Integrating soil and climate-related aspects into the valuation of willingness to pay for public goods provided by agriculture in an intensive agricultural production region: The case of the Marchfeld

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In the context of an upcoming CAP-reform which will most likely condition payments to farmers stronger on a measurable provision of public goods, the aim of this study is to elicit the willingness to pay (WTP) for public goods (PGs) provided by agriculture in the Marchfeld, a dynamically developing and semi-urban region in Austria. Situated between Vienna and Bratislava it is marked by an intensive agricultural production and at the same time rising environmental awareness of the local population. We carry out a discrete choice experiment for the 3 public goods ground water quality, landscape diversity and climate stability, which were pre-selected via focus groups. Due to high preference heterogeneity we estimate a random parameters logit model and include interactions with socio-demographic factors in order to further disentangle differences in preferences. We find a positive and significant WTP for all three public goods, with groundwater quality being most important for the participants, followed by landscape diversity and climate stability. The results of this study in combination with a supply-side assessment, consisting of different management options for farmers, could form the basis for the development of governance mechanisms for the smart provision of public goods by agriculture in the Marchfeld region.

Acknowledegment:

JEL Codes: Q12, Q16

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Keywords: choice experiment, mixed logit model, public goods, agriculture

1 Introduction

Agriculture is subject to increasing tensions concerning the interrelation between a rising demand for food due to population growth, climate change and its effects on agricultural production and negative effects of intensive agricultural production on the environment. With respect to climate change, agriculture is not only affected, but also responsible for about 14% of total anthropogenic greenhouse gas emissions (FAO, 2006). These issues have led to a growing recognition of sustainable production methods in order to address these issues simultaneously (OECD, 2017).

Especially in intensive agricultural production regions, which are often situated at the fringe of larger urban agglomerations, tensions between society and agriculture manifest themselves in increasing public debates about a sustainable agricultural production. Within the European Union (EU) this problem is even more pronounced, as public support makes up around one third of agricultural income on EU-average and becomes more and more linked to environmental and climate aspects (European Comission, 2017a). However, current agri-environmental policies of the EU fail in sufficiently addressing public-good related problems, particularly in intensive agricultural production regions. The European Commission in its recent communication on The Future of Food and Farming thus put forward that the next CAP-reform will be even more conditioned on better targeted policies in order to achieve a smarter provision of environmental and climate public goods and therefore better address citizens' concerns regarding sustainable agricultural production (European Comission, 2017b). A more efficient provision of public goods like soil functionality, climate stability, water quality or landscape diversity is at the core of these ambitions.

In this context, the aim of this paper is to assess the potential for the development of smart governance mechanisms in an intensive agricultural production region in order to improve the provision of public goods by agriculture. Specifically, our analysis focusses on the three public goods (i) groundwater quality, (ii) landscape diversity and (iii) soil functionality in connection with climate stability We apply a discrete choice experiment (DCE) in the Austrian Marchfeld region in order to elicit the local populations' willingness to pay (WTP) for an increase in the provision of these public goods provided by agriculture. Being situated between the two capitals of Austria and Slovakia, Vienna and Bratislava, and suffering from several issues regarding the provision of public goods by agriculture, the Marchfeld region embodies many of the problems found in other intensive agricultural production regions within and outside the EU.

Our study makes two contributions to the extensive literature on valuation of environmental public goods and ecosystem services (Adamowicz et al., 1994; Birol et al., 2006; Colombo et al., 2009; Martin-Ortega et al., 2012; Ragkos and Theodoridis, 2016; van Zanten et al., 2016 among many others). Firstly, the analysis focusses on an intensive agricultural production region at the fringe of large urban agglomerations. This is an aspect which is of particular importance, given the above stated problems and has received less attention in the literature, where the focus often lies on high nature value farmland. Moreover, we provide additional estimates of marginal willingness to pay (MWTP) for an increase in the provision of the public goods soil functionality, ground water quality and landscape diversity.

Secondly, our discrete choice experiment considers the connection of the public goods soil functionality with climate stability, which is clearly stressed in the literature (Powlson et al., 2011) but to the best of our knowledge less considered in other DCEs.

The further structure of the paper is as follows: in the next section, we introduce our case study region, the Marchfeld, 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 some concluding remarks.

2 Material and methods

2.1 Agriculture and public goods in the Marchfeld region

The Marchfeld region is located in the North-East of Austria and is a sedimentary basin between the Eastern Alps and the Carpathian Mountains. It 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 (BMLFUW, 2015).

Our case study region consists of 23 Marchfeld municipalities covering 70.800 ha. The average population density is 97 persons/km², but density strongly varies in the single municipalities and reaches from 15 to 881 persons/km². Since about 10 to 15 years the region experiences a strong population growth caused by in-migration (Statistik Austria, 2016). 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. 95% of the farms in the case study region are cash crop farms, while around 12% of all farms are organic farms (BMLFUW, 2016). The good soil quality (BFW, 2018) in combination with the possibility of irrigation, which is given due to the Marchfeld canal, an artificial stream, leading through the area, lead to an agricultural system characterised by intensive arable production. 98% of UAA is used as arable land (BMLFUW, 2016) and around 25% of agricultural area in the region is managed under irrigation (Betriebsgesellschaft Marchfeldkanal, 2016).

The Marchfeld region is framed by two major agglomerations, Vienna and Bratislava. This leads to a multitude of sensitivities and claims affecting the regions such as urban outmigration, recreation demands, space requirements for infrastructural planning (e.g. Roads, Highways, flood protection, etc.) and regional food supply.

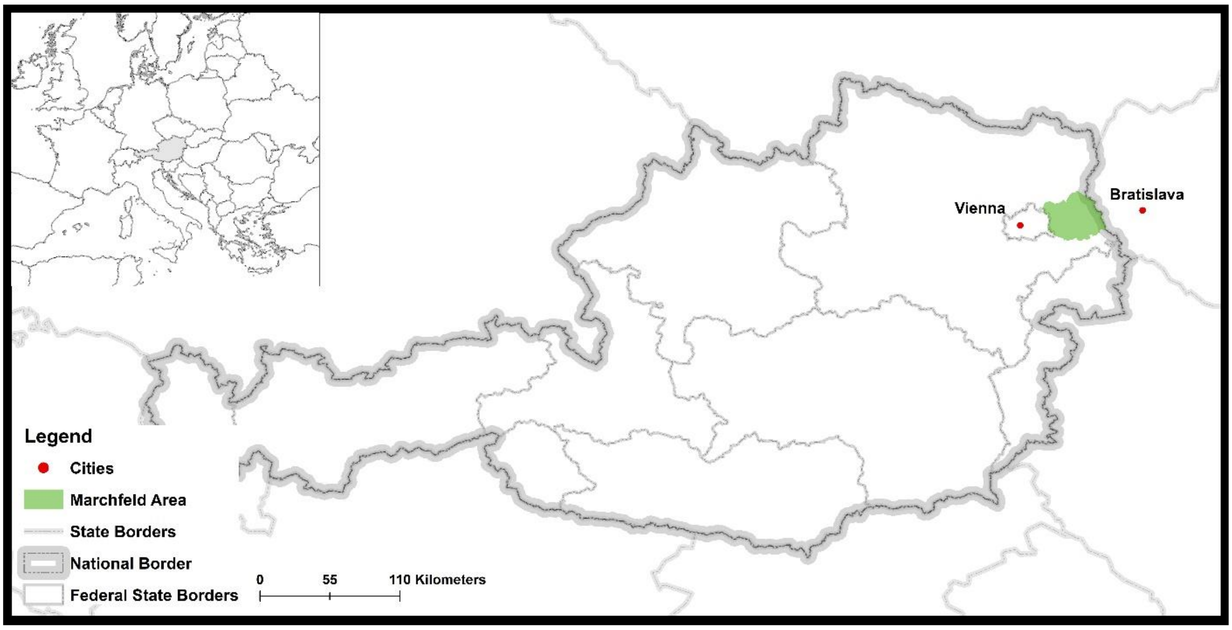

Figure 1: Location of the Marchfeld region

Throughout several stakeholder workshops during our research, one major public good issue identified by regional stakeholders and experts in the Marchfeld region is the functionality of the agricultural soils. Particularly due the intensive agricultural management, but also due to 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 to have impacts on other public goods in the region and to intersect with important environmental issues such as climate, groundwater, erosion, etc. Here, particularly the quality of the groundwater in the Marchfeld is seen as a critical point. At the moment, groundwater quality in the Marchfeld region is very poor compared to other Austrian regions (BMLFUW, 2013). 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, groundwater treatment is inevitable to reach the standard values for potable water. To improve soil functionality and consequently also reach a positive impact on groundwater quality, changes of the agricultural management are suggested by the experts and stakeholders. Mainly these changes include measures to increase soil humus contents such as minimum tillage, intercropping and the mixing of straw, compost and harvest residues into the ground. Also changes of 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. Due to intensive agriculture the fields are on average relatively large and there is a lack of landscape elements like hedges and flower strips, which would make the landscape more diverse and additionally hamper wind erosion and promote biodiversity.

Despite existing agri-environmental measures in Austria, the above-mentioned problems remain in the Marchfeld region suggesting the need for specifically tailored agri-environmental policies. However, from a societal point of view the decisive question is how the local population perceives the status-quo of public goods provided by agriculture and whether they would be willing to pay for an improvement of their provision.

2.2 Survey, choice sets and experimental design

In order to elicit the preferences of the local population for an improved provision of public goods by agriculture, we carried out a survey which included a discrete choice experiment. The survey consisted of (i) an introductory section, where aim and scope of the study were presented, (ii) a section where participants were asked about their attitudes towards the three public goods (PGs) of interest in the CSR, (iii) a choice experiment in order to receive information about their preferences and willingness to pay for an improvement of the three above-mentioned PGs, (iv) follow-up questions after the choice experiment in order to gain information about their motives and believes which drove their choices, (v) a section with questions of a common exercise, which was also included in surveys of other project partners of the PROVIDE project and (vi) a section on socio-demographic characteristics of the participants.

The online survey was administered by a market research company, which recruited the participants and ensured representativeness of the sample regarding age and gender. All participants were residents of the Marchfeld region (people had to specify their ZIP-code). From a total of 559 people contacted, 204 people completed the survey and represent the basis for the econometric analysis. Throughout the research process we orientated on the state of the art of environmental valuation with discrete choice experiments (Hoyos, 2010).

The three public goods, groundwater quality, rural landscape and soil functionality (in connection with climate stability) were selected in focus groups. The levels of the public goods and the payment vehicle were also determined in the focus groups. An overview of the attributes and their levels used in the choice experiment is given in Table 1. The levels of the public goods are all transferable to concrete management options for farmers. 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 rural landscape we varied the percentage of hedges and flower strips on agricultural land from 2.5% (status quo) to 10%. The percentage of hedges and flower strips was visualized with a google earth image which was edited with an image-editing program in order to show the respective percentage of hedges and flower strips. 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. This attribute is connected to conservation agricultural management practices (Knowler and Bradshaw, 2007) which consist in our case of no tillage and leaving residues on the field after harvesting, on certain proportions of agricultural land in the Marchfeld region. Such practices can be a very cost-effective measure to reduce greenhouse gas emissions through soil carbon sequestration (Schneider et al., 2007). Specifically, conservation agricultural management practices on the whole agricultural land in the Marchfeld (50,000 ha) or one percent (500 ha) could save annual greenhouse gas emissions caused by oil heating of approximately 30,000 or 300 households, respectively (Triebe, 2007). Finally, the payment vehicle was expressed as additional annual payments in €/year, ranging from 40€ to 160€. Only the status quo option was associated with no additional payment.

All possible combinations of the attribute levels lead to a full factorial design with 128 alternatives. In order to reduce the amount of combinations to a manageable size we used a D-optimal orthogonal design (Street et al., 2005) reducing the number of alternatives to 24, which we divided into 4 blocks. Each respondent was presented 6 choice sets with 2 varying alternatives and the fixed status-quo option, leading to a total of 1.224 choices. An example of a choice set, which was translated to English, is given in Figure 2.

Table 1: Attributes and levels 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.
Rural landscape (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 payment (cost)	0€ (status quo), 40€, 80€, 120€, 160€	Additional payment in €/year.

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

Figure 2: Example of a choice set used in the choice experiment (translated to English)

2.3 Econometric analysis

The basis for our econometric analysis are Random Utility Models (RUM) which were developed by McFadden (1974). 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}) part. Assuming that those parts are additive, one ends up with the following formula 1 (Train, 2009):

$$U_{nj} = V_{nj} + \varepsilon_{nj} \quad (1)$$

The observed part of utility is assumed to be a weighted sum of attribute levels x of each alternative. Again, assuming that people choose between alternatives in order 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 conditional logit model is given in formula 2

$$U_{nj} = \beta x_{nj} + \varepsilon_{nj} \quad (2)$$

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 parameter β which maximize the probability of the observed choices. A conditional logit model has the following choice probabilities of individual *n* choosing alternative *j* over other alternatives, ranging from *k* to *K*

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

and can be estimated by maximum likelihood (Train, 2009).

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, like the random parameters logit model (RPL) and in a more general form also referred to as mixed logit model (MXL), have been developed. A random parameters logit model allows for some or all parameters to be individual-specific by assuming they vary with density $\beta_n \sim f(\beta|\theta)$, where θ are the parameters, describing the distribution of β like mean and variance. This enables modelling unobserved preference heterogeneity across individuals. However, the distributional form of β has to be specified by the researcher. For example, when estimating a random parameters logit model, where the parameters are assumed to be normally distributed, then the means and standard deviations of those β are estimated. The utility-specification of a random panel random parameters logit model, where several choices for each individual are observed, 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 alternatives, one for each time period, $j = j_t, \dots, j_T$ the choice probabilities conditional on β to observe a sequence of choices for person *n* is given as

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

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

$$P_{nj} = \int L_{nj}(\beta) f(\beta) d\beta \quad (6)$$

For the random parameters logit model, the simulated maximum likelihood method is a suited estimation method as it has no closed-form solution (Train, 2009). Assuming that unobserved heterogeneity stems from preference heterogeneity across individuals is a very common assumption in environmental valuation with discrete choice models (Hoyos, 2010). The model can also be extended in order to allow for correlation among utility coefficients, which can be for example caused by scale-heterogeneity (the magnitude of all random coefficients differs over people) (Hess and Train, 2017).

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 (Hensher et al., 2015).

In order 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 ration of two coefficients is calculated. If the alternatives also include a cost-attribute, the marginal willingness to pay (MWTP) can be calculated as the ratio of other attributes and the cost-attribute. Also, confidence intervals can be calculated for the MWTP-estimates, using the delta method (Train, 2009).

3 Empirical results and discussion

Descriptive statistics of the variables available for the econometric analysis are provided in Table 2. Besides the attributes of the alternatives we also created an alternative-specific constant for the status-quo option, in order to gain information about the utility/disutility associated by respondents with the status-quo option. The socio-economic variables can be used to disentangle possible preference heterogeneity in the econometric models based on observable characteristics. The average age of the sample 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 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 also were asked about 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 degree and 5 a master's degree or higher. Other socio-economics variables included were whether the respondents have children, are farmers or have relatives which are farmers. For farmers, we expected a different choice-behaviour, especially with respect to the status-quo alternative. Further we expected people with farmers as relatives to have different preferences compared to others, because of a possible higher awareness with respect to the public goods provided by agriculture.

Table 2: descriptive statistics of attributes and socioeconomic variables (N =204 respondents)

Variable	Description	Mean	Standard deviation	Minimum	Maximum
ASCSQ	Constant for status-quo	0.33	0.47	0	1
WATER	Groundwater quality attribute	0.33	0.47	0	1
LANDSCAPE	Rural landscape attribute	5	2.89	2.5	10
CLIMATE	Climate attribute	33.37	38.53	0	100
COST	Cost	66.71	59.70	0	160
MALE	Gender (1 = male)	0.41	0.49	0	1
AGE	Age	41.06	14.45	16	76
EDUCATION	Education level (1 to 5)	2.87	1.01	1	5
CHILDREN	Children (1 = yes)	0.66	0.50	0	1
FARMER	Farmer	0.09	0.29	0	1
FARMERREL	Related to a farmer	0.47	0.50	0	1

Estimation results of the conditional logit and random parameters logit models are provided in Table 3. 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 and no interaction terms, while the third model (RPL-INT) is a random parameters logit model, which also includes interaction terms with some of the socio-economic variables in order to disentangle the observable part of preference heterogeneity of respondents.

In general, the signs of the variables throughout the models are as expected and all 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 ASC for the status-quo is negative, meaning that respondents show disutility with respect to the status-quo and therefore tend to prefer one of the other alternatives which are associated with an improvement of the provision of public goods by agriculture in the Marchfeld region compared to the status quo. The same is true for the coefficient of the cost attribute, therefore an increase in cost has a negative effect on utility of respondents. The decrease in Akaike Information Criterion and in the Pseudo R^2, when moving from the CL model to the RPL and RPL-INT model, illustrates that the more complex models have a better fit, particularly when comparing the CL-model with the two RPL-models. The RPL-INT-model does not show a strong increase in model fit, but some of the interaction terms with socio-economic variables are statistically significant. In general, the pseudo R^2 lies in a range that is in a similar range of comparable environmental valuation studies (e.g. Rodríguez-Entrena et al. (2012)).

Beginning with the CL-model, the positive coefficients of the three attributes show that people derive utility from an increase in ground water quality, landscape diversity and climate-friendly soil management. With respect to magnitude, the coefficient of water is the largest followed by landscape and climate. However, due to the different specification and range of the attributes one has to be careful when comparing their relative importance.

In order to overcome the previously mentioned limitations of the conditional logit model, the RPL models were estimated, for which the three attributes ground water quality, rural landscape and soil functionality in connection with climate stability were assumed to be random and normally distributed. In the basic RPL model without interactions the magnitude of the coefficients of the three attributes increase, 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-economic variables, being a farmer, being related with a farmer and age showed a statistically significant effect. Therefore, we only show a model specification including the statistically significant interaction effects of those three variables.

Firstly, we included an interaction between the alternative-specific constant for the status quo and being a farmer. The effect of this interaction is positive and statistically significant at the 1%-level, meaning that farmers are in general more likely to choose the status quo-option compared to other respondents. This makes sense, given the current problems with respect to public goods provided by agriculture in the Marchfeld region. One possible explanation could be scepticism of farmers towards an adequate financial compensation associated with the implementation of more sustainable production methods.

Table 3: Estimation results of the conditional logit and random parameters logit models

Independent Variable	**Conditional logit (CL)**		**Random Parameters Logit (RPL)**		**Random Parameters Logit with interaction terms (RPL-INT)**	
ASCSQ	-1.1493	***	-1.9007	***	-1.9957	***
WATER	0.8790	***	1.4119	***	2.5643	***
LANDSCAPE	0.0926	***	0.1435	***	0.0929	**
CLIMATE	0.0079	***	0.0143	***	0.0297	***
COST	-0.0128	***	-0.0205	***	-0.0201	***
Interactions and mean shifters						
ASCSQ x FARMER					1.2595	***
WATER x AGE					-0.0284	***
LANDSCAPE x FARMERREL					0.1089	*
CLIMATE x AGE					-0.0004	**
Standard deviations						
WATER			1.6854	***	1.5401	***
LANDSCAPE			0.2858	***	0.2794	***
CLIMATE			0.0230	***	0.0217	***
Number of observations	1,224		1,224		1,224	
Number of halton draws			1,000		1,000	
AIC	2,081.31		1,781.69		1,768.62	
Pseudo R^2	0.15		0.28		0.28	

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

The interaction term between WATER and AGE is also highly significant and has a negative sign. Thus, the positive utility associated with an improved ground water quality decreases with increasing age of the people. At the same time, the coefficient of WATER is larger, compared to the other two models. However, if we multiply the mean value of age (41.06) with the interaction effect of AGE with WATER (-0.0284) and build the sum of the two coefficients, we end up at a value similar to that of the WATER attribute in the RPL model without interactions. A similar behaviour can be observed for the CLIMATE and its interaction with AGE. However, the magnitude of this effect is considerably smaller.

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

Finally, we calculated MWTP of respondents by dividing the respective coefficients of the attributes through the cost coefficient. Due to the interaction effects, the MWTPs depend on the value taken on by the interacted socio economic variables. For example, the MWTP for water is calculated by summing up the coefficient of WATER with the product of WATER and AGE for each respondent, respectively and dividing the result through the COST variable. In Table 4 summarized MWTP values are provided, which were calculated by plugging in the mean values of the socio-economic variables into the above described calculation.

Table 4: MWTP for an improved provision of public goods by agriculture in the Marchfeld region, based on the RPL-INT model results

Attribute	Marginal willingness to pay in €/person and year	
WATER	69.60 [50.80-86.63]	For groundwater which is potable without treatment
LANDSCAPE	7.14 [3.77-10.20]	For a one percentage point increase in hedges and flower strips on agricultural land
CLIMATE	0.72 [0.44-0.95]	For a one percentage point increase in climate-friendly management practices on agricultural land

Note: Sample means of the variables AGE and FARMERREL were used for calculation of the MWTP. Numbers in parenthesis are 95% confidence intervals.

According to this results, respondents have a WTP for groundwater which is potable without treatment of about € 69.60, for an increase in hedges and flower strips on agricultural area by one percentage point of around € 7.14 and for an increase of climate-friendly soil management on agricultural area by one percentage point of roughly € 0.72. However, due to the high preference heterogeneity, the WTP varies across respondents to by a considerable degree.

In a final step we compare our WTP-estimates with others found in the literature. For example, Latinopoulos (2014) finds a WTP for an improvement in water quality of around € 95.6, which is considerably higher than our results. However, as this study was carried out in a Mediterranean country, where water shortage is a considerable problem, a comparison is difficult. It is also possible that our estimate is to high and suffers from a hypothetical bias (see e.g. Loomis et al., (2009) for an example in the context of water quality valuation). Even though, this study 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, where we informed them about this problem and asked them to choose as if in a real situation. Tonsor and Shupp (2011) show that cheap talk scripts can help to reduce hypothetical bias and come to more reliable estimates.

With respect to soil functionality in connection with climate stability, the estimated individual WTP for saving a ton of CO^2 equivalent greenhouse gases lies in other studies between € 4.35 x 10^-6 and € 1.74 x 10^-4 (see Rodríguez-Entrena et al., (2012) for an overview). Taking our mean WTP as a basis, we receive a value of around € 9.6 x 10^-4, which lies in the upper range of estimated values.

4 Conclusions and outlook

In the context of an upcoming CAP-reform which will most likely condition payments to farmers stronger on a measurable provision of public goods, the aim of this study was to elicit the willingness to pay (WTP) for public goods (PGs) provided by agriculture in the Marchfeld in order to assess the potential for the development of smart governance mechanisms in an intensive agricultural production region. Based on a DCE we find a positive and significant WTP for all three public goods analysed, with groundwater quality being most important for the participants, followed by landscape diversity and climate stability.

Even though our estimated WTP values are in line with other findings in the literature, comparing WTP in different settings and based on slightly different attribute definitions is very difficult. Moreover, such estimates should rather be seen as upper boundaries of WTP, as hypothetical bias may still play a role, even though we followed the recommendations in the literature and included a cheap-talk script. Having these general potential limitations of such a stated preference approach in mind, our study still is able to show that inhabitants of an intensive agricultural production region have a positive WTP for an improvement in the provision of public goods by agriculture. These results could also be relevant for other intensive agricultural production regions and it would therefore be interesting to carry out a similar DCE in a comparable regional setting.

Given the positive WTP of the local population, the remaining question is, how high the opportunity costs of farmers, who would have to implement more sustainable production methods, are. The DCE is part of a research project associated with the development of governance mechanisms for the improved provision of public goods by agriculture in several hotspot-regions in the EU. The results of this demand-side valuation of public goods will in a next step therefore be combined with a separately carried out supply-side assessment, where the opportunity costs of different management options for farmers are estimated. With such a cost-benefit analysis, governance mechanisms for the smarter provision of public goods by agriculture in the Marchfeld region could potentially be developed.

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