributes are contained in the vector $\boldsymbol{x}_{ijt}^{\top}$ with dimension $K \times 1$. ϵ_{ijt} is the i.i.d. extreme value type 1 idiosyncratic error term. Under the standard MNL, $\boldsymbol{\beta}_i$ is assumed to be constant for the whole sample. Individual i's choice probability for alterative j in situation t is then given by

[2] We choose to use the average score of the NEP-scale's items, as we find it we find a sufficient internal reliability of the unidimensional scale (Cronbach alpha= 0.84) (Revelle, 2013).

$$P_{ijt} = \frac{\exp(\boldsymbol{x}_{ijt}^{\mathsf{T}}\boldsymbol{\beta}_i)}{\sum_{j=1}^{J}\exp(\boldsymbol{x}_{ijt}^{\mathsf{T}}\boldsymbol{\beta}_i)}. \tag{2}$$

For the LCM, the individuals are assumed to belong to a class q with a certain probability w_{iq}. This means that $\boldsymbol{\beta}_i = \boldsymbol{\beta}_q$ with a probability of w_{iq} for $q = 1, \dots, Q$ (where $w_{iq} > 0$ and $\sum_q w_{iq} = 1$). Q denotes the total number of classes. The class assignment probability (w_{iq}) is unknown to the researcher. A common parameterisation of w_{iq} is the semi-parametric multinomial logit form (cf. Sarrias and Daziano, 2017):

$$w_{iq} = \frac{\exp(\boldsymbol{h}_i^{\mathsf{T}}\boldsymbol{\gamma}_q)}{\sum_{q=1}^{Q}\exp(\boldsymbol{h}_i^{\mathsf{T}}\boldsymbol{\gamma}_q)}, \text{with } \boldsymbol{\gamma}_1 = \boldsymbol{0}. \tag{3}$$

Here, $\boldsymbol{h}_i$ represents a set of socio-demographic variables that are used to determine the class assignment. Normalising $\boldsymbol{\gamma}_1$ to zero allows the identification. In the simplest form, only a constant is included, without any potential sociodemographic characteristics.

Combining (2) and (3), individual i's choice probability for alternative j in choice situation t can then be given as

$$P_{ijt} = \sum_{q=1}^{Q} w_{iq} \frac{\exp(\boldsymbol{x}_{ijt}^{\mathsf{T}}\boldsymbol{\beta}_q)}{\sum_{j=1}^{J}\exp(\boldsymbol{x}_{ijt}^{\mathsf{T}}\boldsymbol{\beta}_q)}. \tag{4}$$

The LCM can either be estimated using maximum-likelihood- or expectation-maximisation-techniques. In this paper, the estimation is done using the maximum-likelihood-approach. In the following section, we provide details about the used estimation and model selection procedures.

3.3 Estimation procedures

The maximum-likelihood estimations were done using the 'gmnl'-package (Sarrias and Daziano, 2017) for the software 'R' (R Core Team, 2016). All levels were included as dummy variables. Two general issues arise for the estimation of LCMs. First, the researcher has to determine the number of classes in the model, as this number has to be fixed prior to the estimation (Louviere et al., 2000). The second issue is the selection of good starting values, as LCM often have local optima to which the optimisation can converge (Elshiewy et al., 2017).

Although the final decision on the number of classes has to be made by the researcher, information criteria can be used as a guidance tool. Following Louviere et al. (2000), the

Corrected Aike Information Criterion (CAIC) was relied upon. It takes both the sample size and the size of the parameter space into account and can be calculated as;

$$CAIC = -LL(\hat{\theta}) - (Q \times K_{\beta} + (Q-1)K_{\gamma} - 1)(\ln(2N) + 1) \quad (5)$$

Where $LL(\hat{\theta})$ is the log-likelihood, given the estimated parameters for $\theta = (\boldsymbol{\beta}, \boldsymbol{\gamma})$. K_{β} and K_{γ} are the numbers of the parameters in the segment-specific choice models and the classification model, respectively. N denotes the number of observations in the sample. Louviere et al. (2000) points out, that either the number of observed choices or as the number of respondents can be used as N. In the following, references to the former case as “CAIC A” and the later as “CAIC B” were made. The number of classes which leads to the lowest CAIC-value is the suggest value according to the criterion. Due to construction, CAIC B tends to suggest a higher number of classes.

Concerning the starting values, a first step is to estimate a standard MNL. Per default, the ’gmnl’-package uses a systematic variation of the MNL-estimates as the starting values for the class-specific parameters (and starting values of 0 for the class assignment model, implying an equal assignment probability for each class at the initialisation). In order to increase the confidence in the estimation results, we also choose to also apply an alternative approach. The model is repeatedly estimated (for 500 times), using random, uniformly distributed starting values with a range of (-1.5, 1.5). This approach generated candidate starting values that outperformed the starting values generated by the ‘gmnl’-package. The results of the best candidate set are used for the analysis. Following the estimation of the final models, the WTP of individual classes can be calculated. Here, we also rely on the ‘gmnl’-package, which allows for the calculation of standards error of the WTPs, using the delta-method (Oehlert, 1992).

Table 4: CAIC-values for a LCM with different number of classes

No. of Classes	2	3	4	5	6	7	8	9	10
CAIC A	8,103	7,557	7,302	7,338	7,545	7,605	7,699	8,016	8,170
CAIC B	8,053	7,475	7,183	7,177	7,336	7,344	7,381	7,636	7,722

Notes: Authors calculations; CAIC A: N= no. of observed choices; CAIC B: N= no. of respondents

4 Results and Discussion

Following the approach outlined in the previous section, first the number of classes was determined (based on a simple model, without sociodemographic variables). Table 4 shows the CAIC A and B values for models with 2 up to 10 classes. The CAIC A suggests 4 classes, while the CAIC B suggests 5. Given this inconclusive result, a more parsimonious model with 4 classes was chosen.

All attribute levels are coded as dummy variables. An alternative specific constant (ASC), equal to 1 if one of the two alternatives was chosen, is included in the model. The first part of Table 5 shows the results for a 4-class-LCM without sociodemographic variables. Additionally, the second part shows the results for the same model, this time including sociodemographic variables. These include the average NEP-score, the income and municipality size (both on an ordinal scale, compare Table 2), age and dummy variables indicating the individuals gender, whether the individual has a personal relationship with farming, is a vegetarian or vegan (“Nutrition”) and whether he or she is a member of an environmental NGO. Additionally, a set of dummy variables concerning the respondents’ federal state of residence were included. These include the variables “Northern Germany” and “Southern Germany” (leaving “Middle Germany” as the reference variable), “Former GDR” and “City State” (compare section 3.2 and Table 3). As expected these results of the two models are close to each other. With one exception, there are no differences regarding the statistically (non-) significance of the preference parameters.

Given the comparable results yielding almost identical interpretations of the two models, only the results of the model including sociodemographic variables are discussed in the following. Apart from the cost attribute (where all estimated parameters are statistically significantly negative), we find different preference patterns in the different classes, not only in terms of the parameter magnitudes, but also in parameter signs. Also, not all parameters are statistically significant in all classes. This indicates that there are clear differences in the landscape evaluation between the classes, where some landscape attributes are not of importance or even perceived negatively.

Individuals in Class 1 have a statistically significant positive preference for medium and high numbers of visible livestock. They also show a statistically significant negative preference for all three levels of additional parcels. The statistically significant parameter for point landscape elements is positive, while the parameter for linear landscape elements is not statistically significant. Considered jointly, this indicates a preference for “open” pasture landscapes with livestock present. Further, the parameter for the ASC is statistically significant and positive. This can be interpreted as an overall preference for the implementation of a pasture protection program, or more general, as a preference for environmental protection policies. Class 1 has a predicted share of 24 % in the sample.

Table 5: Regression results of the LCM with 4 classes

	LC without sociodemographic variables				LC with sociodemographic variables			
	Class 1	Class 2	Class 3	Class 4	Class 1	Class 2	Class 3	Class 4
Preference parameter								
ASC	4.52**	2.34**	1.12	1.37**	4.56**	2.28**	0.65	1.56**
	(0.57)	(0.60)	(1.07)	(0.48)	(0.58)	(0.60)	(1.02)	(0.53)
Livestock: low	0.55	1.50**	-1.52*	2.84**	0.59	1.53**	-1.11	2.81**
	(0.32)	(0.33)	(0.71)	(0.35)	(0.33)	(0.32)	(0.66)	(0.37)
Livestock: medium	0.71*	1.31**	-1.7**	2.95**	0.75*	1.33**	-1.41*	2.95**
	(0.32)	(0.30)	(0.62)	(0.31)	(0.30)	(0.30)	(0.58)	(0.33)
Livestock: high	0.74*	1.20**	-1.92**	2.89**	0.77*	1.24**	-1.39*	2.86**
	(0.32)	(0.36)	(0.73)	(0.37)	(0.33)	(0.35)	(0.70)	(0.39)
Structuredness: low	-0.97**	0.56*	-0.05	-0.10	-1.00**	0.57*	0.11	-0.16
	(0.32)	(0.24)	(0.50)	(0.21)	(0.33)	(0.23)	(0.48)	(0.23)
Structuredness: medium	-1.11**	0.58*	-0.12	-0.18	-1.13**	0.58*	-0.05	-0.23
	(0.29)	(0.25)	(0.49)	(0.22)	(0.29)	(0.25)	(0.46)	(0.23)
Structuredness: high	-0.57*	0.46*	-0.24	-0.07	-0.61*	0.47*	-0.06	-0.11
	(0.28)	(0.22)	(0.52)	(0.22)	(0.29)	(0.22)	(0.50)	(0.24)
Point Elements	0.89**	2.17**	-1.04*	0.71**	0.91**	2.14**	-0.77	0.67**
	(0.18)	(0.19)	(0.52)	(0.17)	(0.19)	(0.19)	(0.47)	(0.18)
Linear Elements	-0.07	0.81**	-0.03	0.04	-0.03	0.80**	-0.04	0.00
	(0.16)	(0.12)	(0.31)	(0.13)	(0.16)	(0.12)	(0.28)	(0.14)
Cost	-0.07**	-0.01**	-0.02**	-0.01**	-0.08**	-0.01**	-0.02**	-0.01**
	(0.00)	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)
Class assignment								
Intercept	-	0.40**	-1.53**	0.37**	-	-3.15**	5.37**	1.94**
		(0.04)	(0.07)	(0.04)		(0.44)	(0.76)	(0.45)
Age					-	0.02**	0.01**	0.00
						(0.00)	(0.00)	(0.00)
City State					-	0.32	-0.88*	0.40*
						(0.18)	(0.39)	(0.19)
Environmental-NGO					-	0.57**	-9.64	-0.18
						(0.19)	(53.55)	(0.23)
Former GDR					-	0.13	-0.68**	0.31**
						(0.12)	(0.23)	(0.12)
Gender					-	-0.06	0.16	-0.14
						(0.08)	(0.15)	(0.08)
Income					-	0.08**	-0.07	0.04
						(0.03)	(0.05)	(0.03)
Municipality size					-	-0.16*	-0.03	-0.46**
						(0.07)	(0.13)	(0.07)
NEP score					-	0.79**	-1.62**	-0.02
						(0.08)	(0.15)	(0.09)
Northern Germany					-	-0.16	-0.40*	0.27*
						(0.12)	(0.20)	(0.12)
Nutrition					-	-0.15	-0.58	-0.48**
						(0.16)	(0.34)	(0.18)
Relationship with Farming					-	-0.28**	-0.33*	-0.15
						(0.08)	(0.15)	(0.08)
Southern Germany					-	-0.44**	-1.51**	-0.47**
						(0.10)	(0.17)	(0.10)
Model statistics								
Class shares	24.05 %	35.90 %	5.20 %	34.85 %	23.78 %	36.68 %	5.56 %	33.98 %
N	5,388				5,388			
log likelihood	-3,404				-3,374			
CAIC a	7,302				7,366			
CAIC b	7,182				7,217			

Notes: Authors calculations; * p<0.05, ** p<0.01

In contrast to Class 1, all preference parameters (except for the cost attribute) are statistically significant and positive for Class 2, indicating that individuals in this Class prefer structured landscapes with visible livestock. Again, the parameter for the ASC indicates a general preference of the implementation of a pasture protection program. Class 2 has the highest predicted share in sample (with 37 %).

Class 3 is the class with the lowest predicted share (around 5.5 %). Here only the parameters for the medium and high numbers of visible livestock were statistically significant. Their negative sign implies that participants in this class prefer pasture landscapes without visible livestock. The remaining statistically not significant estimates indicated indifference regarding the other landscape attributes. Class 3 is the only group without a statistically significant ASC for the implementation of a pasture protection program, indicating no overall preference.

Individuals in Class 4 had the lowest statistically significant ASC-parameter, while having the highest estimates for the livestock-presence parameters. Further, only the parameter for the point landscape elements was statistically significant. This showed a preference structure which is most comparable to the one of Class 1. Class 4 has the second largest predicted share (34%). With respect to the different levels of livestock presence it has to be noted, that no statistically significant differences between the estimated parameter values can be identified within all four classes[3]. This indicates that, although there are clear differences between the classes, individuals in one class do not have different preferences for varying livestock densities.

Summarising, the 4 classes can be characterised in the following way: Individuals in Class 1 preferred a moderately structured landscape (with respect to the attributes of the experiment) with visible livestock. Their preference parameters are relatively moderate; expect a high preference for the implementation of a pasture protection program. Class 2 preferred a “fully” structured landscape (representing the potentially most environmentally friendly landscape); while in contrast, Class 3 had no clear preferences, except negative preferences for livestock presence. Class 4 showed a similar preference pattern as Class 1 (only being indifferent with respect to the number of parcels) but with higher magnitudes regarding livestock presence. In order to provide further intuition for the preferred landscape aesthetics of the four classes, the

[3] Multiple comparisons (using the Bonferroni correction) yield no significance levels <0.05.

most preferred attribute level combinations (based on the highest statistically significant parameter estimates) are graphically presented in Figure 2.

Figure 2: Most preferred attribute level combinations; upper left: Class 1; upper right: Class 2; lower left: Class 3; lower right: Class 4; Source: Authors' illustration

Proceeding to the effects of sociodemographic variables on the individual's class assignment, it was noted, that Class 1 represented the reference group (which is, in terms of the preference parameter magnitudes, the most moderate group). Therefore, the interpretation of statistically significant coefficients always indicate that an individual is more (or less) likely to belong to the respective class then belonging to Class 1.

The most significant effects on the assignment were found for Class 2. For example, individuals with higher incomes are more likely to belong to Class 2. Individuals living in larger municipalities are less likely to be in the Class 2 and 4. The participant's gender has no significant effect on the class assignment, while older individuals are more likely to either belong Class 2 or 3. Interestingly, individuals who report a personal relationship with agriculture have a significantly lower probability to prefer either fully structured landscapes (Class 2) and to be indifferent regarding the landscape and reject livestock in the landscape (Class 3). Vegetarians (and Vegans) are only less likely to be in Class 4, which could be explained by a potentially higher scepticism towards animal production. Individuals who are members of an environmental protection NGO were more likely to belong to Class 2, thus preferring richer structured landscapes. Compared the environmental NGO-membership, the individuals environmental attitude (NEP-score) has stronger effects. Individuals with a higher NEP-score are more likely to be in Class 2 and less likely to be in Class 3. Particularly the effect for Class 3 is as expected, given that the class had the lowest preferences for landscape elements.

With respect to variables indicating the individual’s federal state of residence, it was found that individuals living in city states more likely to be in Class 4 and less likely to be in Class 3. The same pattern holds for individuals living in a federal state in the area of the former GDR and individuals living in northern Germany. In contrast, people from southern Germany are more likely to be assigned to Class 1 (statistically significantly negative coefficients for all three other classes), thus having moderate preferences towards pasture landscapes. Here the differences in the agricultural structure could be an explanation, for example as farms in southern Germany are on average smaller than in the rest of the country.

While the findings regarding the livestock presence appeared to be in line with the general findings in the literature (van Zanten et al., 2014), there are some differences with more recent work, which also focuses on Germany. In contrast to the present results, Häfner et al., (2018) found the importance of livestock presence less pronounced. The authors also found differences in the effect of socioeconomic variables (e.g. the gender). Regarding the regional differences, van Zanten et al. (2016) also found differences between regions and argued that these could be explained by existing differences in the agricultural structure. There are some aspects which could explain the differences with prior research. Differences in the graphical representation of the same landscape attribute can lead to different evaluations. Also differences in the used scenario could influence the outcomes of the experiment, for example by inducing unintended framing effect. In contrast to Häfner et al. (2018), the present study did not investigate particular regions.

Finally, the WTP for the different attribute levels were calculated in Table 6. Naturally, there were similar patterns of the statistical significance between the different classes for the original parameter estimates. Also, the magnitudes of the WTPs differ accordingly. Here, Class 2 and 4 exhibited higher values then Class 1 and 3. Given that these values are also larger as the highest level of the cost attribute, this result appears suspicious. Although the range of the cost attribute was thoughtfully chosen (compare section 2.3), the calculated values could be interpreted as an indication that the chosen levels of the cost attribute should have been higher[4]. According to Kjær (2005) this can result in “non-trading of the cost attribute” by the participant and ultimately leading to overestimated WTPs. Given that the range also varies strongly between the classes, this interpretation appeared reasonable. Therefore, the results presented in Table 6 should be interpreted with caution.

Table 6: Calculated WTP for the 4-class-LCM with sociodemographic variables

	Class 1	Class 2	Class 3	Class 4
ASC	60.32** (5.85)	240.37* (100.07)	30.67 (44.86)	165.60* (82.14)
Livestock: low	7.81 (4.54)	161.14** (39.07)	-52.63 (31.40)	297.07** (65.12)
Livestock: medium	9.92* (4.12)	140.63** (36.79)	-66.77* (31.13)	311.92** (74.06)
Livestock: high	10.22* (4.56)	131.07** (35.14)	-65.83* (33.26)	303.27** (67.89)
Structuredness: low	-13.21** (3.92)	59.95** (19.58)	5.43 (23.58)	-16.50 (26.64)
Structuredness: medium	-14.88** (3.47)	61.35** (22.81)	-2.49 (21.49)	-23.85 (27.60)
Structuredness: high	-8.13* (3.73)	49.55* (22.17)	-2.63 (23.36)	-12.04 (25.92)
Point Elements	12.07** (2.57)	225.87** (51.40)	-36.56 (23.33)	70.68** (17.47)
Linear Elements	-0.37 (2.18)	84.22** (19.83)	-1.72 (13.40)	-0.25 (14.52)

Notes: Authors calculations; * $p<0.05$, ** $p<0.01$

5 Conclusions

Given the role of pastures for the agricultural production, the environmental protection and the corresponding societal expectations, this study aimed to improve the understanding of public preferences towards pasture landscapes in Germany. Using a DCE, the focus was on the role of livestock presence in these landscapes. In order implicitly account for different production systems, the experiment differentiated not only in terms of presence or absence of livestock, but also in terms to livestock density. The experimental data was analysed by the means of a LCM, which allowed the identification of four latent classes. By using a dataset on the national scale it was possible to account for regional differences and effects of sociodemographic variables on the class assignment.

[4] Interestingly, the 2-step-procedure was chosen to avoid an ad-hoc-determination of the cost attribute. While discussing the results of the first pilot study with colleagues, we faced some suspicion whether these were reliable, as the stated WTP appeared too high. This makes the findings of the final study even more surprising, but also underlines the often stated importance of cautious reasoning for the experimental design (cf. Kjær, 2005).

A main finding of the study is that, although there are multiple groups with different preference patterns, there are no statistically significant differences with respect to the livestock density within a group. This is of particular interest for agricultural production, as it shows that there are groups in the population which differ with respect to their overall livestock preference, the preference does not vary with livestock density. The interpretation is that within the groups it does not matter the livestock presence originates from extensive or intensive production systems. It was observed that in three out of four classes (with a combined share of 90 %) there was a general preference for the implementation of a pasture protection program. Furthermore the study indicated that there were multiple sociodemographic variables on the class assignment, as well as of the individual's residence.

These results have two broader implications. From the farmers' perspective, they show that there are different public groups, with different preferences regarding the visibility of livestock presence. Nevertheless, the particular production system does not matter for these groups (at least with respect to the related livestock visibility). Further, it was possible to show regional differences in the prevalence of the preference groups. Concerning agricultural policies, influencing the landscape, this showed that a "one-size-fits-all"-approach would potentially be suboptimal with respect to the public perception of these policies. This highlights that, given the often critical public reception of agricultural policies, they should allow for a sufficient flexibility for locally adapted implementations.

Although the study helps to understand public landscape preferences with respect to pasture landscapes, it revealed some limitations. The calculated WTPs were likely overestimated. Given the cautious procedure for the experimental design, this result is unexpected. Also, the broad setting and the experimental design originating from landscape research does not allow for cost-benefit analyses.

These limitations imply two main directions for future research. In order provide more reliable WTP estimations, researches could investigate alternative approaches to determine optimal ranges for cost attributes, or apply DCEs with individual specific reference points. Also specific policy measures could be included in an experimental design. Results of such an experiment could be combined with insights from farm management research, in order perform cost-benefit analyses. Linking the approach presented in this paper with issues from product-marketing related to consumer research could also represent a fruitful research direction. Still, this would require cautious theoretical considerations, in order to disentangle the complex relationships of environmental, economic and social dimensions.

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Die Wurzeln der **Fakultät für Agrarwissenschaften** reichen in das 19. Jahrhundert zurück. Mit Ausgang des Wintersemesters 1951/52 wurde sie als siebente Fakultät an der Georgia-Augusta-Universität durch Ausgliederung bereits existierender landwirtschaftlicher Disziplinen aus der Mathematisch-Naturwis-senschaftlichen Fakultät etabliert.

1969/70 wurde durch Zusammenschluss mehrerer bis dahin selbständiger Institute das **Institut für Agrarökonomie** gegründet. Im Jahr 2006 wurden das Institut für Agrarökonomie und das Institut für Rurale Entwicklung zum heutigen **Department für Agrarökonomie und Rurale Entwicklung** zusammengeführt.

Das Department für Agrarökonomie und Rurale Entwicklung besteht aus insgesamt neun Lehrstühlen zu den folgenden Themenschwerpunkten:

- Agrarpolitik
- Betriebswirtschaftslehre des Agribusiness
- Internationale Agrarökonomie
- Landwirtschaftliche Betriebslehre
- Landwirtschaftliche Marktlehre
- Marketing für Lebensmittel und Agrarprodukte
- Soziologie Ländlicher Räume
- Umwelt- und Ressourcenökonomik
- Welternährung und rurale Entwicklung

In der Lehre ist das Department für Agrarökonomie und Rurale Entwicklung führend für die Studienrichtung Wirtschafts- und Sozialwissenschaften des Landbaus sowie maßgeblich eingebunden in die Studienrichtungen Agribusiness und Ressourcenmanagement. Das Forschungsspektrum des Departments ist breit gefächert. Schwerpunkte liegen sowohl in der Grundlagenforschung als auch in angewandten Forschungsbereichen. Das Department bildet heute eine schlagkräftige Einheit mit international beachteten Forschungsleistungen.

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