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# FARMERS' PERCEIVED COST OF LAND USE RESTRICTIONS: A SIMULATED PURCHASING DECISION USING DISCRETE CHOICE EXPERIMENTS

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# 5 ABSTRACT

6 This paper reports on the findings from discrete choice experiments designed to estimate 7 farmers' perceived costs of land use restrictions, i.e. crop restrictions, additional fertilizing restrictions, and usage restrictions, as opposed to having no such restrictions. To this end, 8 9 hypothetical land purchasing decisions were simulated based on the information about 10 productivity, lot size, distance to other land, driving time to home, land use restrictions, and 11 price. Farmers from the Campine area (Belgium) were invited to participate in the survey as the 12 agricultural land in this region still faces the effects of historical heavy metal contamination 13 resulting in crop restrictions. For identical pieces of land, we estimate the perceived cost, calculated as a change in the consumer surplus due to having a land use restriction, to be about 14 15 46,000 €/ha for the crop restriction, 50,000 €/ha for the usage restriction, and 70,000 €/ha for 16 the fertilizing restrictions. Assuming this cost to represent a perpetuity, then with a discount 17 rate of 5% the yearly fixed costs respectively equal about 2,300 €/ha, 2,500 €/ha, and 3,500 18 €/ha.

# 19 KEY WORDS

20 Farmland value; Land use restrictions; Perceived cost; Compensation; Support

# 21 HIGHLIGHTS

- We use choice experiments to simulate a hypothetical farmland purchasing situation
- We investigate the effect of land use restrictions on farmers' preferences
- We calculate farmers' perceived cost of farmland restrictions
- We find a yearly fixed costs of about 2300 €/ha for crop restrictions, 2500 €/ha for land usage restrictions and 3500 €/ha for fertilizing restrictions

# 27 **1. Introduction**

# 28 1.1. The joint provision of public and private goods

29 Land ownership allows the landowner to carry out a limited set of actions (Coase, 1960). 30 Furthermore, if private land also provides significant public benefits, it can be seen as the 31 government's role to reallocate property rights in order to maximize social welfare (Thomson 32 and Whitby, 1976). Such a reallocation is often instigated by environmental protection and 33 conservation. The Endangered Species Act of 1973 in the United States (US) is an example of 34 the tension created by such regulation culminating in the question: 'Should compensation be 35 paid for such reallocation of property rights?' (Blume et al., 1984; Polasky and Doremus, 1998; Smith and Shogren, 2002). Similarly, the European Common Agricultural Policy (CAP) has 36 37 shown growing attention for environmental protection and sustainable agriculture since 1992 38 (European Commission, 2012). This trend has made direct payments to farmers conditional 39 upon cross-compliance to conditions relating to the environment, food safety, and animal 40 welfare also known as the statutory management requirements (SMR) and standards for good 41 agricultural and environmental condition of land (GAEC) (European parliament and the 42 Council, 2013a). This trend persists as the latest CAP reform puts the joint provision of public 43 and private goods at the core of its policy. To support this change, a new support instrument has been created, accounting for 30% of the national direct payment envelope, called 'payment 44 45 for agricultural practices beneficial for the climate and the environment' or in short 'green (direct) payments'. It targets farmers entitled to a payment under the basic payment scheme or 46 47 the single area payment scheme. This instrument will be active from 2015 onwards and serves 48 to support farmers for the public services their land is now obligated to provide. Specifically, 49 the agricultural practices leading to public benefits include: (1) crop diversification, which aims 50 at soil quality improvements, (2) permanent grasslands, which aim at carbon sequestration, and 51 (3) ecological focus areas, which aim at biodiversity conservation. Consequently, the EU will 52 be relying heavier on mandatory measures, while keeping the voluntary agri-environmental 53 schemes alive in the second pillar (European Parliament and the Council, 2013b; European 54 Union, 2013). Therefore, the situation of a reduction in private landowners' rights for the public's benefit will be encountered more often in the future. 55

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# 57 1.2. The reallocation of property rights in the public's interest

58 The answer to the question 'Does such reallocation require compensation?' differs according 59 to whom is giving the answer. In the European Union the private agricultural landowner is 60 legally protected in most countries from the deprivation of possessions, including a nominal 61 change in the degree of property rights. Our personal assessment based on the framework by 62 Schutte (2004), who has listed the criteria of the European Court for Human Rights, provides 63 little hope for farmers to be compensated for land-use restrictions such as those installed by the CAP out of legal motivations. Indeed, (1) whereas land-use restrictions are a deprivation of a 64 65 possession (2) causing interference with the peaceful enjoyment of that possession (3) which is 66 lawful in the EU as it is installed via regulations, (4) such land use controls are pursued in the public's interest as the scenery, the climate, and biodiversity are public goods, and (5) they 67 68 strike a fair balance (i.e. the balance between the public's gains and the individuals' losses in 69 property rights) given the fact that the policy is equal for all farmers and can be seen as solving 70 a collective action problem (i.e. the misuse of a resource to which no one is inclined to stop first 71 as others might benefit). Economic literature has mostly dealt with the debate of Kaldor-Hicks 72 efficiency and effectiveness of such regulation. Nevertheless, Mullan et al. (2011) argue that if 73 the new regulation is based on society's beliefs about what constitutes a public good, such as 74 agricultural land, side payments may be a practical way to lower the transactions costs of 75 implementing a change by overcoming resistance from those who stand to lose. Originally the 76 European Council (1992) proposed measures to 'compensate farmers for any income losses 77 caused by reductions in output and increases in costs and for the part they play in improving 78 the environment'. Such payments can be justified from a social point of view if more friendly 79 environmental practices lead to a growth in consumer surplus greater than the decrease in 80 producer surplus, signaling that the Kaldor-Hicks efficiency criterion is fulfilled (Bonnieux et 81 al., 1998). For an overview of the full set of tools policy makers have to their disposal in promoting the services public goods deliver, we refer to Van Zanten et al. (2014). In conclusion, 82 83 the view taken here is that the payments, offered to farmers for complying with novel 84 regulation, serve to decrease resistance from those that stand to lose.

85

# 86 1.3. Assessing the amount of compensation

87 Bateman (1996) found that farmers are more familiar with the concept of assessing potential compensation than households are with estimating hypothetical payments for increased 88 89 provision of public goods. Still, mostly discrete choice experiments (DCEs) have been used to 90 estimate societies' preferences and hence willingness to pay (WTP) for an increase in 91 agricultural non-commodities (Campbell, 2007; Colombo et al., 2009; Garrod et al., 2012, 2014; Huber et al., 2011; Kallas et al., 2007; Scarpa et al., 2009). Nonetheless, DCEs have 92 93 previously also been used to inform the design of (novel) payments to farmers intended to 94 increase the provision or quality of non-market goods (see Table 1). Espinosa-Goded et al. 95 (2010), Christensen et al. (2011), Broch et al. (2013), Beharry-Borg et al. (2013), Kaczan et al. (2013), and Greiner et al. (2014) have investigated farmers' willingness to accept (WTA) 96 97 (novel) voluntary payment schemes. Alternatively, to the best of our knowledge, Schulz et al. 98 (2014) are the first to have explored the prospective compliance with the mandatory greening 99 of the CAP. They have estimated farmers' marginal WTA an increase in 'greening'. All studies 100 mentioned above have the following in common. They used the additional payment following 101 compliance or equivalent reduction in payment following noncompliance with a novel 102 payment scheme as the price vehicle that allows calculating the WTA an increase in the 103 provision of non-market goods by farmland.

104

Table 1: Literature review on DCEs valuing land use restrictions

Authors	Goal	Scheme	WTP/	Price	Opt-out
		type*	WTA	Vehicle	
Ruto and Garrod	Compare design preferences	Voluntary	WTP	Payment/	Neither
(2009)	of current participants and			ha.year	
	non-participants for a				
	hypothetical payment				
	scheme				
Espinosa-Goded et	Calculate design change	Voluntary	WTA	Payment/	Current
al. (2010)	preferences of participants of			ha.year	level
	a nitrogen fixing crop				
	payment scheme				
Christensen et al.	Calculate design preferences	Voluntary	WTA	Payment/	Neither
(2011)	for a novel pesticide-free			ha.year	
	buffer zone payment scheme				

Broch et al. (2013)	Calculate design preferences	Voluntary	WTA	Single	Neither
	for a novel payment for			payment/ ha	
	ecosystem services (i.e;				
	recreation, groundwater, and				
	biodiversity) scheme				
Beharry-Borg et al.	Calculate design preferences	Voluntary	WTA	Additional	Neither
(2013)	for a novel water quality			payment/	
	payment scheme			ha.year	
Kaczan et al. (2013)	Calculate design preferences	Voluntary	WTA	4 types	Neither
	for a novel anti-deforestation				
	scheme				
Greiner (2014)	Calculate design preferences	Voluntary	WTA	Payment /	Neither
	for a novel biodiversity			ha.year	
	conservation payment				
	scheme				
Schulz et al. (2014)	Calculate design preferences	Mandatory	WTA	Reduction in	No
	for a novel greening scheme	(Pillar I)		payment/	compliance
	including the share of			ha.year	
	ecological focus areas (EFA),				
	the permissible use of EFA,				
	and the location of EFA				

\* Scheme types are considered: (a) voluntary if the payments require contractual agreements to be made between
 parties and (b) mandatory if the payments (which are a necessity for the continuity of farmers' operations) depend
 on compliance with policy

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109 Similar to the branch of literature revised above, it is our ambition to calculate the level of 110 compensation required to motivate farmers to comply with the regulations of a payment 111 scheme. Previously, mostly a change from a situation without additional restrictions (i.e. the 112 real situation) to a situation with additional restrictions (i.e. the hypothetical situation) is 113 considered. Here, we apply an approach in which a situation without any additional restrictions 114 (i.e. the unaffected situation) is compared to a situation with additional restrictions to calculate 115 the perceived cost estimates. Note that unaffected does not signal that there are no restrictions 116 at all. It simply refers to the situation in which the three restrictions under study are 117 simultaneously absent while other regulation is kept constant. In particular, we study land use 118 restrictions motivated by water protection i.e. the fertilizing restriction (European Council, 1991), carbon sequestration i.e. the permanent pasture restriction (European Commission, 119

120 2009; European Parliament and the Council, 2013b), and food safety i.e. the crop type 121 restriction (European Parliament and the Council, 2002). It should nevertheless be noted that the interpretation of the perceived cost estimate of crop restrictions differs from that of the 122 123 usage and fertilizer restrictions. In the former case the farmer is the victim of a situation caused 124 by the zinc smelters, whereas the usage restriction and fertilizer restriction are brought into life 125 to prevent contributions to climate change and water pollution caused by farmers. Nevertheless, 126 the attribute was included in the experiment due to the case study context and for comparison 127 purposes. The height of the perceived cost of the crop restrictions attribute can serve as a 128 measure of how much farmers having to cope with the crop restriction would like to be 129 compensated at the time of surveying. A lump sum payment by the polluter would be the ideal 130 solution in this case. In practice this ideal is unreachable as the polluter has ceased to exist as a 131 legal entity. A second best could be the creation of a fund created by tax payer's money. 132 However, agreeing with existing legislation we do not feel such compensation should be 133 granted to the farmers if in reality they bought the polluted land at a price rebate and were aware 134 or could have been aware that the rebate is due to the environmental stigma (Flemish 135 Government, 2006). The fertilizer restriction and the usage restriction are actually part of an 136 agricultural payment scheme. Hence, their matching perceived cost estimates can be interpreted 137 as the amount farmers would like to be compensated by for installing such restrictions on an 138 unaffected piece of land. Such payments could be offered to farmers for complying with novel 139 regulation in order to decrease resistance from those that stand to lose.

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141 In this paper, a methodology using DCEs, building on the work of Tegene et al. (1999) and 142 Gelso et al. (2008), is put forward that allows calculating farmers' perceived cost of land use restrictions by comparing the difference in utility between buying a restricted parcel and buying 143 144 an unaffected parcel (see equation 1). Such a calculation coincides with a change in consumer 145 surplus, caused by the land use restrictions, which serves as an approximation of the 146 compensating variation in logit models as originally proven by Small and Rosen (1981). In 147 equation 1 the superscript I represents the situation with a restriction and the superscript O is 148 the unaffected situation for respondent *n* and alternative *j* (Train, 2003).

149 
$$\Delta E(CS_n) = \frac{1}{-\beta_{price}} \left[ ln \left( \sum_{j=1}^{J^1} e^{V_{nj}^1} \right) - ln \left( \sum_{j=1}^{J^0} e^{V_{nj}^0} \right) \right]$$
(1)

150 The perceived cost, as defined here, is equal to the sum of both monetary (e.g. production 151 income losses and transaction costs) and non-monetary costs (e.g. anxiety, reduction in freedom 152 of choice) of installing such legislation. It thus represents the amount farmers would like to 153 receive. The valuation was performed using DCEs motivated by the lack of available data for 154 agricultural land prices. Hence, land use restrictions were embedded as an attribute in a discrete 155 choice experiment simulating a purchasing decision as it was our goal to find out land use 156 restrictions' impact on farmland value. Finding out how to (re)design a payment scheme is out of this study's scope. Finally, it should also be noted that expanding farm operations is also 157 possible through rent and that using rental rates as the payment vehicle would result in entirely 158 159 different appraisals of the perceived cost (Kaczan et al., 2013). We chose not to investigate the 160 rental decision as in Flanders rental prices of agricultural land are regulated by the government. 161 They cannot exceed a legal maximum level, whereas the latter is below the market price. The 162 remainder of this paper is divided as follows. In the following section the DCEs method is 163 described. In a third section, this method is applied on a case study undertaken in the Limburg 164 Campine region of Belgium. In a fourth section, the results are discussed. Finally, the main 165 findings are presented.

# 166 **2. Methodology**

# 167 2.1. Discrete choice experiments' elicitation mechanism and the estimation models used

In this manuscript, discrete choice experiments (DCEs) are adopted as a stated preference (SP) 168 169 methodology. DCEs aim to identify individual's indirect utility function associated with 170 attributes of goods or services by examining the tradeoffs they make when making choice 171 decisions (Garrod and Willis, 1999). Therefore, multiple alternatives - described by several 172 product characteristics or attributes with varying attribute levels – are presented to respondents 173 in choice sets. The respondent is then asked to pick one single alternative from each choice set, 174 thereby revealing his/her preference for certain attributes or attribute levels. Subsequently, the 175 choices are econometrically analyzed in order to estimate attribute coefficients.

176

The microeconomic theory underlying DCEs is based on the notion that utility is derived from attributes of a particular good or situation, which was put forward by Lancaster (1966). His theory of consumer demand provides the basic conceptual structure for DCEs in an economic setting (Holmes and Adamowicz, 2003). Based on the conceptual foundation of random utility

181 laid out by Thurstone (1927), McFadden (1974) expanded on the DCEs framework and 182 developed an econometric model that formalized respondents' decision making process. This 183 model is often referred to as the conditional logit (CL) model, which is considered to be the 184 base model for DCEs (Hensher and Greene, 2003). The simplicity of its closed-form comes at 185 a cost, given that the CL model translates the independent and identically distributed (IID) 186 assumption into substitution patterns that are restricted by independence of irrelevant 187 alternatives (IIA) (Tesfaye and Brouwer, 2012). This is an assumption which is often violated 188 in social studies to which ours constitutes no exception. Mixed logit type models, such as the 189 random parameter logit (RPL) and error component logit (ECL), fully relax the IIA assumption. 190 These are models having unconditional probabilities  $P_{ij}$  equal to the integral of standard logit 191 conditional probabilities  $L_{ii}(\beta)$  over a density of parameters  $f(\beta)$ , see equation 2. The RPL 192 model allows for coefficients to vary -and thus represent random taste variation- between 193 decision makers according to a continuous distribution with a density  $f(\beta|\phi)$ , which is a 194 function of other metrics  $\emptyset$  (e.g. an unknown mean and covariance). Alternatively, a mixed 195 logit model can be used as simply representing error components that create correlations among 196 the utilities for different alternatives. This is called an error components logit (ECL) model. 197 Here, an analog to the nested logit model can be obtained by specifying a dummy variable for 198 each nest that equals 1 for each alternative in the nest and zero for alternatives outside the nest. 199 It is convenient in this situation to specify the error components to be independently normally 200 distributed (N( $0,\sigma^2$ )). The variance then captures the magnitude of the correlation. In our case, 201 there is only one nest, consisting of the three hypothetical alternatives (Train, 2003). It is likely 202 that a cross-correlation exists between these alternatives, seeing that the opt-out, which is 203 included in each choice set in order to mimic actual market behavior and increase familiarity 204 with the setting (Kontoleon and Yabe, 2003), is often traded off against the remaining options 205 (Scarpa et al., 2005).

206 
$$P_{ij} = \int L_{ij}(\beta) * f(\beta) * d\beta$$

## 207 2.2. Setting up the discrete choice experiments

208 Generally, setting up discrete choice experiments requires seven steps (Garrod and Willis, 209 1999; Louviere et al., 2000). These steps are outlined in Table 2. The decision problem has

(2)

- been characterized in subsection 1.3. Steps 2 to 5 are handled below, while steps 6 and 7 are
- 211 elaborated on in the Results section.
- 212

Table 2: Steps in setting up a discrete choice experiments study

Step	Action
1	Characterize the decision problem
2	Identify key attributes and attribute levels
3	Develop an experimental design
4	Design questionnaire survey
5	Pre-test and undertake survey
6	Estimate model
7	Interpret results

213

214 In light of the different steps required in setting up a DCEs study, Boerenbond – the largest 215 farmer association in Flanders (Northern part of Belgium) – agreed to act as a sounding board 216 and expert panel. Their sole function was to co-decide on the factors that influence a local 217 farmer's purchasing decision, in return for their membership list. The resulting cooperation has 218 allowed decreasing the cost of both attribute selection and data gathering, while its expense 219 consisted of Boerenbond being given first-hand insight into the attribute coefficients. We 220 decided on incorporating the following attributes in the DCEs simulating a purchasing decision 221 based on two focus group meetings with Boerenbond's experts: location, lot size, price, soil 222 productivity, and land use restrictions (see Table 3). The location attribute was subdivided into 223 two independent attributes, one that indicates the driving time by tractor from their home to the 224 parcel and one that indicates how far the parcel is located from other farmland that is cultivated 225 by the farmer. Consequently, we included six attributes in the DCEs. Note that the complexity 226 of the DCEs goes side by side with the number of attributes (Caussade et al., 2005). Evidence 227 for including these attributes is also found in literature. Numerous studies have analyzed prices 228 to identify the principal factors determining land values of agricultural and urban land. The 229 classical vision on agricultural land values is that prices equal the present value of the expected 230 stream of rents produced by the land and hence differences in values correspond to productivity 231 differentials (Freeman III, 2003). This warrants the inclusion of the attributes soil productivity 232 and parcel size in the DCEs. Xu et al. (1993) have previously included these features in a 233 hedonic pricing study measuring the contributions of site characteristics to the value of 234 agricultural land. Economic theory also suggests that access to transportation may play an 235 important role in determining agricultural land value seeing that it provides farmers with access

Table 3: Farmland attributes and levels

Attribute	Level 1	Level 2	Level 3	Level 4
Lot size (ha)	0.5	1.5	2.5	3.5
Soil productivity	Low	Rather low	Rather high	High
Driving time to home (min)	5	10	15	20
Distance to other land (km)	0	0.750	1.500	2.250
Land use restrictions	None	Crop restriction: No arable crops and vegetables due to soil contamination	Fertilizer restriction: 25% less usage of fertilizers	Usage restriction: Permanent pasture
Price (€ ha <sup>-1</sup> )	15,000	25,000	35,000	45,000

### 237

238 to markets and reduces input costs. This finding supports the inclusion of the location-based 239 attributes, i.e. driving time to home and distance to other farmland. Johnston et al. (2001) have 240 previously included these characteristics in a hedonic pricing study estimating the amenity 241 benefits of coastal farmland. Grammatikopoulou et al. (2012) have shown that distance is an 242 important factor in land use decisions. The classical vision on agricultural land value only holds 243 true for perfect markets, which the land market is not. Hence, pleas were made for more 244 complex models (Clark et al., 1993). Land value literature has shown that institutional factors, 245 i.e. effects of various types of policy, play a role. Most relevant to our case is that evidence has 246 also been found of the influence which operational restrictions, motivated by the demand for 247 environmental protection, may have on agricultural land values (Nickerson and Lynch, 2001; 248 Vukina and Wossink, 2000). This supports the inclusion of three land use restrictions, which 249 are most relevant to farmers living in the case study region according to Boerenbond. As noted 250 in section 1.3., the level 'none' refers to the situation in which the restrictions under study are 251 simultaneously absent while other regulation is kept constant. A price vehicle has to be included 252 to translate utility into monetary equivalents.

253

Each attribute was assigned four levels, which aimed to reflect the farmland market in the Campine region as closely as possible. For three continuous variables – i.e. price, lot size and driving time to home – level allocation was based on the distribution of these variables from actual purchases over the period 2004-2011 (Adamowicz et al., 1994). Information on the distribution of these variables can be found in Table 4. For the price variable, 15% of the
observations were found to deal with real sales prices lower than 15,000 €/ha. However, this is
partly due to sales transactions in nature area and partly due to the extensive time range 20042011 of the dataset. At the time the survey was administered (December 2012 - February 2013),
farmland prices below 15.000 and above 45.000 €/ha can be considered as exceptional in the
area. The average real price in Flanders in 2009 and the average perceived price of land held in

264

Table 4: Distribution of the variables from real purchases

	Price		Lot size		Distance to home	
	Level (€ ha <sup>-1</sup> )	Percentile	Level (ha)	Percentile	Level (km)	Percentile
Lower range	15,000	15 <sup>th</sup>	0.5	$40^{\text{th}}$	0	15 <sup>th</sup>
Upper range	45,000	92 <sup>th</sup>	3.5	$94^{th}$	7	95 <sup>th</sup>

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266 the study region is respectively about €28.300/ha (Bergen, 2011) and €32.000/ha. With regard 267 to lot size, the dataset included a vast amount of very small parcels, some of which we suspect 268 were intended for residential purposes. Recognizing that this influences the mean, the average 269 lot size was found to be about 1.5 ha. The driving time to home was estimated using GIS. 270 Assuming a tractor drives at an average speed of 20 km/h, it will have travelled about 7 km in 271 20 minutes. Parcels at zero driving time were disregarded, because we assumed it to be highly 272 likely that such a parcel is currently owned by the respondent and as such constitutes an 273 unrealistic choice option. Family sales are outside this study's scope, while it should be 274 recognized that personal relationships are an inherent part of farmland transactions which have 275 a significant depreciating effect on sales prices (Tsoodle et al., 2006). Since no information was 276 available on the distance to other farmland in the sales data, these attributes were assigned levels 277 on the basis of expert opinions in both focus groups. The non-numeric attributes, i.e. soil 278 productivity and land use restrictions, are dummy coded. The attribute 'land use restrictions' 279 uses 'none' as the base level, while "high productivity" was used as the base level for the 280 attribute "soil productivity". Being a qualitative attribute, we acknowledge that the soil 281 productivity is open to heterogeneity. However, we have tried to fix this attribute to be 282 homogeneous by creating a relative judgment. The soil productivity attribute was defined as 283 the productivity of the hypothetical parcel compared to other parcels in its vicinity. A relative 284 judgment simultaneously offers the advantage of being able to survey several types of farmers,

285 which have differing notions of productivity in mind. We have done so seeing that Campine region is considered of being an 'agricultural area' due to the homogeneity of its soil 286 287 characteristics. Finally, we admit that whereas the land use restrictions under study can occur 288 simultaneously, in this work they are assumed to be mutually exclusive. This assumption, 289 nevertheless, allows calculating the perceived cost of a single land use restriction versus no 290 such restrictions. We acknowledge that by doing so information is lost about the difference 291 between degrees of freedom, however, it keeps the amount of attributes more manageable for 292 respondents.

293

294 The next step in setting up DCEs involves developing an experimental design. Given that 6 295 attributes are included in the design, each with 4 attribute levels, 4096 possible profiles exist. 296 Consequently, a generic fractional factorial design is created to reduce the amount of choice 297 sets presented to the respondents. In this study, a main effects, D-efficient utility neutral design 298 for a MNL model was created using SAS. The prevailing argument for selecting a D-efficient 299 design over an orthogonal design is the minimization of standard errors on parameter estimates, 300 which allows for smaller sample sizes (Bliemer and Rose, 2011). This resulted in a design 301 consisting of 16 choice sets, which was blocked over two surveys in order to reduce respondent 302 fatigue. The choice sets in each block were randomized five times to counter order effect bias 303 (Day et al., 2012). Per choice set, three hypothetical parcels and an opt-out were offered to 304 farmers. An example of a choice set is provided in Table 5.

305

### Table 5: Choice set example

	Option A	Option B	<b>Option C</b>	
Lot size	2.5 ha	3.5 ha	1.5 ha	
Soil productivity	High	Rather low	Rather high	
Driving time to home	15 min	20 min	5 min	I do not wish to buy any of the
Distance to other land	2.250 km	0.750 km	0 km	former; I would
Land use restrictions	None	No arable crops and vegetables due to soil contamination	25% less usage of fertilizers	refrain from expanding
Price	45,000 €/ha	25,000 €/ha	15,000 €/ha	
Choice	0	0	0	0

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307 Subsequently, both blocks were inserted in the survey, which was designed to fit the guidelines 308 provided by (Bateman et al., 2002): (1) Survey purpose, (2) Farm-level questions, (3) 309 Attitudinal/motivational questions, (4) Choice sets, and (5) Socio-economic questions. The 310 second section in the survey contained questions about the agricultural activities of the farmer 311 and the farm's land allocation. The third section included statements that assessed their risk 312 attitude and environmental awareness. The survey was pre-tested in both focus groups as well 313 as in a subsample of 6 farmers in the area. The goal was to verify their understanding, not to 314 improve or test the experimental design.

315 The final decision to be made concerns the distribution method. There are only two modes of 316 administration suitable for discrete choice experiments, i.e. in-person interviews or computer-317 assisted surveys. In this study, the in-person option by means of non-Boerenbond affiliated 318 surveyors was preferred because of two major arguments. Although in-person interviews are 319 time consuming, this distribution method produces high quality data in which the amount of 320 missing data is strongly reduced. Moreover, it enables the interviewers to provide the 321 respondents with extra information in order to clarify the objective and the interpretation of 322 certain questions. Secondly, given that mail questionnaires have the lowest response rates of all 323 survey methods (Champ, 2003) and the amount of farmers in the study area is rather limited 324 (N=1560), this method might return a too small sample of respondents. We received contact 325 information for Boerenbond members in all municipalities that were located for at least 50% 326 (of surface area) in the Campine region. This list was used as a sampling list for contacting 327 respondents. This list was corrected by Boerenbond to exclude farmers that were classified as 328 having a very limited amount of agricultural activities. The final sampling list only contained 329 684 addresses and telephone numbers from farmers living in the study area. Respondents were 330 selected by simple random sampling from the contact list. Farmers were first contacted by 331 telephone to briefly explain the nature and the objectives of this research, after which they were 332 asked whether they were willing to participate in the study. If the respondent agreed to 333 cooperate, an appropriate date and time was arranged for an in-person interview.

334 2.3. The case study area

In Figure 1 the municipalities in the case study area are displayed on a map of Belgium in which the Campine region is the brown area. Our research area covers solely municipalities located in the Limburg province. According to the agricultural census there was 35788 ha of land in 338 cultivation in the area in 2012 (FOD Economie, 2013a). The farmers in our survey cultivate 339 roughly 10000 hectare, hence about 28% of the agricultural surface was covered. Large 340 agricultural areas in the Campine region are contaminated with cadmium (Cd), lead (Pb), and 341 zinc (Zn) caused by historical pollution. The contamination was caused by thermal zinc 342 smelters, indicated on Figure 1. Although the latter have stopped emitting anomalous elements 343 in the 1980s, soil Cd concentrations remain higher than allowed in a number of places 344 throughout the area. This has frequently led to confiscation of food and feed, because their 345 contents exceed the legal threshold values for cadmium (Witters et al., 2009).



### 346

347

Figure 1: Case study area

# **348 3. Results**

### 349 3.1. Descriptive statistics

350 The survey was completed by 188 farmers. A high response rate of 67% was obtained. 351 Presuming the census includes the complete population of farmers, it can be examined whether 352 the sample in this study represents the farming population in the entire Campine region. In 353 Table 6 the socio-economic characteristics of the sample and population are displayed. It can 354 be observed that the sample includes more male farmers that are considerably younger than the 355 population. This can partly be explained by the inclusion of all farmers with some agricultural 356 activities in the census, while our sampling list was corrected for farmers with a minimal 357 amount of farming operations. The fact that almost 21% of the farmer population is older than 358 65 confirms that the census includes a significant amount of retired farmers. The farm level characteristics also show that our sample includes more active, professional farmers. 98% of the sample are full time farmers, while the census indicates that merely 69% of the farming population is employed full time. In the category of farmers over 50 years old, the sample contains substantially more farmers with a successor in comparison with the entire population. The underrepresentation of older farmers in the sample might also be explained by the study's set-up. Older farmers without successor are often not interested in investing in purchasing farmland anymore. Consequently, these farmers often refused to participate in the survey.



Characteristics		Sample (n=188)	Population (n=4351)
Sex of farm manager	Male	95.5%	86.21%
	Female	4.5%	13.79%
Age of farm manager	>35	6.5%	4.55%
	35-44	18%	18.21%
	45-54	58%	37.37%
	55-64	14%	18.97%
	>65	3.5%	20.9%
Employment	Full time	98%	68.59%
	Part time	2%	31.41%
Successor (age>50)	Yes	33%	10%
	No	47%	61%
	Not sure	20%	29%

### Table 6: Descriptive statistics

367 With respect to farming types, the census only reports general percentages on farms' activities 368 and does not report on the main activities in the area. Therefore, the sample cannot be compared 369 to the population on the basis of farming types. The sample primarily includes specialist farms 370 (see Table 7). A farm is considered as specialist if at least two thirds of the farm's gross margin 371 emanates from one agricultural activity. The sample particularly includes three types of 372 farming, i.e. specialist dairy farms, specialist pig farms and mixed farms. However, the sample 373 is clearly dominated by specialist dairy farmers. Hence, it should be noted that the Campine 374 region has by far the largest amount of dairy cows per company of all Belgian agricultural areas 375 (FOD Economie, 2013a). Moreover, the Campine region also has a high amount (>1.1) of dairy 376 cows per ha according to FADN data (2007).

377

Farming type	Percentage		
Specialist farms:	79,5%:		
Field crops	2%		
Milk	56,5%		
Pig	10%		
Grazing livestock	4,5%		
Vegetables	1,5%		
Fruits	3%		
Other	2%		
Mixed farms	20,5%		

Table 7: Farming types

### 379 3.2. Results analysis: data inspection and model estimation

380 As a first step in results analysis, the choice data must be inspected. This revealed that not a 381 single respondent chose the opt-out in all 8 choice sets. However, the opt-out was chosen in 382 about 12% of the times over all respondents and was used at least once by about half of the 383 respondents. The lack of farmers, which consistently opted out, can be explained by the study's 384 set up. Farmers uninterested in purchasing land refused to participate in the survey thus 385 avoiding the need to delete their protest answers afterwards. As shown in section 3.1., this 386 approach has led to an overrepresentation of both young, professional farmers and older farmers 387 having a successor compared to the population.

388

389 Being good practice in model estimation, a simple CL model was estimated in order to obtain 390 a general insight into the results and potential sources of observed heterogeneity (Hensher et 391 al., 2005). The quantitative attributes were coded using their respective levels. For the 392 qualitative attributes, i.e. soil productivity and land use restrictions, the levels 'high 393 productivity' and 'none' were used as base levels. An ASC for the opt-out option is included in 394 the analysis. Following Holmes and Adamowicz (2003), each attribute level of the opt-out 395 alternative was handled using zeros. The results of the CL model are omitted, because -as was 396 expected- the IIA assumption was proven to be violated. Mixed logit type models fully relax 397 the IIA assumption without having to adopt different distributions for the error terms or 398 different structures in decision making. Subsequently, a random parameter logit (RPL) and an 399 error component logit (ECL) model were estimated. These models respectively allow

400 identifying whether heterogeneity is present and verifying whether significant correlation 401 between alternatives is present. In the RPL model all parameters, except price, were assumed 402 to have a normal distribution. Previous investigation has shown that an experimental design 403 intended for a CL may be reused with limited efficiency loss for the estimation of a panel-based 404 RPL model (Bliemer and Rose, 2010). The results can be found in Table 8. The main effects' 405 coefficients show that the presence of soil contamination and the resulting crop restrictions 406 reduce farmland utility at the 1% level in comparison with the base level in which none of the 407 three land use restrictions under study are applied. The average farmer prefers parcels of 408 farmland that are not affected by soil contamination. A similar negative value was found for 409 the usage restriction originating from the permanent pasture obligation. A more negative value 410 was derived for the fertilizing restriction, which indicates that the average farmer is even less 411 likely to select a parcel of farmland that has such restrictions. All other attribute (level) 412 coefficients exhibit the expected sign. The lot size attribute indicates that the average 413 respondent is more attracted to larger pieces of farmland. Lots with lower productivity are 414 disliked. However, in comparison with the high productivity base level farmers do not expect 415 to experience significantly less utility from a parcel that is labeled as having a rather high 416 productivity. The results also reveal that farmers are less likely to buy farmland which is located 417 further away from the farmer's home or from other parcels in the farmer's cultivation area. 418 Finally, the negative coefficient for the ASC points out that choosing the opt-out option 419 provides significantly less utility to respondents in comparison with selecting one of the three 420 hypothetical farmland alternatives. These findings are identical in both model specifications. 421 Marginal WTP estimates for the average respondent can easily be computed as they are equal 422 to the ratio of a main effects' coefficient and the price vehicle. A ranking can be made indicating 423 attribute importance by: (1) calculating the utility range per attribute; (2) summing the utility 424 ranges, and (3) dividing the attribute utility range by the sum of the utility ranges (Lizin et al., 425 2012). This showed that the attribute importance ranked from high to low is: land use 426 restrictions, productivity, price, lot size, distance to other land, driving time. Regarding 427 heterogeneity in parameter estimates, the RPL model indicates that there are a number of 428 attribute(s) (levels) with unobserved heterogeneity as shown by the significant standard 429 deviation. More specifically, the respondents seem to have divergent preferences with respect 430 to the attributes lot size, distance to other farmland, driving time to home, and all three of the 431 land use restrictions. This finding does not change by including

	RPL		ECL	
	Coeff.	Std. err.	Coeff.	Std. err.
Main effects				
Lot size (ha)	0.108***	0.300	$0.108^{***}$	0.027
Low productivity	-0.559***	0.085	-0.542***	0.083
Rather low productivity	-0.558***	0.092	-0.512***	0.085
Rather high productivity	-0.052	0.093	-0.058	0.081
Driving time to home (min)	-0.012**	0.006	-0.011**	0.005
Distance to other land (km)	-0.090**	0.04	-0.082**	0.040
Crop restriction	-0.423***	0.104	-0.369***	0.081
Usage restriction	-0.481***	0.117	-0.397***	0.084
Fertilizing restriction	-0.673***	0.121	-0.559***	0.090
Price (€/ha)	-1*10 <sup>-5***</sup>	3*10-6	-8*10 <sup>-6***</sup>	2*10-6
ASC	-1.875***	0.213	-2.247***	0.230
Standard deviations				
Lot size	0.219***	0.040	/	/
Distance to other farmland	0.0002***	0.00006	/	/
Driving time to home	0.027***	0.009	/	/
Crop restriction	0.447***	0.148	/	/
Fertilizing restriction	0.650***	0.143	/	/
Usage restriction	0.427**	0.177	/	/
Error component	/	/	-1.267***	0.170
Pseudo R <sup>2</sup>	0.081		0.084	
Log likelihood	1915.28		-1909.31	

433

\*, \*\*, \*\*\* represents significance at 10%, 5%, and 1% level

interaction effects, which represent observed heterogeneity. Correlation between the 435 436 hypothetical alternatives was confirmed as a significant error component was identified. Seeing 437 that the ECL has the highest log likelihood with fewer parameters, it is the model providing the 438 best fit for our data based on a likelihood ratio test (Ben-Akiva and Swait, 1986). In case these 439 models were not nested, one can still turn to the Akaike Information Criterion (AIC). For our 440 data the lowest AIC is found for the ECL as such reconfirming the results of the likelihood ratio 441 test. Consequently, the perceived cost of each of the land use restrictions is calculated based on 442 the results of this model and equation 1, which represents how to calculate a change in consumer 443 surplus for logit models. For identical pieces of land, this formula estimates the perceived cost 444 for an average respondent to be 46125€/ha for the crop restriction, 49625€/ha for the usage 445 restriction, and 69875€/ha for the fertilizing restrictions. Note that these costs have an infinite

<sup>434</sup> 

time horizon. If we assume this cost to represent a perpetuity, then with a discount rate of 5%
the yearly fixed costs respectively equal 2306 €/ha, 2481 €/ha, and 3494 €/ha.

## 448 **4. Discussion**

449 Previous work has mostly estimated farmers' willingness to participate (-respectively WTA-) 450 in payment schemes, be it voluntary or mandatory, with a focus on investigating the impact of 451 payment scheme characteristics, e.g. contract duration and flexibility, on farmers' intention of 452 participating in a payment scheme envisioning a single goal. In spite of these differences, 453 conclusions were inferred that are useful in the light of our own results. A highly consistent 454 finding was that some farmers appear willing to sign up to payment schemes for modest levels 455 of compensation, whilst other farmers are extremely resistant to participating (Ruto and Garrod 456 2009; Espinosa-Goded et al. 2010; Christensen et al. 2011; Beharry-Borg et al. 2013). 457 Furthermore, Christensen et al. (2011) concluded that the overall flexibility of the contract 458 might be more important to farmers than the practical restrictions in flexibility that a contract 459 induces. Hence, the lack of overall flexibility going side by side with regulation might have 460 influenced our results, as such reconfirming the statement by Espinosa-Goded et al. (2010) 461 which articulated the need for higher compensation in case of compulsory measures. In this 462 regard it should be noted that Beharry-Borg et al. (2013) found that the average compensation 463 required to persuade farmers to participate in a voluntary scheme installing a 25% reduction on 464 farmyard manure equals 20£/acre/year or 65 €/ha/year (using a 1.3 €/£ conversion rate) over a 465 five to ten year period for a sample of farmers from a region where farming is predominantly 466 extensive sheep and cattle rearing, with dairy being important locally. It is hence difficult to 467 compare our estimates with the ones presented in literature. Nevertheless, the latter authors also 468 found that specialist cattle and/or dairy farmers are more averse to making 25 and 50% 469 reductions in farmyard manure applications than other farmers. Similarly, Schulz et al. (2014) 470 revealed that highly intensive dairy farms perceive it to be significantly harder to cope with 471 greening than their less intensive counterparts. Our study is hence in line with the qualitative 472 findings of previous studies that have investigated (the heterogeneity in preferences for) land 473 use restrictions when acknowledging that our results provides intuitions that are most 474 appropriate for specialized dairy farmers. One reason for the overrepresentation of dairy 475 farmers might be that the sampling frame provided by Boerenbond was overrepresented by 476 dairy farmers, especially after correcting for very small farms. Unfortunately, farm type

477 information was not included in the membership list due to privacy reasons, so this could not 478 be verified. Another reason might be that dairy farmers, bearing the abolition of the milk quota's 479 in mind, are most concerned with land purchasing decisions at the moment in order to comply 480 with the strict fertilizing conditions in Flanders. The data confirm that dairy farmers are highly 481 represented (i.e. 83%) in farm types that have bought more land than the average farm in the 482 last 5 years. Compliance with regulation was found as one of the key drivers for purchasing 483 land as was increasing the scale of operations. On top, farming activities on the sandy soils of 484 the Campine region also have to respect a more tight fertilization norm due to the higher risk 485 of leaching compared to other areas (VLM and Mestbank, 2011). Hence, the combination of 486 dairy farmers' productivist attitudes and the trend of tightened fertilization norms might 487 contribute to the perceived cost estimates. Indeed, attribute weights have been found to differ 488 in function of the envisioned land use (Grammatikopoulou et al., 2012). Thus, although being 489 counterintuitive to compensations based on forgone income, for the reasons mentioned above 490 our results are understandable in a Flemish context.

491

492 Compensation demands of specialist dairy farms are also revealed in the actual market. The 493 average direct support (Pillar 1) that farmers received in Flanders in 2012 was 10.065€ (Peeters, 494 2013). Having an available surface of 620.101 ha and 25.258 companies (FOD Economie, 495 2013b), the average direct support per ha per annum roughly equaled 410€. No such data is 496 available which is tailored to the case study region. Still, it should be noted that full-time dairy 497 farmers, which constitute the majority in our sample, have received above average levels of 498 direct support -by at least 40%- in the past (Van der Straeten et al., 2013). Rural development 499 (Pillar 2) is a second channel that offers support for farmers voluntarily undertaking certain pro-500 environmental actions. Novel voluntary agreements have been proposed by the competent 501 authority, i.e. the Flemish Land Agency, and are available as of 01/01/2015 under the limiting 502 condition of approval by the European Commission. These agreements, which are financed by 503 Flanders and the EU, offer payments that are now based on average lost income and transaction 504 costs. For instance, a reduction in fertilization to reach a nitrate residue level of 4kg lower than 505 the threshold value proposed by Flemish legislation would be compensated by about 1000 506 €/ha.year for grassland in Natura 2000 areas for a five year period (VLM, n.d.). Note that a 507 fertilizing restriction on grassland for dairy farmers may not only lead to less feed but also to 508 an increase in required manure spreading area. The latter loss is not being valued at the moment. 20

509 Moreover, a third channel are payments financed by Flanders. Support is also provided by the 510 Flemish Land Agency for certain pro-environmental measures based on average lost income 511 and transaction costs. For instance, if cropland were to be converted to permanent pasture 512 aiming at biodiversity conservation, farmers would be compensated by about 1200 €/ha.year 513 (VLM, n.d.). Admittedly, these estimates do not take into account farmers' reluctance towards 514 change or any other non-rational mindset that might influence preferences as shown by Howley 515 et al. (2015) Moreover, it also does not take into account their loss of options to diversify their 516 operational risk, whereas our estimates for the usage restriction do. Similar arguments for 517 discrepancies between the revealed compensation and perceived cost estimates have been 518 argued for (Schulz et al., 2014).

519

520 Nevertheless, we cannot exclude the possibility that the perceived cost estimates are high due 521 to the used method. The perceived necessity of buying land in order to comply with regulation 522 might have led farmers to act strategically, in spite of our plea to take into account their budget 523 constraint and lack of referral to policy consequences of our study, leading to inflated perceived 524 cost estimates. Participants might have acted strategically in an effort to skew results and as 525 such exert pressure on any program influenced by the survey's findings. Finally, it is possible -526 although we are dealing with average sized DCEs and a familiar good- that complexity might 527 be an issue leading to decision making heuristics being used instead of the rational behavior 528 which our estimation models assume. Attribute non-attendance, for instance, has been shown 529 to affect the welfare estimates (Hensher et al., 2005b; Kragt, 2013; Scarpa et al., 2013).

# 530 **5. Conclusion**

531 This paper aimed to investigate the perceived cost of having land use restrictions on agricultural 532 land. To quantify these costs, land use restrictions were embedded in a hypothetical purchasing 533 situation by means of DCEs. 188 farmers in the Limburg Campine area were surveyed if they 534 agreed to cooperate after being contacted. This allowed us to quantify farmers' preferences for 535 the following attributes: driving time to home, distance to other farmland, lot size, productivity, 536 land use restrictions, and price. To do so, the RPL and ECL model were used as they are not 537 subject to the IIA assumption. The latter model was found to provide the best fit to our data. 538 For identical pieces of land, this model estimates the perceived cost, calculated as a change in 539 the consumer surplus due to having a land use restriction, to be 46,125 (ha for the crop 540 restriction, 49,625€/ha for the usage restriction, and 69,875€/ha for the fertilizing restrictions. 541 Assuming this cost to represent a perpetuity, than with a discount rate of 5% the yearly fixed 542 costs respectively equal 2,306 €/ha, 2,481 €/ha, and 3,494 €/ha. This means that the average in-543 sample farmer would like to be compensated by 2,306 €/ha.year by the zinc smelters for the 544 regulatory effects the pollution has caused now. To the best of our knowledge, we are the first 545 to calculate the compensation required for the damage caused. We would like to remind the 546 reader that we do not feel such compensation should be granted to farmers if in reality they 547 bought the polluted land at a price rebate and were aware or could have been aware that the 548 rebate is due to the environmental stigma. Alternatively, the average in-sample farmer would like to be compensated by 2,481 €/ha, and 3,494 €/ha for converting unaffected land to 549 550 permanent pasture and for a 25% decrease in fertilization as opposed to the current legislation. 551 These amounts represent the side-payments necessary to avert resistance from those that stand 552 to lose. Bearing the Kaldor-Hicks efficiency principle in mind, such support levels do not have 553 to be realized. It can be agreed upon to provide lower levels. However, the option to perform 554 this transfer should be existing if regulation enhances welfare. Hence, it could be verified 555 whether the public's benefits are greater than farmers' perceived costs. Additionally, whereas 556 these estimates may seem high, we have identified the following arguments in favor of their 557 realism. First, the sample is biased towards full-time specialist dairy farmers, which have been 558 shown to be reluctant towards greening and fertilization restrictions in the DCEs literature. 559 Second, specialist dairy farmers may be on the lookout for land which allows them to comply 560 with tightening fertilizing norms -which are even tighter in the Campine area because of its 561 sandy soils and hence leaching risk- while expanding their operations in view of the abolition 562 of the milk quota. Third, perceived cost estimates are expected to be higher for inflexible 563 payment schemes. Fourth, the perceived cost estimates are higher, but still in the same order of 564 magnitude as the estimates based on lost income and transaction costs. Fifth, the perceived cost 565 estimates represent the compensation or support that farmers would like to receive and hence 566 also incorporate the valuation of non-market costs such as the joy from working the land. Still, 567 we cannot exclude the possibility that the estimates might be inflated because of strategic 568 behavior or complexity issues. Nevertheless, based on our findings policy makers are advised 569 to take into account farm type differences instead of relying on current calculations based on 570 average estimates of lost production income and transaction costs. Our findings show that dairy 571 farmers perceive fertilizing restrictions more burdensome than usage or crop restrictions, 22 572 whereas support levels based on average lost income and transaction costs point towards the 573 opposite conclusion.

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