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Heterogeneous Preferences for Public Goods Provided by Agriculture in a Region of Intensive Agricultural Production: The Case of the Marchfeld

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Abstract: The aim of this paper is to elicit the marginal willingness to pay (MWTP) for the improved provision of public goods (PGs) by agriculture in a region of intensive agricultural production, embodying many of the environmental problems related to agriculture within and outside the European Union (EU). Our analysis was based on a participatory approach, combining the involvement of local stakeholders and a discrete choice experiment (DCE) in the Marchfeld region in Austria. We estimated a random parameters logit model (RPL), including interactions with socio-demographic factors, to disentangle preference heterogeneity and find a positive MWTP of the local population for all three PGs analyzed: (i) groundwater quality; (ii) landscape quality; and (iii) soil functionality in connection with climate stability. Furthermore, MWTP varies considerably with respect to age, farmers/non-farmers and locals/incomers. Further research could combine the results of this demand-side valuation with those of a supply-side valuation, where the opportunity costs of different management options for farmers are estimated. Based on such a cost–benefit analysis and further participation of local stakeholders, new governance mechanisms for the smart and sustainable provision of PGs by agriculture could be developed for the Marchfeld region and for comparable European regions.

Keywords: discrete choice experiment; random parameters logit model; preference heterogeneity; willingness to pay; public goods; agriculture

1. Introduction

Agriculture faces increasing and opposing social and environmental challenges: due to population growth and changes in global dietary patterns, the global demand for (cheap) agricultural products remains high and is set to increase further [1]. In many places, this demand leads to the intensification and spatial expansion of agricultural production, resulting in negative externalities for the environment [2] and the global climate [3].

With respect to climate change, agricultural production within the Land Use, Land Use Change and Forestry (LULUCF) sector is responsible for about 22% of the total anthropogenic greenhouse gas emissions [3]. At a sectoral level, agriculture therefore causes emissions comparable to those produced by global industry, electricity and the heat production sector [3]. Regarding the environmental effects of an intensifying agriculture, numerous studies have shown negative environmental impacts on, e.g., soils, water, biological or ecological diversity [4]. However, it needs to be noted that certain forms of extensive agricultural production may also have a negative impact on the environment (e.g. extensive beef production could under certain conditions increase carbon emissions compared to more intensive forms of beef production) [5]. Meanwhile, the environmental and social trade-offs of agricultural production are widely acknowledged and the related public and scientific debate is constantly evolving, leading to a growing recognition of sustainable production methods [6].

Within the European Union (EU), societal concerns regarding possible negative effects of agriculture on the environment are of particular relevance, as agricultural production receives respectable public support, making up around one third of agricultural income on EU-average [7]. Therefore, financial support to farms in the EU is increasingly linked to the provision of social and environmental public goods (PGs) [7–9]. PGs are commonly characterized by non-rivalry and non-excludability [10], which means that their use by one individual does not reduce their availability to others and individuals cannot be excluded from its consumption. It is due to these two key-characteristics that even if there were a positive willingness to pay (WTP) by society for such PGs, there would still exist no market for them. PGs provided by agriculture include water quality, agricultural landscapes and functionality of soils. We would like to point out that, while we focus on the concept of PGs in this article, substantial research on environmental valuation is also done using the framework of ecosystem services (ESS) [11–13].

Despite an existing focus on the provision of PGs, the current agri-environmental policies of the EU fail to address environmental problems related to agriculture sufficiently, particularly in regions of intensive agricultural production [14], which are often situated at the fringe of larger urban agglomerations. Here, the trade-offs between agricultural production, on the one hand, and the provision of PGs from the agro-ecosystems, on the other hand, manifest themselves in increasing public debates about a more sustainable agricultural production. In its recent communication on "The Future of Food and Farming", the European Commission has thus put forward a recommendation for the next reform of its Common Agricultural Policy (CAP), concluding that its future focus should be particularly laid on policies targeted towards achieving a smarter provision of PGs and addressing citizens' concerns regarding sustainable agricultural production [15].

Against the background of the growing recognition of the trade-offs between agricultural production and the provision of PGs from agro-ecosystems, a growing number of studies has been dealing with the assessment of society's demand for these goods. Due to the absence of a market for PGs, stated preference (SP) methods such as contingent valuation (CV) or discrete choice experiments (DCEs) are often applied in order to estimate the demand for social and environmental PGs in general [16,17] and those particularly affected by agriculture [18,19]. Alternatively, if PGs can be connected to a market good, it is also possible to apply revealed preference (RP) methods [20]. Valuation studies of PGs provided by agriculture comprise, for example, air quality and climate stability [21,22], (bio)diversity of agricultural landscapes [23–25], soil functionality [26,27] or (ground)water quality [28–30].

In addition, extensive research has already been carried out to analyze preference heterogeneity in DCEs, with respect to PGs provided by agriculture [31–34]. Various statistical models have been developed, which attribute heterogeneity either to the deterministic or to the stochastic part of the model [35]. Beyond these different models, an informative approach is to investigate preference heterogeneity with respect to the socio-demographic characteristics of respondents such as gender, age or education level (see, e.g., van Zanten et al. [36] for an overview of socio-demographic variables influencing preferences for agricultural landscapes).

Based on these considerations, the aim of this study was to elicit the marginal willingness to pay (MWTP) of local residents for the improved provision of PGs by agriculture in a typical region of intensive agricultural production, which embodies many of the environmental problems related to agriculture found in comparable regions within and outside the EU. Our analysis took place in the

Marchfeld region, a dynamically developing, semi-urban border region in Austria. Situated between the two capitals of Austria and Slovakia (Vienna and Bratislava), our case-study region (CSR) is marked by intensive agricultural production and, at the same time, rising concerns from the local population regarding a more sustainable agricultural land use. We applied a multi-stage stakeholder process to identify the main issues regarding the provision of PGs and target levels of their provision in the CSR. Based on a DCE, a conditional logit (CL) and random parameters logit (RPL) model were used to elicit the local population's MWTP for an increase in the provision of PGs by agriculture. In the analysis, we particularly aimed to identify factors driving differences in MWTP, such as socio-demographic characteristics or personal attributes.

Our paper contributes to the literature on valuation of public goods provided by agriculture in three ways. First, we focused on a region marked by intensive agricultural production which is situated at the fringe of large urban agglomerations. Such regions have received less attention in previous studies. Therefore, our analysis helps to gain better understanding of the complex local demand for PG-provision by agriculture in this specific regional context.

Secondly, we investigated and visualized the effects of socio-demographic factors on MWTP. Specifically, due to increasing in-migration from adjacent urban areas to the CSR, we also considered the possible role of the origin of respondents (locals or incomers who have moved to the Marchfeld region) with respect to their preferences.

Thirdly, we provide additional estimates of MWTP for an increase in the provision of the three main PGs identified by local stakeholders in our CSR: groundwater quality, landscape quality and soil functionality for which we emphasize its connection with climate stability [37].

The structure of the paper is as follows: in the next section, we introduce our CSR, outline the process of PG-identification, describe our data basis and the choice experiment, as well as the econometric analysis. Subsequently, we proceed with the presentation and discussion of our results before providing concluding remarks.

2. Material and Methods

2.1. Description of the Case Study Region

Our CSR, the Marchfeld, is located in the northeast of Austria. It is a sedimentary basin between the Eastern Alps and the Carpathian Mountains and is characterized by a semi-arid climate with hot, dry summers and cold winters, very deep and fertile chernozem soils and a low annual precipitation of around 500 mm/year [38].

The Marchfeld region consists of 23 municipalities covering 70,800 ha. The average population density is 97 persons/km^2, but it strongly varies in the single municipalities, ranging from 15 to 881 persons/km^2. For approximately the last 10–15 years, the region has experienced a strong population growth caused by in-migration [39]. An overview of the location of the Marchfeld region is given in Figure 1.

Agricultural management is carried out on around 50,800 ha utilized agricultural area (UAA). Cash-crop farms make up around 95% and organic farms around 12% of all farms (roughly 900) in the CSR [40]. The good soil quality [41], combined with the possibility of irrigation, leads to an agricultural system characterized by intensive cash-cropping. Ninety-eight percent of UAA is made up of arable land [40] and around 25% of the arable land in the region is irrigated [42].

The Marchfeld region is framed by two major agglomerations, Vienna and Bratislava. This leads to a multitude of sensitivities and claims affecting the region such as in-migration, recreation demands, space requirements for housing and infrastructural planning (e.g., roads, highways, flood protection) and regional food supply [43].

2.2. Identification and Validation of Demand for Public Goods in the Marchfeld Region

The main PGs, which are facing an imbalance between supply and demand and their target levels have been identified in a participatory process with local stakeholders, coming from the areas administration, agriculture, environment and rural development. In a first regional workshop, a group of stakeholders discussed what is understood by agricultural PGs and what problems exist with respect to their provision in the Marchfeld region. It became clear that there are many demands regarding agricultural production and the provision of PGs by agriculture. On the one hand, the Marchfeld region is highly suitable for the efficient and intensive production of food—with, in part, negative effects on PGs. On the other hand, mainly due to its spatial location, the Marchfeld region is a strong growth and inflow region, which in turn leads to increased demand, but also increased pressure on the provision of PGs by agriculture.

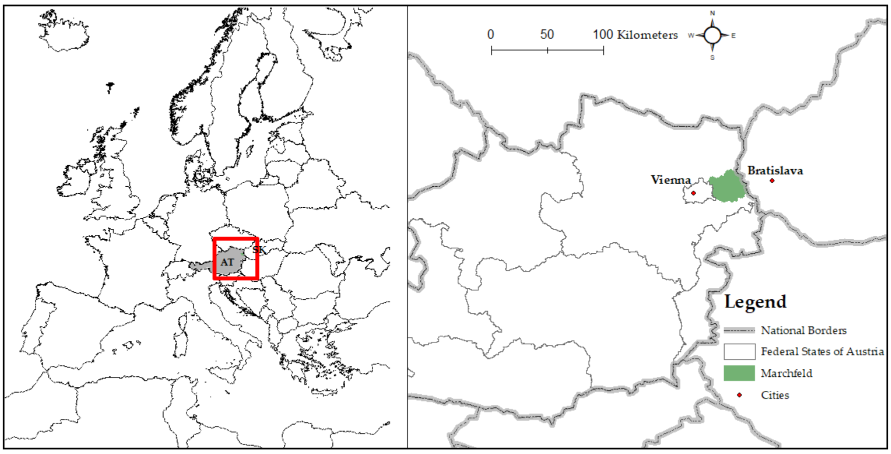

Figure 1. Location of Austria in Europe (**left**) and of the CSR Marchfeld within Austria (**right**).

One major PG-issue identified by regional stakeholders and experts in the Marchfeld region is the functionality of agricultural soils. Particularly, due to intensive agricultural management as well as the climatic conditions in the Marchfeld region, soil fertility and soil health are assumed to be endangered, while simultaneously representing the most important basis for agricultural production. Soil conditions are identified by the stakeholders as intersecting with important environmental issues such as climate, groundwater, erosion, etc. Here, in particular, the groundwater quality in the Marchfeld region is seen as a critical point. At the moment, groundwater quality in the Marchfeld region is very poor compared to other Austrian regions [44]. This is first and foremost due to the high level of nitrate pollution resulting from agricultural management, combined with the low precipitation rates leading to insufficient dilution. In many parts of the Marchfeld region, groundwater treatment is necessary to reach the standard values for potable water. To improve soil functionality, and consequently also to reach a positive impact on groundwater quality, changes of the agricultural management are suggested by the experts and stakeholders. These changes mainly include measures to increase soil-humus contents such as minimum tillage, intercropping and the mixing of straw, compost and harvest residues into the ground. In addition, changes in crop rotation are seen as potential ways to reduce chemical fertilization and enhance soil fertility. Further issues addressed in the stakeholder workshops were the agricultural landscape appearance and biodiversity (landscape quality). Due to intensive cash-cropping, the fields are on average relatively large and there is a lack of landscape elements such as hedges and flower strips, which would make the landscape more diverse and additionally hamper wind erosion and promote biodiversity.

Despite existing agri-environmental policies in Austria, the above-mentioned problems remain in the Marchfeld region—suggesting the need for specifically tailored local agri-environmental policies. However, the decisive question is how the local population, which would be directly affected by such policies perceives the status-quo of PGs provided by agriculture and whether they would be willing to pay for an improvement in their provision. To assess the target levels of a balanced provision of the three identified PGs soil functionality, groundwater quality and landscape quality, a second regional stakeholder workshop took place. Here, the necessary improvements in the levels of provision for the three main PGs were discussed and determined. In a third regional stakeholder workshop, the results of the DCE were presented to the stakeholders and discussed regarding their reliability and the driving factors behind those results.

2.3. Survey, Choice Sets and Experimental Design

We developed an online questionnaire which consisted of: (i) an introductory section, where the aim and scope of the study were presented; (ii) a section where participants were asked about their attitudes towards the three PGs of interest in the CSR; (iii) a choice experiment to receive information about their preferences and willingness to pay for an improvement in the three above-mentioned PGs; (iv) follow-up questions after the choice experiment to gain information about the motives and beliefs which drove their choices and their general view on PGs and agri-environmental policies; and (v) a section on the socio-demographic characteristics of the participants.

To achieve an adequate sample size in the CSR, we cooperated with a market research institute. From 559 people contacted, 204 people completed the survey. After removing 10 respondents due to protest responses [45], 194 respondents represented the basis for the econometric analysis. The resulting sample was representative regarding age and gender and all participants were residents of the Marchfeld region (people had to specify their ZIP-code). Throughout the research process, we followed the state of the art of environmental valuation with discrete choice experiments [46].

An overview of the attributes and their levels used in the choice experiment is given in Table 1. Groundwater quality can take on two levels: it is either potable only after a treatment, which is the case in the status quo, or potable without treatment. With respect to landscape quality, we varied the percentage of hedges and flower strips on agricultural land from 2.5% (status quo) to 10%. The increasing percentage of hedges and flower strips was visualized with a Google-Earth image, which was edited with an image-editing program. For soil functionality in connection with climate stability, we presented respondents with different numbers of households for which the annual greenhouse-gas emissions (based on oil heating) are saved through implementation of conservation agricultural management practices [47]. Those practices consist in our case of no tillage, intercropping and leaving residues on the field after harvesting, on certain proportions of agricultural land in the Marchfeld region. Aside from their positive impact on soil functionality, such practices can be a very cost-effective measure in reducing greenhouse-gas emissions through soil-carbon sequestration [48]. Specifically, conservation agricultural management practices on all the agricultural land in the Marchfeld region (~50,800 ha) or one percent (~508 ha) could save annual greenhouse-gas emissions caused by the oil heating of approximately 30,000 or 300 households, respectively [49,50]. Lastly, the payment vehicle was expressed as additional annual tax payments in €/household and year, ranging from €40 to €160. Only the status-quo option was associated with no additional payment.

Table 1. Attributes and levels used in the choice experiment.

Attribute	Level	Description
Groundwater quality (water)	Groundwater potable only after treatment (status quo), Groundwater potable without treatment	Indicates, whether groundwater needs to be treated before it is potable
Landscape quality (landscape)	2.5 (status quo), 5, 7.5, 10	Percentage of hedges and flower strips on agricultural land
Soil functionality in connection with climate stability (climate)	0 (status quo); 10,000; 20,000; 30,000	Number of households for which the annual greenhouse gas emissions (oil heating) are saved
Additional tax payment (cost)	0 (status quo), 40, 80, 120, 160	Additional tax payment in €/household and year

All possible combinations of the attribute levels led to a full factorial design with 128 alternatives. To reduce the number of combinations to a manageable size, we used a D-optimal orthogonal design [51] reducing the number of alternatives to 24, which we divided into four blocks. Each respondent was presented with six choice sets with two varying alternatives and the fixed status-quo alternative, leading to a total of 1164 observed choices (= 194 × 6). An example of a choice set, which was translated to English, is given in Table 2.

Table 2. Example of a choice set used in the choice experiment (translated to English).

	Alternative A	**Alternative B**	**Status Quo**
Percentage of flower strips and hedges on agricultural area	 10%	 2.5%	 2.5%
Groundwater potable	only after trearment	without treatment	only after trearment
Saved annual GHG emissions	20,000 households	30,000 Households	No GHG-emissions saved
Additiaonl costs	80 €	120 €	0 €
I would choose	Alternative A	Alternative B	Status Quo

2.4. Econometric Models and Willingness to Pay Estimation

Building up-on the characteristics theory of demand, welfare theory and consumer theory [52], the basis for the econometric analysis of our DCE are Random Utility Models (RUM) [53]. The principal idea is that utility (U_{nj}) for an alternative j perceived by respondent n can be decomposed into an observed (V_{nj}) and unobserved (ε_{nj}), stochastic part. Assuming that those parts are additive, one ends up with the following formula [54]

$$U_{nj} = V_{nj} + \varepsilon_{nj}, \tag{1}$$

where the observed part of utility V_{nj} is assumed to be a weighted sum of attribute levels x of each alternative. Again, assuming that people choose between alternatives to maximize their utility, considering budget constraints, econometric models can be applied to estimate weights β for the attributes. The most basic RUM is the conditional logit model (CL), which assumes constant (homogeneous) parameters for each attribute over all respondents. The utility-specification of a CL model is given in the following formula [54]

$$U_{nj} = \beta x_{nj} + \varepsilon_{nj}, \tag{2}$$

where x_{nj} is an attribute of alternative j for individual n, β is a parameter of the attribute and ϵ_{nj} is an error term which is assumed to be identically and independently extreme value type 1 distributed (Gumbell-distribution). The researcher cannot observe utility, only the choices made by individuals, but one can estimate the parameters β which maximize the probability of the observed choices. A CL model has the following choice probabilities of individual n choosing alternative j over other alternatives, ranging from 1 to K

$$P_{nj} = \frac{e^{\beta x_{nj}}}{\sum_{k=1}^{K} e^{\beta x_{nk}}} \tag{3}$$

and can be estimated by maximum likelihood [54].

To overcome some restrictive assumptions of this model (no random taste variation, restrictive substitution patterns and no correlation of unobserved factors over time), more flexible models, such as the random parameters logit model (RPL), in a more general form also referred to as mixed logit model (MXL), have been developed [54]. An RPL model allows for some or all parameters to be individual-specific by assuming that they vary with density $\beta_n \sim f(\beta|\theta)$, where θ are the parameters, describing the distribution of β, for example means and variance-covariance matrix. This enables modeling unobserved preference heterogeneity across individuals. However, the distributional form of β has to be specified by the researcher. For example, when estimating an RPL model, where the parameters are assumed to be normally distributed, then the means and standard deviations of those β are estimated. Similar to Equation (2), the utility-specification of an RPL model, where several choices for each individual are observed (panel RPL model), is given as

$$U_{njt} = \beta_n x_{njt} + \varepsilon_{njt}, \tag{4}$$

where x_{njt} is again an attribute of alternative j for individual n in choice situation t, β_n is an individual-specific parameter and ϵ_{njt} is an error term which is again assumed to be identically and independently extreme value type 1 distributed (Gumbel-distribution). For a sequence of choices $j = j_t, \ldots, j_T$, the choice probabilities conditional on β to observe a sequence of choices for person n is given as

$$L_{nj}(\beta) = \prod_t^T \left[\frac{e^{\beta_n x_{nj_t t}}}{\sum_{k=1}^K e^{\beta_n x_{nkt}}} \right]. \tag{5}$$

The unconditional probability is then the integral of the previous expression, evaluated over all values of β:

$$P_{nj} = \int L_{nj}(\beta) f(\beta) d\beta\,. \tag{6}$$

The log-likelihood function based on the sample of N individuals is, therefore, defined as:

$$LL(\theta) = \sum_{n=1}^N ln(P_{nj}) = \sum_{n=1}^N ln\left(\int \left(\prod_{t=1}^T \left(\frac{e^{\beta_n x_{nj_t t}}}{\sum_{k=1}^K e^{\beta_n x_{nkt}}} \right) \right) f(\beta|\theta) d\beta \right). \tag{7}$$

Given that there is no closed form of $LL(\theta)$, the probabilities are approximated through simulation for any given value of θ. The simulated log-likelihood function is, therefore, defined as

$$SLL(\theta) = \sum_{n=1}^N ln\left(\frac{1}{R} \sum_{r=1}^R \left(\prod_{t=1}^T \left(\frac{exp\left(x'_{nj_n t}\,\beta_r\right)}{\sum_{k=1}^K exp(x'_{nkt}\,\beta_r)} \right) \right) \right), \tag{8}$$

with the number of draws ranging from 1 to R. The maximum simulated likelihood estimator is the value of θ that maximizes $SLL(\theta)$ [54].

The assumption that unobserved heterogeneity stems from preference heterogeneity across individuals is a very common one in environmental valuation with discrete choice models [46]. The model can allow for correlation among utility coefficients, which can be, for example, caused by scale-heterogeneity (the magnitude of all random coefficients differs over people) [35]. Such a model is sometimes referred to as random parameters logit model with correlated effects and is able to capture all types of unobserved heterogeneity, including scale heterogeneity, but it cannot disentangle scale-heterogeneity from other unobserved sources of correlation [35].

In logit models, one can only estimate the ratio of the coefficients and the variance of the error term and not the coefficients themselves. Due to this so-called scale-parameter, the estimated coefficients cannot be compared between different models, as they vary with the magnitude of unobserved heterogeneity. However, their signs still represent utility/disutility associated with the respective attribute [55].

To provide a more meaningful interpretation of results, marginal rates of substitution between attributes can be calculated as the scale-parameter drops out, when the ratio of two coefficients is calculated. If the alternatives also include a cost-attribute, the MWTP in a CL model can be calculated as the ratio of the coefficient of a non-cost attribute β_{nc} and the cost-attribute β_c multiplied by -1.

$$\text{MWTP}_{nc} = -\left(\frac{\beta_{nc}}{\beta_c}\right) \tag{9}$$

In an RPL model, MWTP is calculated in a similar manner, only instead of point estimates of the coefficients, their distribution is used. In addition, confidence intervals can be calculated for the MWTP-estimates, using the Krinsky and Robb method [54], which is based on simulating random draws from the respective distributions of the estimated random parameters. For MWTP-calculation, we use the median of the cost-attribute, as it is more robust to outliers due to the fat tail of a log-normal distribution [56].

Interaction effects of attributes x with respondent-specific information (e.g., socio-demographic variables S) can be added to both of the models described above to further disentangle preference heterogeneity with respect to the observable part of utility [57]. Similar to other regression models, the marginal effect of an attribute (which is defined as the first derivative of the specification with respect to the attribute) then depends not only on the coefficient of the respective non-cost attribute β_{nc} and/or the respective cost attribute β_c, but also on the coefficient of their interaction between a socio-demographic variable and the respective attributes, which can be denoted as α_{nc*S} for a non-cost attribute and α_{c*S} for a cost attribute. These additional coefficients have to be further multiplied with a meaningful value of the respective socio-demographic variable, for example the median (denoted as $\widetilde{S}$), because the socio-demographic variable does not cancel out, when taking the first derivative. The same is true for the calculation of the MWTP, where the MWTP for a non-cost attribute would then be calculated as

$$\text{MWTP}_{nc} = -\left(\frac{\beta_{nc} + \alpha_{nc*S} \cdot \widetilde{S}}{\beta_c + \alpha_{c*S} \cdot \widetilde{S}}\right). \tag{10}$$

3. Results

3.1. Descriptive Statistics

Descriptive statistics of the variables available for the econometric analysis are provided in Table 3. Apart from the attributes of the alternatives, we created an alternative-specific constant (ASC) for the status-quo alternative to gain information about the utility/disutility associated by respondents with the status-quo alternative. We also included an ASC for the second alternative as a means of controlling for other factors affecting choices in an unlabeled DCE (e.g., respondents having a tendency to choose the alternative placed in the middle). With respect to the attributes, we rescaled the climate-attribute, so that a unit-increase is associated with saving annual greenhouse-gas emissions of 10,000 households.

Table 3. Descriptive statistics of attributes and socio-demographic variables (N =194 respondents).

Variable	Description	Mean	Standard deviation	Minimum	Maximum
WATER	Groundwater quality attribute	0.33	0.47	0	1
LANDSCAPE	Rural landscape attribute	5	2.89	2.5	10
CLIMATE	Climate attribute	1	1.16	0	3
COST	Cost attribute	66.71	59.70	0	160
MALE	Respondent is male (1)	0.41	0.49	0	1
AGE	Age	40.53	14.28	16	76
EDUCATION	Education level	2.91	1.01	1	5
CHILDREN	Respondent has children (1)	0.45	0.50	0	1
FARMER	Farmer	0.09	0.28	0	1
LOCAL	Respondent is a local (1)	0.74	0.44	0	1

The socio-demographic variables can be used to disentangle possible preference heterogeneity in the econometric models based on observable characteristics. The average age of respondents is roughly in line with the average age of the population of the Marchfeld region. However, women are slightly overrepresented. In order to assess whether this deviation has an effect on results, respondents were weighted by gender and age and those weights were used during the estimation of the econometric models. As this did not have any effect on results, the weights were not used for the final model specifications. During the survey, participants were also asked for details of their level of education.

Education ranges from 1 to 5, with 1 being compulsory school, 2 an apprenticeship or a middle school degree, 3 a high school degree, 4 a Bachelor's degree and 5 a Master's degree or higher.

The resulting average education level of our sample is higher than the regional average. Other socio-demographic variables included were whether the respondents have children (45%), are farmers (9%) or are locals (74%). For farmers, we expected a lower utility for the PGs. Furthermore, we expected locals to have different preferences compared to people who moved to the Marchfeld region (incomers).

3.2. Econometric Models

Estimation results of the CL and RPL models are provided in Table 4. The three models increase in complexity from left to right. The first two models (CL and RPL) are a conditional logit and random parameters logit model with an alternative-specific constant for the status-quo alternative, as well as the second alternative and no interaction terms. The third model (RPL-INT) is an RPL model, which also includes interaction terms with the socio-demographic variables to disentangle preference heterogeneity with respect to observed characteristics of respondents. We also estimated random parameters logit models with correlated effects, allowing for correlation between the random parameters. A comparison of the two competing model specifications (RPL and RPL-INT with and without correlated effects) based on a likelihood ratio test did not reveal any statistically significant differences between the models, which is why we present the models with uncorrelated effects as our final specifications. All models were estimated in R [58], using the gmnl-package [59].

In general, the signs of the coefficients throughout the models are as expected and all coefficients of the attributes and the alternative-specific constant for the status-quo alternative are statistically different from zero at the 1%-level. In all three models, the coefficient of the ASC for the status-quo alternative is negative, meaning that respondents show disutility with respect to the status quo and therefore tend to prefer one of the other alternatives associated with an improvement in the provision of PGs by agriculture in the Marchfeld region compared to the status quo. The coefficient of the ASC for the second alternative is also negative and statistically significant at the 1% and 5% levels in the RPL and RPL-INT models, respectively. In combination with the negative sign of the coefficient of the ASC for the status-quo option, this indicates that, all else being equal, on average, respondents had a tendency to choose alternative A, i.e., the first column of the choice card in Table 2. Not considering such alternative-specific effects, even if they do not have an interpretational meaning, would lead to biased estimates of the other coefficients in the models [60,61]. The coefficient of the cost attribute is also negative throughout all models, as expected. Therefore, an increase in cost has a negative effect on utility of respondents. As can be seen in Table 4, the magnitude of the cost-coefficient changes, when moving from the MNL to the two RPL models. This is due to the assumed log-normal distribution. To get comparable values to the MNL model, one first has to calculate the mean or median of the log-normal variable. For example, the median is calculated by applying the exponential function to the estimated parameter.

Table 4. Estimation results of the CL and RPL models.

Independent Variable	Conditional logit (CL)		Random Parameters Logit (RPL)		Random Parameters Logit with interaction terms (RPL-INT)	
ASCSQ	−1.660	***	−3.211	***	−3.201	***
ASC2	−0.102		−0.294	***	−0.285	**
WATER	0.900	***	1.416	***	3.151	***
LANDSCAPE	0.095	***	0.150	***	0.057	
CLIMATE	0.276	***	0.539	***	0.639	
COST	−0.013	***	−4.018	***	−4.037	***
Mean shifters of random parameters						
WATER × MALE					0.136	
WATER × AGE					−0.031	***

Table 4. *Cont.*

Independent Variable	Conditional logit (CL)	Random Parameters Logit (RPL)	Random Parameters Logit with interaction terms (RPL-INT)
WATER × EDUCATION			−0.035
WATER × CHILDREN			0.311
WATER × FARMER			−0.589
WATER × LOCAL			−0.681 *
LANDSCAPE × MALE			−0.025
LANDSCAPE x AGE			0.004 **
LANDSCAPE × EDUCATION			0.023
LANDSCAPE × CHILDREN			−0.002
LANDSCAPE × FARMER			−0.171 *
LANDSCAPE × LOCAL			−0.160 **
CLIMATE × MALE			0.163
CLIMATE × AGE			−0.010 *
CLIMATE × EDUCATION			0.020
CLIMATE × CHILDREN			0.135
CLIMATE × FARMER			−0.079
CLIMATE × LOCAL			0.175
COST × MALE			0.144
COST × AGE			−0.003
COST × EDUCATION			0.019
COST × CHILDREN			0.343 *
COST × FARMER			0.183
COST × LOCAL			−0.173
Standard deviations			
WATER		1.431 ***	1.336 ***
LANDSCAPE		0.220 ***	0.188 ***
CLIMATE		0.826 ***	0.562 ***
Additional model information			
Number of observations	1164	1164	1164
Number of individuals	194	194	194
Number of Halton draws		5000	5000
AIC	1843	1623	1755
Pseudo R^2	0.29	0.38	0.38

***, ** and * and denote significance at the 1%, 5% and 10% levels, respectively.

The decrease in Akaike Information Criterion (AIC) and increase of the Pseudo R^2, when moving from the CL model to the more complex models, illustrates a better fit of the more complex models, particularly when comparing the CL-model with the two RPL-models. In general, the pseudo R^2 lies in a range which is comparable to the results of similar environmental valuation studies (e.g., [22]). With respect to AIC, the RPL-INT-model has a worse fit than the RPL-model, as only some of the interaction terms with socio-demographic variables are statistically significant. Nevertheless, we keep all of the interaction terms in the model because we want to explore preference heterogeneity based on observable characteristics of respondents. Beginning with the CL-model, the positive coefficients of the three attributes mean that people derive utility from an increase in groundwater quality, landscape quality and climate-friendly soil management.

To overcome the previously mentioned limitations of the CL model, the two RPL models were estimated, for which the three attributes groundwater quality, landscape quality and soil functionality in connection with climate stability were assumed to be normally distributed. For the cost-parameter, we assumed a log-normal distribution with changed sign, as this ensures that its coefficient takes on a negative sign [56]. The results of both RPL-models were estimated with the simulated maximum likelihood method based on 5000 Halton draws. In the basic RPL model without interactions, the magnitude of the coefficients of the three attributes increases, especially the coefficient of groundwater quality. This change in magnitude, in combination with high and statistically significant standard deviations of the random parameters, points towards the presence of unobserved preference heterogeneity, which cannot be captured in a CL model.

In order to disentangle observable preference heterogeneity, the RPL-INT model was estimated. From the available socio-demographic variables, AGE, CHILDREN, FARMER and LOCAL were statistically significant in combination with at least one attribute. Therefore, we only discuss the interaction effects of these variables more in detail. It is important to note that, in this model, the coefficients of the three attributes have a different meaning compared to the other two models, as the mean utility derived from a unit-increase in one attribute now also depends on the interaction effects and the values taken on by the socio-demographic variables.

The two interaction effects of AGE with WATER and CLIMATE are significant at the 1% and 10% levels, respectively, and have a negative sign. Thus, the positive utility associated with an improved groundwater quality and an increased climate-friendly management of agricultural land decreases with increasing age of respondents. The opposite is true for LANDSCAPE, where an increase in age is associated with an increase in utility of respondents.

Respondents who are farmers show a lower preference for an increase in hedges and flower strips on agricultural land, which is indicated by the negative sign of the interaction effect of LANDSCAPE and FARMER. However, the effect is only statistically significant at the 10% level.

The variable CHILDREN is only statistically significant at the 10% level when being interacted with the COST attribute. The positive sign of the estimate means that people with children are more sensitive to additional costs, possibly indicating higher budget constraints for families with children.

Lastly, the variable LOCAL is statistically significant at the 10% and 5% levels, respectively, when being interacted with WATER and LANDSCAPE. In both cases, the interaction effect has a negative sign, meaning that locals derive less utility from an increase in groundwater quality and landscape diversity, due to more hedges and flower strips on agricultural land.

3.3. Willingness to Pay

Based on the RPL-INT model, we calculated summarized MWTP values by plugging in the median values of the socio-demographic variables into the calculation, as described in Equation (10). According to the results, respondents have a MWTP/household and year for groundwater which is potable without treatment of about €67.87, for an increase in hedges and flower strips on agricultural land by 1% of around €9.62 and for an increase of climate-friendly soil management on arable land by roughly 33% of €28.41 (representing saved greenhouse-gas emissions of 10,000 households caused by oil heating per year). However, due to the high preference heterogeneity, the WTP varies across respondents by a considerable degree.

In a second step, we therefore illustrate the effect of the single socio-demographic variables on MWTP by letting one socio-demographic variable at a time take on its 5th and 95th percentile, while the others are held at their median value, offering a deeper insight into variations regarding MWTP. Figure 2 presents 25th and 75th percentiles of different simulated MWTP distributions based on the RPL-INT model. Gender, education level and the presence or absence of children do not seem to have a notable effect on MWTP. However, for the other three variables, variations in MWTP can be observed. For age, the median MWTP for potable groundwater without previous treatment in €/household and year varies between around €20 for older people (age of 65) up to around €100 for younger people (age of 19). A similar pattern can be observed for the climate-friendly management practices on agricultural land. Here, the MWTP varies between €11 and €36/household and year for saving emissions of 10,000 households, which is equivalent to climate-friendly management practices on one-third of the agricultural land in the Marchfeld region. With respect to an increase of hedges and flower strips on agricultural land, we also observe differences in MWTP. However, the relationship is the reverse. While younger people are willing to pay around €2/household and year, older people are willing to pay around €16/household and year for a 1% increase in hedges and flower strips.

For farmers, we observe a relatively clear tendency. They have a lower MWTP for all three PGs compared to non-farmers. This finding makes sense from a theoretical point of view: after all, farmers are the ones directly affected by the proposed changes in PGs. Specifically, the median of the MWTP-distribution of farmers and non-farmers varies between €17 and €68/household and year for groundwater, which is potable without treatment, virtually €0 and €9/household and year for an increase in hedges and flower strips by 1% and €17 and €27/household and year for climate-friendly management practices on one-third of the agricultural land in the Marchfeld region.

One final finding with respect to observed variations in MWTP relates to the origin of respondents. Locals seem to have a lower MWTP than incomers for potable groundwater without previous treatment (€66 compared to €87/household and year) and a one-percentage-point increase in hedges and flower strips (€9 compared to €18/household and year), but a higher MWTP for climate-friendly management practices on agricultural land (€24 compared to €11/household and year). The lower MWTP for the first two attributes may reflect the fact that locals have known the region for a very long time and therefore perceive the current situation in the Marchfeld region as "normal". Incomers, which have predominantly moved to the Marchfeld region from Vienna in the last decades, seem to be more sensitive to these PGs in their newly selected "homeland". With respect to climate-stability, the situation is reversed. Here, it might be possible that locals are willing to pay more, because "their region" may contribute to mitigating climate change, whereas incomers seem to put less emphasis on this aspect. However, it needs to be considered that this last effect, despite its magnitude, is not statistically significant.

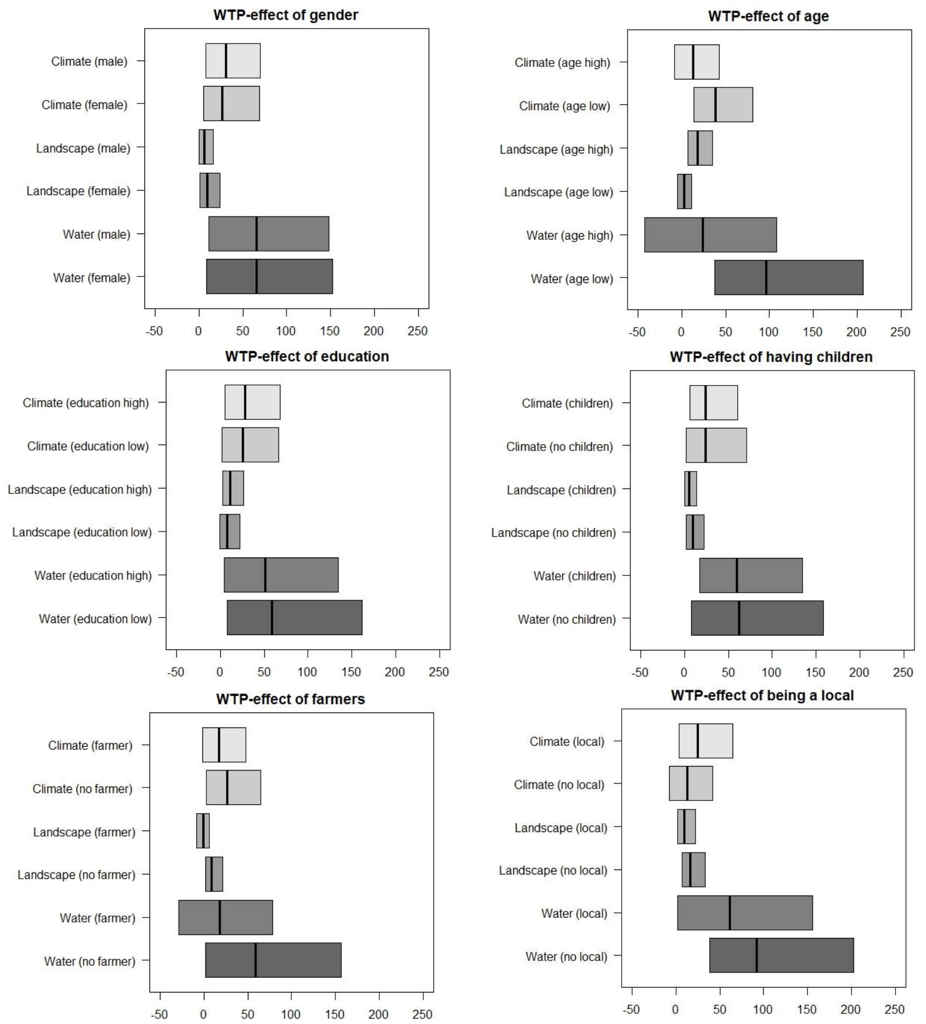

Figure 2. Effects of socio-demographic variables on MWTP.

4. Discussion

4.1. Results

We now turn to the discussion of our results by first comparing our summarized MWTP-estimates with others found in the literature. For example, Latinopoulos [62] found a MWTP for an improvement in water quality of around €95.6, which is considerably higher than our results. However, the study was carried out in a Mediterranean country, where water shortage is a considerable problem, which hampers a direct comparison.

Moving on to landscape quality, a positive MWTP for more structured agricultural landscapes has been found throughout the literature [24,63,64], but a comparison is difficult due to a wide range of different specifications of the landscape-attributes, the region-specific context of the analyses and personal preferences of the respondents.

With respect to soil functionality in connection with climate stability, the estimated individual MWTP for saving a ton of CO^2 equivalent greenhouse gases lies in other studies between €4.35 $\times 10^{-6}$ and €1.74 $\times 10^{-4}$ [22]. Taking our summarized MWTP as a basis, we receive a value of around €4.2 $\times 10^{-4}$, which lies in the upper range of estimated values. Thus, measures aimed at achieving a higher level of soil functionality may also contribute to climate-change mitigation.

As regards the stakeholder validation process of our results, the MWTP for the improvement of the three selected PGs stated by the inhabitants of the Marchfeld region was considered to be unexpectedly high. The stakeholders explained this result by a rising awareness of the local population with respect to the unsatisfying condition of the three PGs. The stakeholders assume that this is caused by the fact that inhabitants feel deteriorations of these three PGs on a daily basis in their landscape and water consumption, and in the extreme climatic conditions of the low precipitation area. As groundwater in the Marchfeld region has to be treated to be potable, there is an awareness of the fact that the groundwater quality is low. In addition, the lack of structural landscape diversity in the flat Marchfeld region is obvious in many parts of the area and the landscape is perceived by many inhabitants as being an "industrial" agricultural area. Nevertheless, according to the stakeholders, preferences for the three public goods, particularly the issue of landscape quality depend on individual preferences and could indeed be related to the provenance of the respondents, as incomers, who moved from the city to the Marchfeld region are often more sensitive for environmental issues. For the stakeholders, the results of the DCE are assumed to be transferable to other regions only to a limited extent, especially since the level of direct affectedness and the resulting awareness/concern about the conditions of the PGs play a major role in the magnitude of MWTP. The stakeholders expect a considerable shift of MWTP as soon as levels of affectedness change, e.g., if the panel of interviewees are not located in the area itself.

4.2. Methodological Considerations

As in any study, several methodological considerations need to be taken into account when interpreting our results. Firstly, our data stem from an online survey. This survey-mode reduces cost and time for carrying out the survey as well as social desirability bias of respondents. However, at the same time, it also reduces the control of how respondents perceive information during the experiment compared to face-to-face interviews and the sample composition is often skewed towards younger, well-educated respondents. A detailed overview of advantages and disadvantages of online-based SP methods can be found in Lindhjem [65]. Indeed, while our sample is representative with respect to gender and age, higher-educated people (education level between 3 and 5) are over-represented compared to the district where the CSR is located. Even though we did not find a statistically significant effect of education on MWTP, this aspect could potentially influence our results.

Secondly, it is also possible that our estimates suffer from a hypothetical bias (see for example Loomis et al. [66] for an example in the context of water-quality valuation), which could lead to an overestimation of WTP. Even though they used a contingent valuation approach, where such a bias is more likely to occur, we cannot rule this out. However, we provided respondents with a cheap talk script before the choice experiment, in which we informed them of this problem and asked them to make their choices as if in a real situation. Tonsor et al. [67] showed that cheap talk scripts can help to reduce hypothetical bias and arrive at more reliable estimates.

A third aspect concerns the basic assumption of rational utility maximization of respondents. More and more findings in behavioral economics show that this assumption does not always hold. For example, Foosgard et al. [68] showed in a public good game that even in simple choice situations a varying framing of the choice situation may substantially influence optimizing mistakes people make when choosing, leading to irrational choices. Brekke et al. [69] showed in another recent public good game that the framing of the contribution to the public good either in absolute monetary terms or relative to one's endowment and stated either as "contributing" to the public good or "keeping" some part of their own endowment influences how much people are willing to contribute. They found that a framing with "contributing" expressed in absolute monetary terms, causes people with low endowments (the "poor") to contribute significantly more compared to other, economically equivalent framings. This would suggest that our framing of the cost-attribute could lead to a higher MWTP for poorer people. Even though those findings are not directly comparable to our DCE, as they are based on game-theoretic public good games, where people interact in groups, future research should control for such framing-effects.

5. Conclusions and Policy Implications

In the context of an upcoming reform of the Common Agricultural Policy (CAP) of the European Union (EU), which will most likely link payments to farmers more closely to a measurable provision of public goods, the aim of this paper was to elicit the marginal willingness to pay (MWTP) of local residents for the improved provision of public goods (PGs) by agriculture in a typical region of intensive agricultural production, which embodies many of the environmental problems related to agriculture within and outside the EU.

The analysis was carried out in the Marchfeld region, a dynamically developing, semi-urban border region in Austria which is marked by intensive agricultural production and at the same time rising concerns from the local population regarding a more sustainable agricultural land use. Based on a participatory approach, combining the involvement of local stakeholders and a discrete choice experiment (DCE), we found a positive and significant MWTP for all three PGs analyzed: (i) groundwater quality; (ii) landscape quality; and (iii) soil functionality in connection with climate stability.

Although our estimated MWTP values are roughly in line with other findings in the literature [22,24,62–64], comparing MWTP in different regional settings based on slightly different attribute definitions remains challenging. In addition, our estimated MWTP may still suffer from different sources of bias caused by the composition of the sample, the hypothetical nature of the DCE or non-compliance with the assumption of rational utility maximization of respondents. Nevertheless, having these general potential limitations of a SP approach in mind, our study is able to show that inhabitants of a typical region of intensive agricultural production in the EU have a positive MWTP for an improved provision of PGs by agriculture. Additionally, we show that MWTP varies considerably according to certain socio-demographic factors, specifically the age of respondents and whether they are farmers/non-farmers or locals/incomers.

The integrative participation from local stakeholders we used throughout our research process helped us to gain a better understanding of the regional specifics regarding PG-provision. Moreover, it will facilitate further research on the development of more efficient governance mechanisms, based on participatory approaches [70]. Indeed, an enhanced stakeholder participation has also been acknowledged in the literature to contribute positively to tackling agri-environmental problems [71]. From our experiences, we recommend an enhanced stakeholder participation, which should not only consist in the identification of environmental issues and the assessment of attributes and levels for DCEs, but also in the validation of and further work with results from such DCEs.

Our results can support policy makers in setting policy-priorities for the Marchfeld on the three PGs identified in this analysis. Of particular importance in this context are the observed differences in MWTP, which show that there are different groups within the population of the Marchfeld that have differing preferences with respect to PGs. Specifically, an increasing share of incomers seems to imply higher preferences for the provision of PGs by agriculture. This finding should not only be of interest for policy makers responsible for the Marchfeld, but also for policy-makers in comparable regions which are also subject to increasing in-migration from adjacent cities. Notwithstanding, further research is needed to analyze how the differing claims of the population can be practically integrated into local land use concepts and to test to what extent our findings can be transferred to other regions.

In general, a rising demand for the provision of PGs by agriculture may also generate social pressure on local farmers to adopt environmentally friendly management practices [72]. Indeed, farmers have both the property rights for agricultural land and the skills to implement the improved provision of PGs, but at the same time lower preferences for the provision of PGs. Therefore, further research should aim at eliciting the willingness to accept (WTA) of farmers for the implementation of different management options to improve the provision of PGs [31,73]. This could ultimately result in a cost–benefit analysis, comparing estimated costs for farmers and the estimated gains for society. Such research would again have to carefully consider the regional context of the CSR due to a multitude of factors, influencing the adoption behavior of farmers [47] and particularly also recent findings regarding green and social preferences of individuals [74,75] to design governance mechanisms which facilitate a socially optimal and sustainable provision of PGs in the Marchfeld and other European regions.

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