Investigating farmers' preferences for the design of agri-environment schemes: a choice experiment approach

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ABSTRACT

In recent decades agri-environment schemes (AES) have become an increasingly important tool for policy makers aiming to reverse the post-war decline in environmental quality on agricultural land. The voluntary nature of such schemes means that the decision of farmers to participate is central to achieving policy objectives. This paper therefore uses a choice experiment approach to investigate the role that scheme design can have on encouraging farmers to participate. Choice data was gathered from a survey of farmers in 10 case study areas across the EU and analysed using both mixed logit and latent class models. In general, farmers were found to require greater financial incentives to join schemes with longer contracts or that offer less flexibility or higher levels of paperwork. It was also observed that a large segment of farmers ('low resistance adopters') would be willing to accept relatively small incentive payments for their participation in schemes offering relatively little flexibility and high levels of additional paperwork, when compared to other more 'high resistance adopters'.

Keywords: farmers**;** agri-environment; participation; choice experiments; mixed logit; latent class

Introduction

The voluntary nature of agri-environment schemes (AES) means that the participation of farmers is central to achieving policy objectives (Wilson, 1996). There has been considerable research interest in identifying the factors that influence participation (e.g. Vanslembrouck et al., 2002). Brotherton (1989, 1991) stated that both 'farmer factors' and 'scheme factors' need to be taken into consideration when attempting to understand farmer participation in AES. Farmer factors include various individual farmer and farm characteristics such as age, education and farm size. Scheme factors are those that may influence the economic attractiveness of a particular scheme and include the financial incentives offered and a range of other design elements such as the length of the AES contract and the ability of the farmers to choose what land they wish to enter into a scheme.

Following Brotherton (1989), the literature relating to farmers participation in AES (the so called adoption studies) has mainly concentrated on the farmer factors influencing participation behaviour (e.g. Morris and Potter, 1995; Wilson, 1997; Wilson and Hart, 2000; Wynn et al., 2001; Wossink and Wenum, 2003; Vanslembrouck et al., 2002; see Siebert et al, 2006 for a review). The general consensus seems to be that participation in AES is positively influenced by farm size, educational attainment and by a farmer's interest in conservation, but negatively related to a farmer's age. Although such endogenous factors may influence participation decisions, they are of limited interest to policy-makers as they are not readily amenable to change. Falconer (2000) notes that too great a focus on farmer factors is unprofitable, as the private transaction costs associated with participation in a particular scheme also need to be taken into account. Mettepenningen et al. (this issue), investigate the impact of private transactions costs, focusing on potential methodologies for their measurement. Other studies apply the principal-agent theory to analyse the design of AES, focusing on the implications of information asymmetries for contract design (e.g. Moxey et al., 1999; Ozanne et al., 2001).

Unlike the studies just described, this paper focuses on the role that the design of AES contracts can have on encouraging farmers to participate in AES. Therefore, rather than investigating how farmer factors influence entry into AES contracts of uniform design, this study concentrates on the role that scheme factors can have on increasing the likelihood of participation of different groups of farmers. This topic remains largely unaddressed by the literature and this study helps to fill in a significant gap.

This study employs a choice experiment approach (Louviere et al., 2002) to investigate farmers' preferences for key elements of AES design. Modelling farmers' choices permits us to estimate how they would trade-off different levels of these design elements against per hectare payments. Knowledge of such trade-offs can inform AES design and the incentives offered to potential participants.

The paper is structured as follows. Section 2 presents the choice modelling approach adopted in this paper. In section 3, we describe the design and implementation of the choice experiments. Section 4 reports the findings from the analysis of the choice data and some conclusions for the design of AES are drawn in the final section.

The choice experiment approach
In the last decade the choice experiment (CE) approach has increasingly been used to value the effects of quality changes in environmental attributes (e.g. Adamowicz et al., 1998; Garrod and Willis, 1999; Hanley et al., 2001; Hanley et al., 2006). Choice experiments are particularly well suited to measuring the marginal value of the attributes of a good or policy. A recent development in the method is to define attributes in terms of the different aspects of (environmental) policy design, rather than in terms of the characteristics of the environmental goods themselves (Hanley et al., 2003). This is the approach taken by this study.

The CE approach is consistent with Lancaster's theory of consumer choice (Lancaster, 1966) which postulates that consumption decisions are determined by the utility that is derived from the attributes of a good, rather than from the good *per se*. The econometric basis of the approach rests on the behavioural framework of random utility theory, which describes discrete choices in a utility maximising framework (McFadden, 1974; Ben-Akiva and Lerman, 1985). Statistical analyses of the responses obtained from CE can be used to derive the marginal values for attributes of a good or policy or an individual's willingness to pay to gain an outcome with a more desirable combination of characteristics.

The multinomial logit (MNL) model (McFadden, 1974) is the most commonly used discrete choice model for the analysis of results from choice experiments. While the relative simplicity of the MNL model is a clear advantage, it has some important limitations. For example, the MNL framework imposes homogenous preferences across respondents and its concomitant assumption of the independence of irrelevant alternatives (IIA) (Hausman and McFadden, 1984). Preferences, however, may be heterogeneous and accounting for the presence of heterogeneity enables computations of unbiased estimates of individual preferences. In addition, accounting for preference heterogeneity provides a broader picture of the distributional consequences and other impacts of policy actions and provides better insight on policy outcomes.

Among the recent innovations aimed at accounting for preference heterogeneity in choice models are the mixed logit (Train, 1998; McFadden and Train, 2000) and latent class models are a special case of these (Wedel and Kamakura, 2000). These models represent advanced alternative approaches for characterising the distribution of preferences in a given population. The mixed logit model accounts for preference heterogeneity by allowing utility parameters to vary randomly (and continuously) over individuals. The latent class model, on the other hand, postulates a discrete distribution of tastes in which individuals are intrinsically sorted into a number segments (or classes), each characterised by homogenous segments though heterogeneous across segments (Boxall and Adamowicz, 2002). The specification and estimation of these models as applied in this paper are outlined below.

Formally, in each choice occasion, a respondent faces a choice between J=2 alternatives (plus an option to choose neither). Each respondent is presented a series of T=4 choices. In this study the three alternatives that the respondent faces in a particular choice occasion are two AES policy options described in terms of key design attributes (duration of AES contract, per hectare payment rate, etc) and the "choose neither" option. The attributes of alternative i in choice occasion t faced by

respondent n are collectively labelled as vector X_{int}. The utility that respondent n derives from choosing alternative i on choice occasion t is give by:

$$U_{int} = \beta_n X_{int} + \varepsilon_{int} \tag{1}$$

where the coefficient vector β_n, representing individual tastes, is unobserved and varies randomly in the population with density denoted $f(\beta_n|\theta)$, where θ represents the parameters of this distribution. ε_{int} is an unobserved random term that is assumed to be independent and identically distributed (iid) according to an extreme value distribution. Conditional on β_n, the probability that the respondent chooses alternative i in choice occasion t is a standard MNL (McFadden, 1974), since ε_{int}'s are distributed extreme value:

$$L_n(i,t \mid \beta_n) = \frac{\exp(\beta_n ' X_{int})}{\sum_j^J \exp(\beta_n ' X_{jnt})} , \tag{2}$$

Let y_{nt} denote the respondent's chosen alternative in choice occasion t, and let $y_n = (y_{n1}=, \ldots, y_{nT})$ denote the respondent's sequence of choices in the T choice occasions. The joint probability of the respondent's sequence of choices, conditional on β_n, is the product of standard logits:

$$P(y_n \mid \beta_n) = L(y_{n1},1 \mid \beta_n).\ldots.L(y_{nT},T \mid \beta_n). \tag{3}$$

However, the researcher does not observe β_n. Only its density $f(\beta|\theta)$ is assumed to be known, so the unconditional probability of the respondents sequence of choices is the integral of equation 3 over all possible values of β_n weighted by the population density of β_n as shown in equation 4.

$$P(y_n \mid \theta) = \int P(y_n \mid \beta_n) f(\beta_n \mid \theta) d\beta_n \tag{4}$$

The distribution of β can be specified as either continuous or discrete. As noted above, a model with continuously distributed coefficients results in a mixed logit model (McFadden and Train, 2000). A model in which the coefficients follow a discrete distribution and given class membership preferences are homogeneous is, on the other hand, called a latent class model (LCM). In the LCM, the mixing distribution $f(\beta_n|\theta)$ in equation 4 is discrete with β_n taking a finite set of values, one set for each class. In this case, it is assumed that the population consists of a number of unobservable (latent) segments (or classes) each characterized by relatively homogenous tastes, but where preferences vary considerably between segments. The LCM has been frequently applied in market research (for a review, see Wedel and Kamakura (2000)). More recently, LCMs have been used in recreational demand revealed preference studies (e.g. Scarpa and Thiene, 2005; Haynes et. al., 2008) and stated preference applications (e.g. Boxall and Adamowicz, 2002; Garrod et. al., 2002; Greene and Hensher, 2003; Birol et al., 2006; Ruto et. al., 2008).

The log-likelihood for both models is given by $LL(\theta) = \sum_n^N \ln P(y_n)$. In the mixed logit estimation, this expression cannot be evaluated analytically because the choice

probability (equation 4) does not have a closed form. Hence it is approximated using simulation methods (Train, 2003). In particular, a number of draws of β is taken from its density $f(\beta|\theta)$. For each draw, the product of logits in equation 3 is calculated, and the results are averaged over draws. The simulated log-likelihood used in estimation is given by:

$$SLL_{MXL}(\theta) = \sum_{n=1}^{N} \ln\left[\frac{1}{R}P(y_n \mid \beta^r)\right], \tag{5}$$

where R is the number of replications (i.e. draws of β), β^r is the rth draw. We use Halton intelligent draws for the simulation, which have been found to provide far greater accuracy than independent random draws in the estimation of mixed logit models (Train, 2003). The log-likelihood for the LCM with S latent segments is given by:

$$LL_{LCM}(\theta) = \sum_{n}^{N} \ln[\sum_{s=1}^{S} P(s)P(y_n \mid \beta_s)], \tag{6}$$

where P(s) is the probability that individual n belongs to segment s and β_s is a vector of class-specific coefficients. Following Greene and Hensher (2003), P(s) is specified to have the MNL form:

$$P(s) = \frac{\exp(\lambda_s z_n)}{\sum_{s=1}^{S} \exp(\lambda_s z_n)}, \tag{7}$$

where z_n is a set observed individual characteristics which enter the model for class membership probability and λ_s is a vector of segment-specific parameters to be estimated. In this paper, we employ logit models with continuous mixing of taste to identify the existence of preference heterogeneity and the latent class type of finite mixing to estimate the segment-specific utility parameters. Rather than treating them as competing modelling approaches, as has been the case in most previous studies, we view both models as having complementary strengths and weaknesses which can be exploited to enhance our understanding of the preferences underlying observed choices.

Choice experiment design and implementation

Choice experiment design

This study was part of a larger EU research project Integrated Tools to design and implement Agri-Environment Schemes (ITAES-SSPE-CT-2003-502070) aimed at exploring potential methodologies for optimal design and evaluation of AES, drawing from the lessons learnt in the implementation of AES under EU regulation 2078/92. The project involved ten EU case studies (reported later in Table 2) and was conducted between 2004 and 2007. The CE was incorporated into a large sample survey of farmers conducted across the ten case study areas (CSAs). Responses were collected both for farmers who were currently enrolled in AES and those who were not (see Arnaud et al., 2006 for details of the survey).

The main objective of the choice experiment (CE) was to investigate farmers' preferences for key design attributes of AES. Importantly, for the broader objectives of the study, these attributes should both be under the control of policy-makers and likely to have a significant influence on the likelihood of farmers participating in the schemes. Given that AES differ widely across the EU in terms of their implementation and what they require of farmers, the challenge at the initial stage of CE design was to select common scheme attributes so as to maximise the scope of the study to investigate preferences for scheme design both within and across countries or CSAs. The choice of attributes and levels was based on a combination of evidence from the literature and information from focus group discussions with farmers in several of the CSAs. The focus group discussions were used to investigate farmers' attitudes towards AES design elements and to gather background information on what aspects of the design of AES are important to farmers in their participation decision-making, i.e. the scheme factors that are likely to 'tip the balance' in favour of (or against) participation. The group discussions also served as an opportunity to test out alternative approaches to the implementation of the CE. The five key scheme attributes and their associated levels are reported in Table 1.

Table 1. Attributes and attribute levels in choice experiments

Scheme attribute	Description	Attribute levels
Minimum length of agreement (years)	Duration of AES contract	5, 10, 20*
Flexibility over what areas of the farm are entered into the scheme?	whether or not the scheme allows flexibility over which areas of the farm are entered into the scheme	No, Yes
Flexibility over undertaking some of the measures required under the scheme?	whether or not the scheme allows flexibility over adherence to scheme prescriptions	No, Yes
Average time spent on paperwork/administration	levels of administration as measured by the amount of time spent on non-operational aspects of the scheme, such as on paper-work and information gathering	Low, Medium, High
Additional payment per ha	The per hectare payment rate made under the scheme	5%, 10%, 20%

* to take account of national differences 2, 5 and 10 years were used as the minimum length of agreement attributes in the Czech Republic

There was little evidence in the literature on important scheme design factors that explain participation. One notable exception is Wynn et al (2001) who found that scheme flexibility is an important determinant of entry into Environmentally Sensitive Area (ESA) schemes in Scotland. They found that farmers who could choose options that fitted better into their farm operations were more likely to participate.

In the CEs, farmers were asked to consider future changes to the design of a particular AES. For participants in an existing AES this had to be a scheme they were already members of, while for those farmers currently not in a scheme, the CE asked them to

consider an existing scheme with which they were familiar, and had perhaps thought of joining.

The set of attributes within the CE was selected to capture key features of AES design that the government is able to influence through policy design, as well as the cost of the schemes to the taxpayer. For example, the government can decide whether or not to give farmers flexibility in selecting the areas of the farm to enter into the scheme or to adopt a whole-farm approach; whether or not to allow flexibility over adherence to scheme prescriptions; and whether to offer short or long term contracts. Set up in this way, the CE enables us to explore the increases in per hectare payments that farmers would require in return for accepting less-desirable contractual conditions or to assess the proportion of their payments that they are willing to trade off in order to enter schemes that have more attractive attributes.

A large number of unique AES configurations can be constructed from the selected number of attributes and levels (Table 1). Experimental design techniques (see Louviere et al., 2000) and SPSS Conjoint software were used to obtain an orthogonal main effects design. This resulted in 24 paired choice profiles which were then randomly blocked into six sets of four. Each paired choice profile offered respondents a choice of two alternative AES designs (Policy A and Policy B). To conduct the CE respondents are asked which of the two alternatives they preferred, but are allowed to state that they prefer neither. An example choice set (referred to as 'choice card' in CE literature) is shown in Figure 1. Inclusion of an "opt out" alternative, which in this case is the "choose neither" option, avoids a forced choice by allowing respondents to select neither alternative in the choice set and serves to make the results obtained consistent with demand theory (Hanley et al., 2001). Each respondent was presented with a series of four choice tasks (i.e. one of the six blocks of four pairs) yielding a data set of between 400 and 1300 choices across CSAs. In addition, as respondents were completing the choice tasks, a card was provided reminding them of the meaning of each attribute and the levels it could take.

Agreement Element	Policy A	Policy B
We would like to ask you to make choices between **two** ways in which AES could be designed in the future. Assuming the following AES contracts were the ONLY choices you have, which one would you prefer? Please note that nothing else would change apart from the design elements listed. Remember that by answering carefully and honestly you will help to ensure that future contracts are made more attractive to farmers.		
The minimum length of your agreement (years)	20	10
The right to choose the areas of your farm that you enter into the scheme	YES	NO
The right to choose not to undertake at least some of the measures required by the scheme	NO	YES
The average amount of time you spend each week on non-operational aspects of the scheme, e.g. paperwork, information gathering etc	MEDIUM (BETWEEN 2 AND 5 HOURS PER WEEK)	HIGH (MORE THAN 5 HOURS PER WEEK)
Additional payment per ha made under the scheme	5 %	20 %

Figure 1. An example choice experiment choice card

Choice experiment data collection

The CE survey was administered between May and December 2005 using face-to-face interviews with farmers. As mentioned earlier, the CE's were incorporated as part of a much larger questionnaire administered by the ITAES project across the ten European CSAs under investigation (i.e. the same questions were asked in each CSA). Although the CSA's were selected opportunistically, the sample covered a variety of institutional contexts and farming systems across the EU (although the Southern EU states were under represented in the project).

The survey targeted both participants and non-participants in AES, with a quota of about 50 per cent of the sample allocated to each group. Non-participants included both farmers who are not eligible to join an AES and those who had the opportunity to join but chose not to. In each CSA, random samples of participants and non-participants were drawn from lists of farmers provided by the government agencies or commercial sources. Table 2 provides an overview of the number of AES participants and non-participants interviewed in each CSA. Overall 1,247 participants and 1,015 non-participants were interviewed.

Table 2. Case study areas and the number of participants and non-participants surveyed

Country	Case study area (CSA)	Participants	Non-participants
United Kingdom	North East of England	110	109
France	Basse-Normandie	171	157
Netherlands	Friesland	163	58
Belgium	Flanders	199	109
Germany	Brandenburg	126	80
Italy	Emilia-Romagna	75	75
Italy	Veneto	82	68
Ireland	whole country	147	149
Finland	whole country	34	71
Czech Republic	whole country	140	139
Total		1247	1015

Results and discussion

This section presents a selection of results from an extensive analysis of the CE data collected in the study. The data set contains 20 sub-samples—10 CSA samples each with AES participants and non-participant sub-samples separated (see Table 2). Due to space constraints, the focus here is on the estimation results based on the pooled sample across the 10 CSAs. Individual CSA results are available in Ruto and Garrod (2006) or from the authors upon request. In general, however, the analysis revealed considerable similarity in preferences for AES attributes across the CSAs. The list of variable used in the analysis is presented in Table 3

Table 3. Description of variables used in the analysis of choices

Variable	Description
Clength	Contract length (5 years, 10 years, 20 years)
Fland	Flexibility over what areas of the farm or land are entered into the scheme? (1=Yes; 0 otherwise)
Fmeas	Flexibility over undertaking some of the measures required under the scheme? (1= Yes; 0 otherwise)
Lowpw	Average time spent on paperwork/administration; 1=Low (less than 2 hours a week)*; 0 otherwise
Medpw	Average time spent on paperwork/administration; 1=Medium (between 2 and 5 hours per week)*; 0 otherwise)
Highpw	Average time spent on paperwork/administration; 1=High (more than 5 hours per week); 0 otherwise
Payment	Additional payment per ha (5%; 10%; 20%)

Table 3 (*Continued..*)

Variable	Description
Age	Age of farm head in years
Hedu	Education level; 1=Higher education (at least post secondary level); 0 otherwise
Successor	Successor factor; (1=if farmer has successor; 0 otherwise)
Envicon	A measure of environmental consciousness based on a series of questions relating to respondent's level of participation in environmental organisations and frequency of purchase of environmental publications and environmentally friendly products. (1=More environmentally conscious; 0 otherwise)
Farmsize	Farm size (total utilisable agricultural area)
Lfarm	Large farm (1 if farm is >200 ha, 0 otherwise)
Rentprop	Proportion of farm that is rented
Fincdep	Dependency on farm for income (1=more than 50% of the farmer's income is from the farm business; 0 otherwise)

The maximum likelihood estimates for the mixed logit models, estimated on the participant, non-participant and pooled samples are reported in Table 4. The utility parameters for all AES attributes were entered as random parameters assuming a normal distribution, except the payment attribute which was specified as fixed. The models were estimated using maximum simulated likelihood procedures in Limdep/Nlogit version 3.0 (Greene, 2002) utilizing 100 Halton draws for the simulations[1]. In all the three samples, all the AES attributes are statistically significant (at 1% level) in explaining farmers' choices and the coefficient for payment enters with the expected positive sign. Also shown in Table 4 are the estimated standard deviations of the distribution of taste parameters in the population. The standard deviations of all the random coefficients are highly statistically significant indicating that these coefficients are indeed heterogeneous in the population.

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[1] Likelihood ratio tests reject the null hypothesis that an MNL model fits the data better than the mixed logit model estimated on each of the three samples. A specification test of the MNL model to test the assumption of IIA (Hausman and McFadden 1984) also rejects the null hypotheses that IIA holds ($p<0.01$) confirming that less restrictive specifications that do not impose IIA such as the mixed logit and latent models should be employed.

Table 4: Mixed logit estimates for AES attributes

	Participants		Non-participants		Pooled sample	
	Coeff. *(t-value)*	*Coeff. SD* *(t-value)*	*Coeff.* *(t-value)*	*Coeff. SD* *(t-value)*	*Coeff.* *(t-value)*	*Coeff. SD* *(t-value)*
Clenght	-0.138	0.166	-0.151	0.171	-0.143	0.167
	(17.51)	(18.74)	(-16.23)	(16.02)	(23.85)	(25.07)
Fland	0.977	1.18	0.911	1.256	0.944	1.213
	(13.23)	(11.33)	(11.11)	(10.35)	(17.23)	(15.05)
Fmeas	0.832	1.11	0.525	1.636	0.703	1.368
	(12.18)	(10.02)	(6.03)	(13.01)	(12.90)	(16.84)
Highpw	-0.774	0.854	-0.650	0.817	-0.719	0.868
	(9.51)	(5.28)	(7.20)	(4.57)	(11.85)	(7.33)
Payment	0.110	-	0.097	-	0.104	-
	(22.72)		(18.06)		(29.0)	
Log-L	-4393.39		-3669.83		-8089.06	
Adj. Pseudo-R^2	0.194		0.173		0.183	
N (respondents)	1247		1015		2262	
N (choices)	4988		4060		9048	

The results reveal that farmers were found, on average, to prefer shorter rather than longer contracts. They also indicate that farmers have a positive preference for greater flexibility over what areas of the farm are entered into the scheme and for greater flexibility over scheme prescriptions or measures to undertake (hereinafter referred to, respectively, as "flexibility over land" and "flexibility over measures"). As expected, they also prefer lower levels of paperwork. As mentioned previously, this attribute was described in the CE as the amount of time spent in non-operations aspects of the scheme (High, Medium, Low) such as paperwork and information gathering.

The inclusion of payment as one of the factors affecting the probability of choice provided the basis to estimate the marginal rate of substitution (MRS) between the attributes and money using the results in Table 4. This implies that we can interpret the ratios as the marginal WTP for a change in each attribute (Haneman, 1984). Because the impact of each attribute is not predetermined, the marginal WTP values can be either positive or negative. In our CE, the monetary attribute was described in terms of a change to annual per hectare payments, hence positive values indicate the increase in per hectare payments (as a percentage of current levels) that farmers would be willing to trade-off or forgo in order to gain schemes with more desirable attributes. Conversely, negative values indicate the percentage increase in the levels of payments farmers would demand in return for accepting less desirable contractual obligations. In the discussion of the results the abbreviation WTP will be used in all cases with the sign indicating the nature of the impact of the attribute. Table 5 presents marginal WTP estimates as a percentage of current payments.

Table 5. Marginal WTP for AES attributes as a percentage of current payments

	Participants	Non-participants	Pooled sample
Clenght	-1.25 (-1.37 to -1.14)[a]	-1.56 (-1.72 to -1.39)	-1.37 (-1.47 to -1.28)
FLand	8.88 (7.63-10.14)	9.40 (7.74-11.06)	9.08 (8.80-10.09)
FMeas	7.57 (6.41-8.73)	5.42 (3.81-7.03)	6.76 (5.80-7.72)
Highpw	-7.04 (-8.23 to -5.85)	-6.70 (-8.23 to -5.18)	-6.91 (-7.86 to -5.97)

[a] Ninety five percent confidence intervals obtained from asymptotic standard errors approximated by means of the delta method

All of the WTP estimates are statistically significant at below the 1 percent level. It is interesting to note that WTP estimates for participants and non-participants are not statistically different. A simple visual examination of this is confirmed by the large overlap of confidence intervals of WTP for both samples. This suggests that whether or not a farmer is a participant in AES does not seem to be a significant source of heterogeneity in preferences for scheme attributes. The results suggest that farmers, on average, would be willing to trade off about 6-10% of their current payments in order to gain flexibility over land or measure in AES. They would demand an increase of 6-8% of current per hectare payment in return for accepting higher levels of paper work and just over 1% for an increase in the duration of contract by one year.

To investigate the possible sources of heterogeneity in preferences, we introduce interactions between the mean estimate of the utility parameters and farm/farmer characteristics (farmer factors) in a mixed logit model estimated on the pooled sample of participants and non-participants. After extensive testing of various interactions with farmer factors collected in the survey, the model that interact mean preference for contract length with these covariates was found to fit the data best. The results are reported in Table 6. The top part of the table reports estimates of mean taste or preference in the population and the bottom part contain estimates of standard deviations of parameter distributions. Of particular interest are interaction effects of contact length with farmer factors which are reported in the middle section of the Table. These are estimates of 'shifts' in mean taste of contract length occasioned by the relevant farmer factors. The results show that age of respondent, whether or not the farmer has a successor, level of environmental awareness, farm size, proportion of land rented and, level of dependence on farm income are significant sources of heterogeneity in preferences for duration of contract. However, the standard deviation of the distribution of Clength coefficient is still highly significant, which indicate that preferences for duration of contract vary more than is captured by these factors.

Table 6. Mixed logit with interactions estimates for AES attributes

Attribute	Coefficient	Std. Error	p-value
Clength	-0.0518	0.0290	0.0746
FLand	0.846	0.0590	0.000
FMeas	0.715	0.0664	0.000
Highpw	-0.733	0.0676	0.000
Payment	0.108	0.00365	0.000
Heterogeneity in mean parameter for contract length			
Age	-0.000766	0.000478	0.10
Education	-0.0101	0.0105	0.340
Successor	-0.0363	0.0152	0.017
Envicon	0.0181	0.0103	0.079
Farm-size	0.0535	0.0169	0.002
Rentprop	-0.0829	0.0137	0.000
Fincdep	-0.0269	0.0105	0.0107
Standard deviations of parameter distributions			
sdClenght	0.163	0.0072	0.000
sdFLand	1.186	0.0886	0.000
sdFMeas	1.387	0.0914	0.000
sdHighpw	0.960	0.129	0.000
sdPayment			

Log-L=-6912.66; Adj. Pseudo-R^2=0.183; N (respondents)=2262; N (choices)= 9048

Though farmers, on the whole, preferred shorter rather than longer AES contracts, preferences for shorter contract lengths were higher for the older farmers. In other words, older farmers were more likely to demand higher per hectare payments for longer contracts than younger farmers. The level of farmers' formal education did not seem to significantly influence preferences for duration of AES contract. Whether or not a farmer has a successor also appeared to be important in decisions regarding duration of contract. The coefficient value suggests that farmers generally have a preference for not encumbering a successor with a contract that they have negotiated. Encouragingly, it was also noted that favourable attitudes towards the environment reduces the marginal disutility of farmers for long contracts.

Farm size had a significant influence on preferences for AES contract length. Farmers with holdings over 200 ha had a higher preference for longer term contracts than those with smaller holdings. Most previous research on the uptake of AES has found that farmers with larger holdings are more likely to participate in such schemes. The per hectare payment methods used in most AES may disproportionately benefit larger farms over small farmers (especially in whole-farm agreements) and hence larger farms may find longer contract lengths provide advantageous in terms of a guaranteed future income stream. Similarly, such farms may experience greater economies of scale in terms of administration and training. Tenure status also seemed to have a significant effect on preferences for contact length. Farmers who rent the majority of their holdings were found to have a greater preference for shorter term AES contracts than those who owned most of their farms. It is unclear whether such preferences

reflect uncertainties over the duration of tenancies or the influence of landlords who might not wish their land to be tied into a longer-term contract.

Farm households that rely mainly on their farms for income (i.e. that are dependent on the farm for more than half of their income) are less likely to enter into longer term contracts than farm households that are less reliant on the farm for income. It could be argued that the unwillingness of farmers who are more reliant on farm incomes to commit themselves to longer term AES contracts could be explained by the potentially greater opportunity costs of such arrangements in terms of income foregone should market conditions change and the profits available from more intensive farming techniques increase. On the other hand, it could be argued plausibly that farmers who rely mainly on the farm for their incomes may be more likely to welcome the additional financial security offered by longer term AES agreements. In the AES participation literature, dependency on farm income has proved to be an ambiguous variable in explaining participation decisions (Wilson, 1997). It should be noted that the factors identified here as having a positive influence on preferences for longer contracts mirror those that have been identified in the literature as having a positive influence on AES participation (e.g. Wilson, 1997; Ducos et al., this issue).

We now turn to the results of the latent class model (LCM). First, an important issue in the empirical application of latent class models is the number of segments to be used in the analysis. Formal statistical criteria for determining the number of segments, however, do not yet exist. As a guide to the selection of the optimal model, a number of authors have suggested the use information theoretic criteria tempered by the analyst's own judgment (e.g. Swait, 1994; Boxal and Adamowicz, 2002; Scarpa and Thiene, 2005). In this paper, we use the Bayesian Information Criteria (BIC) as a guide to the selection of the optimal model. The criterion decreases monotonically as the number of segments increases but tend to flatten out from the two segment model, i.e. the improvements are much smaller from two to three and three to four segment model; this suggests a two segment solution may be appropriate[2]. It was also found that models with more than three segments suffered from many insignificant parameters due to extremely large standard errors. It was therefore decided that a two segment LCM was the preferred specification. Maximum likelihood estimates of this model are reported in Table 7.

The results show that there is substantial heterogeneity in preferences for AES attributes across segments as indicated by differences in the magnitude, significance and signs of the parameters of the segment-specific utility functions (choice model in Table 7). The parameter estimates in the segment membership model in Table 7 represent the effects of the farmer factors on the probability of membership in the various segments (note that these are the λ_s coefficients in equation 7).

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[2] The BIC values for four segments are 8864, 8324, 8038, 7973, in progressive order. The models were estimated using Limdep/Nlogit version 3.0 (Greene, 2002).

Table 7. Two segment latent class model estimates for AES attributes

	Segment 1		Segment 2	
Choice model				
Attribute X	Parameter	|z-value|	Parameter	|z-value|
Clength	-0.045***	14.8	-0.156***	43.8
FLand	0.674***	16.9	0.760***	17.6
FMeas	0.721***	18.3	0.331***	7.1
Highpw	-0.368***	8.3	-0.640***	12.4
Payment	0.104***	36.8	0.0246***	7.5
Segment membership function				
Attribute Z				
Constant	0.909***	6.6		
Age	-0.324***	2.6		
Education	0.156*	1.9		
Successor	-0.000522	1.0		
Envicon	0.222*	1.9		
Lfarm	0.539***	2.8		
Rentprop	-0.844***	5.6		
Fincdep	-0.156*	1.9		
WTP estimates for AES attributes				
Clenght	-0.43***	15.4	-6.34***	7.7
FLand	6.47***	14.8	30.82***	6.2
FMeas	6.92***	15.9	13.45***	4.2
Highpw	-3.54***	8.3	-25.97***	6.8

*** 1% significance level; * 10% significance level

For segment 1, the coefficients of all five AES attributes are significant and the segment membership model parameters reveal that higher education, higher environmental consciousness and larger farm holdings (defined here as those farms with more than 200 ha of land) increases the probability that the respondent belongs to segment 1. For the second segment, all the AES attributes are also highly significant determinants of choice and the segment membership coefficients show that older farmers, households that rent the majority of their holdings, and households that rely mainly on the farm for income are more likely to belong to this segment. It is found that 59% of the sample belongs to segment 1 and 41% belongs to the second segment. AES participants are slightly more highly represented in segment 1 (56%).

Of significant interest are segment specific WTP estimates, reported at the bottom part of Table 7 all of which highly are statistically significant. While the direction of preferences are similar across the two segments (the WTP estimates all have the same sign), the relative magnitudes of the WTP estimates show the presence of substantial heterogeneity in preferences across the segments. Farmers in segment 2 exhibit a higher disutility for longer contracts, a substantially higher utility for flexibility and markedly greater disutility for paperwork compared to segment 1. Respondents in segment 1 are characterised as "low-resistance adopters" as their participation in schemes such as those portrayed in the choice experiments could be achieved by the offer of relatively low financial incentives. Compared to respondents in segment 2, these farmers are likely to demand far lower levels of compensation for: longer

contracts (about 0.5% of current per hectare payments for every additional year on the contract), reduced flexibility over land and measures (both around 6%) and high amounts of paperwork (about 3%). It seems reasonable that farmers with higher education levels (most likely to be members of segment 1) are less "worried" about paperwork than less educated ones (more likely to be members of segment 2). Also, as may be expected, larger farms (more likely to be in segment 1) seem to suffer less disutility from reduced flexibility over land or measures compared to smaller farms (more likely to be in segment 2).

It is not surprising that the "types" of farms/farmers that have a higher probability of belonging to segment 1 mirror those that have been identified in the adoption literature being more likely to participate in AES. Various studies have found that youth, higher education, and positive attitudes towards the environment are significant pre-disposing factors to participation in AES (e.g. Wilson, 1997; Wynn et al., 2001). Other studies have also found that increasing farm size has a significant and positive influence on the probability of enrolling in AES (e.g. Vanslembrouck et al., 2002; Ducos et al., this issue). Farmers in segment 2 can be characterised as "high-resistance adopters" as they are more likely to suffer greater disutility from being in a scheme and require higher financial incentives as compensation. Based on the model, the incentives required by the high-resistance adopters ranged from an extra 6% of current per hectare payments for every additional year added to the length of a contract, to an additional 30% for contracts offering less flexibility over the area of land entered into to the scheme. As shown by the parameters of the segment membership model, the members of this segment are likely to be older, less well educated, less environmentally aware, and occupy smaller farm holding—again, all of these have been shown in previous studies as having a negative influence on AES adoption. Farmers in this segment are also more likely to be tenants and to rely on their farms for a greater proportion of their incomes.

Conclusions

A consistent pattern of farmer preferences was observed across our case study areas, and was common both to those who currently belonged to AES and those who did not. Predictably, results showed that, in general, farmers require greater financial incentives to join schemes with longer contract lengths, or that offer less flexibility or higher levels of paperwork. More interesting were the results of the latent class model which identified a large segment of farmers who require relatively small incentives to compensate them for the disutility associated with those particular aspects of joining a scheme. A greater number of existing scheme participants were found to belong to this 'low-resistance adopter' segment than to the contrasting 'high-resistance adopter' segment. Members of the low-resistance segment were found to have similar characteristics to those farmers identified in previous studies as being most likely to be participants in an agri-environment scheme. These farmers tended to be better educated, younger and to have larger farm holdings and more positive attitudes to the environment than members of the high-resistance segment. Members of the latter were more likely to be tenant farmers and to rely of the farm business for a greater proportion of their household incomes.

When looking at farmer factors that influenced preferences for contract length, the mixed logit model gave comparable findings to the LCM. In particular, the model suggested that farmers with successors, tenant farmers and those with smaller holdings all tended to prefer the added flexibility of shorter rather than longer contracts.

Therefore, both models suggest that, perhaps predictably, most farmers would prefer schemes to be less restrictive in the elements examined by this study. However, contracts that are shorter in duration and that allow farmers greater flexibility over land and measures may compromise the environmental effectiveness of a scheme. Indeed, more lengthy contracts may be desirable in schemes where the environmental objectives are long term, as is often the case, for example, with measures designed to aid biodiversity conservation or landscape change. Further, more restrictive scheme designs (such as the whole-farm approach) can help to avoid problems such as adverse selection and moral hazard where farmers may be able to enrol only those portions of land in the scheme that would yield the lowest environmental benefits.

In these circumstances, our research confirms the assumption that higher payments could be offered to induce farmers to accept longer and less flexible contracts. Despite this, there is also evidence that a significant proportion of farmers require relatively low levels of incentive to participate in schemes with more restrictive prescriptions and higher administration costs. This may, of course, reflect the lower magnitude of the opportunity costs of participation for these farmers rather than any high degree of support for AESs. Farmers in this category tend to have distinctive characteristics compared to the 'high resistance adopter' segment and it may be possible to use national agricultural census data to identify how common such farmers are in a given area. Within the constraints of international trade agreements, such information, would allow policy makers to consider the possibility of geographically specific payment strategies for AES. For example, to ensure better participation in a more restrictive scheme, higher incentives could be made available in areas characterised by a large population of 'high-resistance adopters'. Less generous incentives may achieve desired participation levels if less restrictive scheme parameters are adopted or in areas where there are likely to be more 'low-resistance adopters'. Further research is required to identify how closely correlated such payments would be to the opportunity costs of participation.

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