Agri-environmental schemes in the European Union: the role of ex ante costs

Jack Peerlings* and Nico Polman**

[*] **Agricultural Economics and Rural Policy Group, Wageningen University**
[**] **Researcher at the Agricultural Economics Institute, The Hague, The Netherlands**
Nico.Polman@wur.nl

Paper prepared for presentation at the 107th EAAE Seminar *"Modelling of Agricultural and Rural Development Policies"*. Sevilla, Spain, January 29th -February 1st, 2008

Abstract

The purpose of this paper is to analyse land allocation between competing agri-environmental contracts taking into account institutional issues and farm household and farm characteristics. We consider a Biodiversity Protection Contract, Landscape Management Contract and a Restriction on Intensive Practises Contract. The paper shows that it is important to study the choice for an agri-environmental contract in combination with the choice for other agri-environmental contracts. The reasons being that a unit of land can only be allocated to one contract (although a farm can select more than one contract) and perceived relative marginal costs of contracts can change if institutional settings and farm household and farm characteristics alter. The model uses a two stage method. In the first step the probability of contract choice is determined. In the second stage these probabilities are linked to ex ante costs (including transaction costs) and optimal contract choice is determined.

Key words: Agri-environmental contracts, transaction costs, contract choice

1. Introduction

In the European Union (EU), the purpose of agri-environmental schemes (AES) is to promote a more environmental friendly way of farming. A mix of agri-environmental measures is often brought together in an agri-environmental contract to address one or more environmental objectives. These measures generally complement each other, but they can conflict internally within the mix and externally with other agri-environmental policies (Jones, 2005; 44). A basic principle of agri-environmental contracts in the EU is that they are optional for farmers. The basic idea is that this promotes constructive cooperation and a positive attitude to wildlife and landscape on the part of farmers, in respect it has an advantage over statutory environmental obligations (European Commission, 2005: 9). Member states have a wide degree of discretion in how to implement agri-environmental contracts (European Commission, 2005: 9). This means that institutional issues within member states as well as attitudes have a great influence on agri-environmental contracts' uptake and their environmental effectiveness. Policy makers aiming at improving the agri-environment have an interest in the reasons why farms choose a specific agri-environmental contract, or why they do not contract, in order to design contracts that increase contracting.

To analyse contract choice several studies focus on the characteristics of farms and farmers that conclude agri-environmental contracts, e.g. Crabtree et al. (1998); Beedell and Rehman (2000); Wenum (2002); and Wynn et al. (2001). These studies typically use logit or probit models. Van Huylenbroeck et al. (2000) and Peerlings and Polman (2004) developed simulation models to evaluate the impact of agri-environmental programmes on production and economic results of dairy farms in order to better explain contract choice. The first group of studies is not able to determine how much land is contracted, the latter two studies fail to include institutional issues and farm household characteristics in their models. None of the studies explicitly analyses how contracts compete. Competition comes from the fact that a farm can only choose one contract on a unit of land while it can conclude more than one contract.

The purpose of this paper is to analyse agri-environmental contract uptake taking into account institutional issues, farm and farmers' characteristics and competition between contracts[1]. To reach this goal a model that allocates land between competing agri-environmental contracts for individual farms will be developed.

[1] This document presents results obtained within the EU project SSPE-CT-2003-502070 on Integrated tools to design and implemented Agro Environmental Schemes (http//:merlin.lusignan.inra.fr/ITAES). It does not necessary reflect the view of the European Union and in no way anticipates the commission's future policy in this area.

In the paper we assume that farms maximize utility from profit (income). This profit is earned by selecting a mix of different types of contracts (or not contracting). Uptake is assumed to depend on the probability that an individual farm will select a specific contract type. Probabilities are derived using a multinomial logit model and are assumed to depend on institutional issues and farm and farmers' characteristics. Selecting a contract is assumed to imply allocating land to a specific contract. An economic model is used to model land allocation. In this paper three different contract types are distinguished: landscape management; biodiversity protection; and restrictions on intensive practices. The model is applied to 848 farms in study areas in Belgium, France, Finland, Italy and the Netherlands.

A theoretical model of contract choice is presented in Section 2. Section 3 discusses the data. Section 4 discusses the empirical model. Section 5 gives the estimation results. In Section 6 the effect of institutional design and contract payments on farm choice between agri-environmental contracts is analysed. Finally, Section 7 concludes.

2. Theoretical model

The theoretical model is presented in equations 1-6. It is assumed that farms maximise utility (see equation 1) derived from the individual contracts selected. Utility from contracting is represented by an additive utility function. Selecting a contract implies that farms allocate (part of) their land to that contract. If a hectare of land is used for contract A it cannot be used for contract B. However, we will assume that more than one contract can be selected by one farm. So the model can be perceived as a land allocation model. The utility maximization problem of an individual farm is given by:

$$\underset{A_{si}}{Max} \quad E[U_i] = \sum_{s=1}^{S} U_{si} \tag{1}$$

Subject to:

$$U_{si} = 1 - \exp(-\pi_{si}) \qquad \forall_{s \in S} \tag{2}$$

$$\pi_{si} = p_{si} \times A_{si} - C_{si}(A_{si}, \gamma_{si}) \qquad \forall_{s \in S} \tag{3}$$

$$\gamma_{si} = \gamma_{si}(F, Q, I, S, V) \quad \sum_{s=1}^{S} \gamma_{si} = 1 \quad 0 \le \gamma_{si} \le 1 \quad \forall_{s \in S} \tag{4}$$

$$\sum_{s=1}^{S} A_{si} = \overline{A}_i \tag{5}$$

$$A_{si} \ge 0 \qquad \forall_{s \in S} \tag{6}$$

Where:

U_i utility of farm *i*; E expectations operator; γ_{si} probability that contract *s* is selected by farm *i*; U_{si} utility of farm *i* of selecting contract *s*; *F* vector of farm's characteristics; *Q* vector of farmer's characteristics; *I* vector of farm's institutional performance; *S* vector of farm's social capital; *V* vector of extension variables; π_{si} profit of selecting contract *s* by farm *i*; p_{si} compensation paid for selecting 1 hectare of land of contract *s* by farm *i*; A_{si} land used for contract *s* by farm *i*; C_{si} total cost of contract s by farm i; $\overline{A}_i$ land availability of farm *i*.

Equation 2 shows that utility per contract is derived from profit (income) from that contract. Not contracting is also seen as a contracting possibility with zero profit. As functional form the negative exponential utility function has been selected. This implies utility is an increasing function of profit. The increase in marginal utility of profit is decreasing with the level of profit. We ignore here profit from other activities.

Equation 3 shows that profit from a contract equals revenue minus costs. Revenue equals payments per hectare times the number of hectares contracted. Costs of contracting include transaction costs, costs of inputs needed to meet the requirements set by the contract (e.g. labour) and opportunity costs of production (forgone profit). Unfortunately these costs are unknown in this research. We will assume that contract and farm specific cost functions can be specified that depend on the area contracted and the probabilities to contract. It is assumed that costs are increasing in area contracted and decreasing in the probability to contract. A high probability is assumed to be correlated to low (expected) costs of contracting while a low probability is linked to high (expected) costs of contracting. Farm characteristics that increase the probability are likely to correlate with low actual costs, farmers' characteristics with perceived costs. Also institutional issues have a link with both actual and perceived costs.

Equation 4 gives the probabilities to select a contract as a function of farm characteristics, farmers' characteristics and institutional issues (see section 3 for a description of the variables). So, the probabilities should be interpreted as the probability that given a number of explanatory variables a specific contract is chosen. There are two strong assumptions made here. First, the probability to contract is also influenced by contract characteristics as contract payment, duration, types of measures, etc. these are not taken into account because of lack of information. Contract payments known are farm-specific and only known for those contracts a farm already has selected. So if a contract is not selected information is lacking. Obtaining contract characteristics is also difficult because the contracts considered are actually group of contracts of a certain type. Second, we assume an inverse relationship between the probability and costs.

Equation (5) shows that the total availability of land equals the hectares used under different types of contracts (or not contracting). Equation (6) gives the non negativity constraints for land.

Because utility is increasing in profit the higher the profit the higher the utility. So utility maximisation can be replaced by profit maximisation for each individual contract. The optimal amount of land contracted by farm i can be found by taking the first order derivatives of equation 3:

$$\frac{\partial \pi_{si}}{\partial A_{si}} = p_{si} - C'_{si}(A_{si}, \gamma_{si}) = 0 \qquad \forall_{s \in S} \qquad (7)$$

Where:

C'_{si} marginal cost of contract s by farm i.

Equation 7 shows that in the profit maximising optimum marginal costs of selecting a contract equal the contract payment. Solving equation (7) gives the optimal amount of land allocated to contract s by farm i. Substituting the optimal amount of land in the model (equation 1-6) gives profit and utility from contracting for each farm.

3. Data

In 2005, a survey was carried out in specific areas in Belgium, France, Finland, Italy, and the Netherlands[2]. The used questionnaire addresses issues concerning their farm, their perception of agri-environmental contracts, information on their income, social capital, motivational issues and hobbies. In addition several questions were asked to contracting farmers on how they manage their contracts and their required farming practices. Contracting farmers were over represented in the sample on purpose in order to get better information on agri-environmental contracts. For all these areas participants and non-participants were interviewed face to face (990 farmers in total). Response rates differ for the regions. In this paper data on 848 farms are used, 236 Belgium, 93 Finnish, 262 French, 132 Italian and 125 Dutch farms.

From the questionnaire several variables were constructed. They describe the farming family (education level and age), their production system (farm legal status, farms size in Standard Gross

[2] The survey was carried out within the ITAES project, see footnote 1.

Margins (SGM[3]), etc.), the professional environment (involvement in agricultural organizations, the use of extension services), social capital (trust and participation in networks). Some variables clearly describe the farmer and his farm. These variables serve as control variables. A second set of variables focuses on information related variables. The third set addresses the relation with the contracting partner (= the government). The final set of variables addresses social capital. Table 1 gives an overview of the data used for the estimation.

Table 1. Overview of data used for estimation, (number of observations = 848), 2005

	Mean	Std. error
Farm characteristics		
Percentage SGM in dairy production	33.3	30.5
Percentage SGM in beef production	1.8	5.3
Farm size in SGM	16.7	45.9
Dummy indicating whether farm is organic	0.9	
Number of technical changes past five years	3.3	1.8
Dummy indicating whether farm is expected to be continued the next 10 years	0.8	
Farmers' characteristics		
Dummy age farmer between 40-55+	0.5	
Dummy age farmer older than 55+	0.2	
Dummy indicating medium education level+	0.9	
Dummy indicating high education level+	0.1	
Dummy indicating whether off-farm income is more than 50% of total income	0.3	
Institutional performance and trust		
Score on 6 items related to institutional design[4]	2.6	0.5
Score indicating the government can be trusted[5]	2.3	0.6
Dummy indicating AES will remain the same over time[6]	0.2	
Social capital		
Dummy indicating that most people can be trusted[7]	0.7	
Dummy indicating the farmer often participates in activities of non-agricultural organizations	0.3	
Dummy indicating the farmer often participates in activities of agricultural organizations	0.5	
Extension services		
Dummy indicating use of public extension	0.6	
Dummy indicating use of private extension	0.7	

The contracts mentioned are different with respect to operational requirements in the contract. We distinguished three types of contracts: focusing on landscape management, biodiversity protection and the restriction of intensive practices (see also Bonnieux et al., 2002). Landscape management focuses

[3] The standard Gross Margin (SGM) of a crop or livestock item is defined as the value of output from one hectare or from one animal less the cost of variable inputs required to produce that output. For each region all crop and livestock items are accorded an SGM. To avoid bias caused by fluctuations, e.g. in production (due to bad weather) or in input/output prices, three year averages are taken.

[4] Average score on 6 items on a Likert scale related to institutional design:
- "The eligibility rules are fair"
- "The procedures for application are easy"
- "The rules and requirements are easy to understand"
- "The intended environmental benefits are clear and easy to understand"
- "It is easy to find the right person to contact in the administration when there are problems"
- "Regarding AES, administration behavior is fair and responsible"

[5] "The … can be trusted" where ... stands for average score on trust in agricultural administration, environmental administration, and EU (on a Likert scale)

[6] The current policy rules and regulations will remain constant over a longer period.

[7] See footnote 4 where … stands for most people

on the maintenance of landscape elements. Biodiversity protection refers to contracts like extensive management of grassland and management to promote flora and fauna. Winter cover on arable land and reduced use of fertilizers are examples of the restriction of intensive practices.

Farm and farmer characteristics are relevant for the uptake of AES. From previous studies follows that farm size and farm type influence the uptake of AES (e.g. Wynn et al, 2001 and Vanslembrouck et al., 2002). The type service delivered by the farmer is different depending on farming type. Implementing biodiversity protection contract on a specialized dairy farm will be different from implementing the same contract on a specialized arable farm. Farmers who develop their farm in a direction not related to AES are expected to be less willing to be involved in agri-environmental contracts. Wynn et al. (2001) show also the importance of the "fit" of the scheme with the farm.

Based on the literature, we included a number of farmer characteristics in the model (see for example, Wilson, 1997). Dummy variables for age and education are added to the model. Reference categories for age and education are dropped from the model in order to avoid a dummy trap (Woolridge, 2006). Further, a variable for off-farm income is added to represent labor availability.

Extension services, both private and public are expected to influence uptake. The questions on extension services did not focus on AES and were asked in a general way. It can be expected that information on AES are only part of these extension services. Private extension follows from feed suppliers, banks, researchers, and processing industry. Public extension will also follow the complete range of governmental regulation including AES and therefore a positive influence is expected on the uptake of AES. Given the type of private extension (focused on general farming practices) it is expected that these will negatively influence the uptake of AES. A positive assessment of institutional design is expected to increase the uptake of AES.

Social capital is measured using the following indicators: (1) trust in general; (2) trust in the government (3) participation in social networks; (4) participation in agricultural networks. Higher levels of trust in general and trust in the government (as contracting partner) are also expected to increase the uptake. The social networks are more general networks not related to agriculture but for example to involvement in sports clubs. Agricultural networks focus on improving agricultural practices. The more general networks are thought to increase the probability of uptake AES because these farmers feel a large social responsibility. Participation in agricultural networks is expected to negatively influence uptake because the farmers are more oriented towards improving on agricultural operation.

4. Empirical model

In the empirical model we first have to derive the probabilities of contracting as a function of explanatory variables. From an econometric point of view there is no obvious solution for estimating a model where farms have more than one choice that do not exclude each other.

A possibility would be to estimate a set of logit or probit models (see Verbeek, 2004: 190-192; Greene, 2008: 772-775) to determine the probabilities of contracting for each contract separately. So in case of selecting contract A, B or not contracting one estimates two logit or probit models (1) one for choosing contract A (and not choosing contract A) and one for (2) choosing contract B (and not choosing contract B). This would lead to a system of (two) equations. An alternative would be to estimate a multivariate probit model (see Greene, 2008: 826-831). With the multivariate probit model again there are several decisions, each between two alternatives. For each choice a probit model is estimated, however, it is assumed that the errors terms of the equations are correlated. This implies that there are unobserved variables affecting the choices made. In the logit, probit and multivariate probit model the explanatory variables can but are not necessarily identical between equations (choices made). So each choice can have its own explanatory variables.

The disadvantage of the logit, probit and multivariate probit models for the purpose we want to use it is that probabilities are difficult to interpret because a normalisation of probabilities is missing (see Verbeek, 2004: 204-205). Each contract is compared to all other choices. In other words the probability of choosing contract A cannot explicitly be linked to the probability of choosing contract B. In a multinomial logit model (see Verbeek, 2004: 208-210; Greene, 2003: 843-847) such a normalisation takes place because the probability of selecting a contract is determined relative to the probabilities of other possible choices (so all probabilities are known and can be related). Probabilities therefore also add up to 1. Disadvantage of the multinomial logit is that it assumes that one contract is selected (just as in a normal logit or probit). Running a multinomial logit for each choice separately is not an option because each choice is already compared to the other choices. We solved this problem by including a farm in the dataset for every time it selects a contract. So if a farm selects both contract A and B this farm appears twice in the dataset, one time selecting contact A and the other time contract B. This is similar to what we do when we estimate a set of logit or probit model or the multivariate probit model and assume that in each equation we have the same explanatory variables.

With a multinomial logit function the probability that a farm i selects a contract (or not contracting) s (γ_{si}) is given by:

$$\gamma_{si} = \frac{\exp(\alpha_s^{'} x_i)}{1 + \sum_{s=1}^{S-1} \exp(\alpha_s^{'} x_i)} \qquad \forall_{s \in S} \quad \alpha_S = 0 \tag{8}$$

Where:

α_s vector of coefficients for contract s; x_i vector of explanatory variables for farm i.

In equation 8 coefficients are contract specific while the explanatory variables are identical for all contracts but their value is farm-specific. Equation 8 guarantees that the probabilities lie between 0 and 1 and add up to 1. An assumption made when using the multinomial logit model is that it assumes that conditional upon observed characteristics the probabilities of any two alternatives are independent (the independence of the alternatives assumption, see Greene, 2008: 847). This is particularly troublesome if two or more alternatives are very similar. However, given that the alternative contracts are rather different (this is how they are defined, see data section) we maintain this assumption. This assumption is also made if we would estimate a system of logit or probit models or estimate the multivariate probit model. A Wald test confirms the independence of the alternatives assumption.

Having estimated the probabilities to contract and assuming that these probabilities influence cost of contracting we can specify a farm and contract specific cost function. For the cost function in equation 4 we take the following function:

$$C_{si} = \frac{1}{(1-\gamma_{si})\beta_{si}} \exp\left[(1-\gamma_{si})\beta_{si} A_{si}\right] - \frac{1}{(1-\gamma_{si})\beta_{si}} \qquad \forall_{s \in S-1} \tag{9}$$

Where:

β_{si} vector of farm and contract specific coefficients.

Marginal cost equal:

$$C_{si}^{'} = \exp\left[(1-\gamma_{si})\beta_{si} A_{si}\right] \qquad \forall_{s \in S-1} \tag{10}$$

We know that if a farm is contracting in the profit maximising optimum marginal revenue (contract payment) equals marginal cost. So, substituting marginal cost by contract payment p_{si} and solving for the optimal amount of land contracted gives:

$$A_{si} = \frac{1}{(1-\gamma_{si})\beta_{si}} \ln p_{si} \qquad \forall_{s \in S-1} \tag{11}$$

So the amount of land under contract s increases if the contract payment goes up (but with a decreasing rate) and the probability of selecting contract s increases. Notice that if contract payments are zero no land is contracted although there can be a positive probability of contracting land. Also in the multinomial logit there can be a positive probability to select a contract although a farm does not actually select that contract.

Equation 10 shows that contract payments should not be included in the multinomial logit model because marginal cost and contract payment are equal, and marginal costs are determined by the probabilities.

The amount of land not contracted can be found by adding up the amounts of land under contract and subtracting this amount from the total amount of land:

$$A_{Si} = \bar{A}_i - \sum_{s=1}^{S-1} A_{si} \tag{12}$$

For a farm contracting land we can derive the cost function (equation 9). For this we have to determine the value of β_{si}. Assuming that the actual amount of contracted land equals the utility maximizing amount of land and using equation 11 we can calculate the β_{si}'s:

$$\beta_{si} = \frac{1}{(1-\gamma_{si})A_{si}} \ln p_{si} \tag{13}$$

The β_{si}'s are coefficients of the contract and farm specific inverse marginal cost functions (the land allocation function, equation 12) that equalise the actual amount of land contracted with the calculated amount.

Equations 8-12 make it then possible to calculate, with changing exogenous variables (variables in vector x_i, and contract payments) the optimal amount of land contracted. Using equation 3 and 4 makes it possible to calculate changes in profit and utility.

5. Estimation results

Given that the estimates are difficult to interpret the marginal effects are calculated, see Table 2 (estimation results are available upon request by the authors). They show how a small change in a variable affects the probabilities. In the case of dummy variables the marginal effects indicate the discrete change of the dummy variable from 0 to 1. Marginal effects in Table 2 are calculated using averages for the explanatory variables. Marginal effects will differ between farms because the value of the explanatory variables will differ between farms.

Landscape Management Contract

Results indicate that selecting a Landscape Management Contract is positively influenced by a medium and high education level of the farmer and the participation of the farmer in non-agricultural organisations. Also trust in the government positively relates to selecting this type of contract. A relatively high education level, focus on non-agricultural activities, and trust in the government probably reflect an open attitude towards landscape and wildlife, and therefore, have a positive effect on participation.

The contract is selected less in case of beef farms and participation of the farmer in agricultural organisations. Also being an organic farm and making use of public extension negatively affect selecting a Landscape Management Contract. Participation of the farmer in agricultural organisations and making use of public extension could be indicators for a negative attitude of a farmer towards contracting (‘conservative’ farmers). The negative sign for organic farms could indicate that landscape management contracts and organic farming compete. Landscape Management Contracts imply relatively high marginal costs of farms (reflected by the relatively high contract payments) indicating it is a big step to select such a contract.

Table 2. Marginal effects calculated from the multinomial logit model for not contracting (not), Landscape Management Contract (land), Biodiversity Protection Contract (diversity) and Restriction on Intensive Practices Contract (intensive).

	not	land	diversity	intensive
Farm characteristics				
Percentage SGM in dairy production	-0.000	0.000	0.002*	-0.002*
Percentage SGM in beef production	0.001	-0.006*	0.004*	0.000
Farm size in SGM	0.001*	-0.000	-0.000	-0.000
Dummy indicating whether farm is organic+	-0.160*	-0.064*	0.044	0.181*
Number of technical changes	-0.026*	-0.001	0.009	0.018*
Dummy indicating whether farm is expected to be continued the next 10 years+	-0.014	-0.008	0.035	-0.014
Farmers' characteristics				
Dummy age farmer between 40-55+	0.087*	-0.007	0.020	-0.100*
Dummy age farmer older than 55+	0.068*	0.007	-0.017	-0.058*
Dummy indicating medium education level+	0.021	0.028*	-0.003	-0.046
Dummy indicating high education level+	-0.009	0.062*	-0.024	-0.029
Dummy indicating whether off-farm income is more than 50% of total income+	-0.125*	-0.003	0.042	0.087*
Institutional performance and trust				
Score on 6 items related to institutional design	-0.158*	0.009	0.080*	0.068*
Dummy indicating the government can be trusted	-0.050*	0.017*	-0.017	0.050*
Dummy indicating AES will remain the same over time+	-0.072*	0.008	0.082*	-0.018
Social capital				
Dummy indicating that most people can be trusted+	-0.011	-0.005	-0.017	0.033
Dummy indicating the farmer often participates in activities of non-agricultural organization+	-0.068*	0.033*	0.013	0.021
Dummy indicating the farmer often participates in activities of agricultural organization+	-0.084*	-0.028*	-0.015	-0.040
Extension services				
Dummy indicating use of public extension+	-0.131*	-0.020*	0.042*	0.110*
Dummy indicating use of private extension+	0.083*	0.009	-0.071*	-0.021

*: Significant at 10% level.
+: Marginal effects is for discrete change of dummy variable from 0 to 1.

Biodiversity Protection Contract

The probability to select a Biodiversity Protection Contract is positively related to being a dairy or beef farm. The trust of the farmer in contract design and that the government will not change contract conditions in the future also positively relate to selecting this type of contract.

Making use of private extension services negatively affects contract choice while the use of public extension services has a positive effect.

The Biodiversity Protection Contract is relatively easy to implement on grassland, and therefore, dairy and beef farms are the obvious contractors. The more farmers trust the contract the more it is selected. Results suggest that this type of contract is chosen by conservative farmers, a group that is probably using public extension services more than private extension services, that without too much extra costs can implement the contract.

Restriction on Intensive Practises Contract

The probability to select a contract imposing restrictions on intensive practises is positively affected by being an organic farm. This seems obvious given that organic farms are in general relatively extensive compared to regular farms. Probabilities are also positively affected when farmers have trust in the government and contract design. Also off-farm income and the use of public extension services contribute to an increase in the probabilities that this contract is selected.

The probability that this type of contract is chosen decreases when the farm is a dairy farm and the farmer is old. Unexpectedly the probability also goes down when the farmer believes that there will be no time inconsistencies (contract terms will be changed over time). This is caused by the fact that farmers in that case choose for other contract types first (especially the Biodiversity Protection Contract). This is a consequence of using the multinomial logit model. Although there is a positive coefficient the sign could be negative in Table 2 because the estimated coefficient is small compared to the other coefficients.

Not contracting

The probability of not selecting a contract is positively influenced by being older, farm size (small effect) and using private extension services. It is negatively determined by being an organic farm, the number of technical changes adopted, trust in government and contract design, participation in agricultural and non-agricultural organisations, and the use of public extension services. These results are, not surprisingly, opposite to the reasons for selecting a contract.

6. Simulations and results

6.1 Scenarios

To analyse how the government can increase participation in AES taking into account the competition between contracts there are three possible routes. First, the government can increase contract payments. This will lead ceteris paribus to an increase in participation. Second, is to change contract terms excluding contract payments, as contract duration and measures to be applied. Finally, the government can determine to influence factors that influence contract uptake but are not contract related. In terms of our model the first possibility can be analysed i.e. to increase the payments p_{si}. The second possibility is impossible to analyse with our model because the exact contract conditions are not known because contracts analysed are groups of actual contracts. The latter possibility can be analysed by looking at the possible effects of changes in the variable that represents the perceived institutional design of contracts (which is not contract specific). Moreover, we analyse the possible effect of the variable that represents the trust of farmers that the government will not change contract terms during the course of the contract. So it is the trust farmers have that time inconsistency will not take place. The latter two variables might be influenced by the government by improving communication and being as transparent as possible. Increasing these variables implies an increase in the probability that a contract is selected. However, since the probabilities add up to one it could be that the increase of the amount of land selected for one contract is at the expense of the amount of land selected for another contract.

In order to analyse the effects of these variables we define three scenarios. Results of these scenarios will be compared with the base scenario. In the scenarios we determine contract choice for each individual farm in the sample (848 farms) using the model described in Section 4 (plus the estimated model of Section 5) and individual farm data from the sample. Notice that the outcomes of the model in the base scenario are exactly equal to the initial situation with respect to the farm specific amount of land selected for each contract.

Scenario I:

In order to look at the possible effects of an increase in payments we increase the payments for all three contracts by10%.

Scenario II:
In order to look at the effects of an increase in perceived institutional performance we increase the variable representing trust in contractual design by 1. Since this variable represents a score on 6 items the total maximum value remains 6 (so there is no increase for farms already scoring the maximum value). This variable is not contract specific.

Scenario III:
In order to look at the effects of (perceived) time inconsistency for farms we change for those farms that have a value 0 for this dummy variable its value into 1.

In the remaining Section results of the three scenarios are presented. Since it is not convenient to present the results for 848 farms we aggregate the outcomes for each country.

6.2 Results

Base scenario
Results with respect to land allocation and profit for the base scenario are presented in Tables 3 and 4.

Table 3. Initial allocation of land over contracts in shares (base scenario).

	Not contracting	Landscape management	Biodiversity	Intensity	Total
Belgium	0.785	0.001	0.035	0.179	1
Finland	0.514	0.000	0.022	0.464	1
France	0.664	0.028	0.150	0.157	1
Italy	0.770	0.010	0.008	0.212	1
Netherlands	0.628	0.009	0.307	0.056	1
Total	0.693	0.012	0.105	0.191	1

Table 4. Initial profit per farm (base scenario).

	Not contracting	Landscape management	Biodiversity	Intensity	Total
Belgium	0	15.45	348.41	917.46	1281.33
Finland	0	3.00	60.01	87.43	150.44
France	0	148.92	1790.64	1119.62	3059.18
Italy	0	471.91	377.07	1278.92	2127.90
Netherlands	0	199.15	996.69	989.54	2185.37
Total	0	153.46	862.40	955.78	1971.64

The land allocation (Table 3) reflects the actual land allocation. We see large differences between countries with respect to land allocation. However, in all countries most land is allocated to non-contracting. The Restriction on Intensive Practices Contract is the second most important land allocation category (except for the Netherlands where the Biodiversity Protection Contract is most important) The Landscape Management Contract is least important for all countries except for Italy. Table 4 shows the profit earned with each contract. Profit is determined by land allocation (see Table 3), contract payments, and probabilities to contract (higher probabilities, less costs, more profit). On average the contract payments are lowest for the Restriction on Intensive Practices Contract and the highest for the Landscape Management Contract. The Biodiversity Protection Contract takes an intermediate position. For the probabilities the opposite is the case. Profits show that high contract payments do not compensate for the higher costs. Profits are high for the Restriction on Intensive Practices Contract and Biodiversity Protection Contract.

Scenario 1: Increase in contract payments

An increase in contract payments for one contract increases profit for that contract. However, probabilities of contracting do not change. This implies (see equation 7) that only for the contract that has become more profitable the amount of land contracted increases. This increase is at the expense of land that is previously not contracted. So in the model contract payments do influence the choice whether to contract or not but do not lead to competition between contracts. In Scenario 1 we increased contract payments for all three contracts with 10%. Table 5 and 6 show the effect on land allocation and profit respectively.

Table 5. Change allocation of land over contracts in percentages of base scenario. Scenario 1: 10% increase in contract payments

	Not contracting	Landscape management	Biodiversity	Intensity	Total
Belgium	-0.71	1.49	1.74	2.78	0
Finland	-8.54	1.64	3.64	9.29	0
France	-1.29	4.13	2.15	2.65	0
Italy	-0.52	1.35	1.58	1.77	0
Netherlands	-1.31	1.87	2.28	2.00	0
Total	-1.57	3.44	2.20	4.28	0

Table 6. Change profit per farm in percentages of base scenario. Scenario 1: 10% increase in contract payments

	Not contracting	Landscape management	Biodiversity	Intensity	Total
Belgium	0	11.74	12.03	12.38	12.28
Finland	0	12.17	13.35	19.50	16.90
France	0	13.16	12.58	13.17	12.82
Italy	0	11.71	11.98	12.36	12.15
Netherlands	0	11.99	13.05	11.93	12.42
Total	0	12.20	12.55	12.66	12.56

Results indicate that especially for Finland the increase in contract payments for the Restriction on Intensive Practices Contract leads to a relatively large increase in land allocated to this contract and also results in a relatively large increase in profit. For all countries the increase in land allocated to a contract is less than 10% and in a large number of cases smaller than 2%. ‘Price elasticities’ of land contracted are therefore (much) smaller than one. However, profit increases are larger than 10%. With an increase in land allocated to a contract the extra revenue is larger than the extra cost (however in profit maximizing optimum marginal cost equal marginal revenue). The reason is that also for the land that was contracted before the contract payments increased revenue goes up.

Scenario 2: Increase in institutional performance

If the institutional performance is improved probabilities to contract land increase. This increase is the largest for the Biodiversity Protection Contract and the smallest for Landscape Management Contract. The Restriction on Intensive Practices Contract takes an intermediate position (see Table 2). The increases in probabilities lead to a decrease in marginal cost, and therefore, given the same contract payments, to a larger amount of land contracted (see equation 11, and Table 7).

Table 7. Change allocation of land over contracts in percentages of base scenario. Scenario 2: increase in institutional performance

	Not contracting	Landscape management	Biodiversity	Intensity	Total
Belgium	-2.40	2.45	12.74	8.00	0
Finland	-9.25	0.18	6.62	9.94	0
France	-5.23	1.18	13.96	8.53	0
Italy	-3.56	1.61	9.43	12.48	0
Netherlands	-8.55	0.86	16.44	5.66	0
Total	-4.82	1.22	14.70	9.33	0

Table 8. Change profit per farm in percentages of base scenario. Scenario 2: increase in institutional performance

	Not contracting	Landscape management	Biodiversity	Intensity	Total
Belgium	0	3.31	13.13	7.02	8.63
Finland	0	0.18	7.42	2.36	4.33
France	0	0.68	14.20	7.44	11.07
Italy	0	1.79	10.30	13.29	10.21
Netherlands	0	0.68	16.04	4.51	9.42
Total	0	1.28	14.08	8.05	10.16

Table 2 shows that the coefficients for the marginal effects are positive for all three contracts. This implies that the increase in the amount of land contracted is at the expense of the land that is initially not contracted. Cost curves are farm specific so the effects per farm differ in size. The outcomes per country show for example that the Biodiversity Protection contract is relatively important in France and the Netherlands. The increase in profit (see Table 8) for this type of contract is therefore also relatively large for these countries (cost decrease for all units of land already contracted).

Scenario 3: No time inconsistency

If there is no time inconsistency the probabilities to contract change but the change is not positive for every contract.

Table 9. Change allocation of land over contracts in percentages of base scenario. Scenario 3: no perceived time inconsistency

	Not contracting	Landscape management	Biodiversity	Intensity	Total
Belgium	0.33	2.40	5.55	-2.55	0
Finland	3.75	1.16	5.92	-4.43	0
France	-1.81	0.90	9.54	-1.65	0
Italy	0.10	1.55	6.69	-0.66	0
Netherlands	-5.67	0.82	12.25	-3.61	0
Total	-0.87	1.01	10.21	-2.54	0

Table 10. Change profit per farm in percentages of base scenario. Scenario 3: no perceived time inconsistency

	Not contracting	Landscape management	Biodiversity	Intensity	Total
Belgium	0	2.98	5.81	-3.35	-0.78
Finland	0	1.15	7.51	-3.05	1.25
France	0	0.51	10.37	-2.02	5.36
Italy	0	1.86	5.76	-0.84	0.93
Netherlands	0	0.73	12.04	-3.67	3.90
Total	0	1.27	9.81	-2.39	3.23

Although the coefficient α for time consistency in equation 8 is positive for every contract the probability of selecting an individual contract can decrease because the relative increase can be smaller than for the other contracts. Table 3 shows that the marginal effect for the Restriction on Intensive Practices Contract is negative. Table 3 represents average effects and in the simulation model the marginal effects differ between farms and also do not necessary have the same sign for one type of contract. Results show indeed that with no time inconsistency less land is allocated to the Restriction on Intensive Practices Contract and more to the Biodiversity Protection Contract and to a lesser extent the Landscape Management Contract (see Table 9). We also see a small decrease in the land not contracted although the average marginal effect in Table 3 has a (small) positive sign. Besides the increase in the amount of land allocated to the Biodiversity Protection Contract and Landscape Management Contract profit from both contracts increases (see Table 10). Overall there is an increase in profit. However, for some farms profit exactly falls (see also average for Belgium). This unexpected result comes from the fact that a farm shifts from a contract with an initial high profit but now low profit (because of a lower probability) to a contract that now has a high profit but had a low profit (because of a higher probability). However the new profit is lower than old profit, decreasing overall profit.

7. Discussion and conclusions

The purpose of this paper is to analyse agri-environmental contract uptake taking into account institutional issues, farm and farmers' characteristics and competition between contracts. To reach this goal a model that allocates land between competing agri-environmental contracts for individual farms has been developed.

In the model utility from profit earned with contracting is maximised. Profit is defined as the revenue from contracting (contract payments times the amount of land contracted) minus costs. Costs are actual and perceived costs of contracting like opportunity costs of contracted land, transaction costs, costs to be made to fulfil contract requirements. Since data on perceived and actual costs of contracting are lacking a farm-specific exponential cost function is specified. The cost function runs through two points: no contracting gives zero costs and the point where marginal cost equal contract payments (marginal revenue). Costs are assumed to decrease when the probability of contracting is higher. This probability depends on farm household characteristics, farm characteristics, institutional performance and trust, social capital and the use of extension services. All these variables are assumed to relate to both perceived and actual costs of contracting.

As expected we find that an increase in contract payments increases the amount of land contracted. In the model a change in contract payments for one contract only increases the amount of land under that specific contract (at the costs of the area not contracted). We also find that an improvement in institutional performance of contracts increases the amount of land contracted. It is not possible to analyse the effects of institutional performance of individual contracts because the contracts simulated are aggregates of real contracts and the contracts are of similar institutional design. Real contracts however would not change the basic message of this paper and would require a larger number of observations. A change in institutional performance increases especially the land allocated to the Biodiversity Protection Contract and to a lesser extent the amount of land allocated to the Restriction on Intensive Practises Contract. A reduction in time inconsistency increases the amount of land contracted allocated to the Biodiversity Protection Contract and Landscape Management Contract but decreases the amount of land allocated to the Restriction on Intensive Practises Contract. This is caused by the fact that the increase in probabilities (and associated cost reduction) for the first two contracts is at the expense of the Restriction on Intensive Practises Contract.

A caveat of the model is that contracts that in the dataset are not selected will not be selected in the simulations because it was not possible to specify the farm and contract cost function. Despite this caveat the model is a flexible tool to study contract choice because it includes a wide variety of explanatory variables in combination with utility maximising behaviour of farmers.

This paper indicates that it is important to study the choice for an agri-environmental contract in combination with the choice for other agri-environmental contracts. Reducing time inconsistency can e.g. lead to the unexpected result that the choice for an agri-environmental contract decreases because other agri-environmental contracts become more attractive. This implies that in order to design effective and efficient policies knowledge about locally existing agri-environmental policies, farming systems and preferences of farmers is needed.

References

Beedell, J. and Rehman, T. (2000). Using Social-psychology Models to Understand Farmers' Conservation Behaviour. *Journal of Rural Studies* 16, 117-127.

Bonnieux F., Dupraz, P. and Retière, C. (2002). Farmer's supply of environmental benefits. In: Vardal, E. (ed.) Multifucntionality of Agriculture. Seminar Proceedings, February 16-18, Department of Economics of the University of Bergen- Research, Council of Norway: 105-133.

Crabtree, B., Chalmers, N. and Barron, N. (1998). Information for Policy Design: Modelling Participation in a Farm Woodland Incentive Contract. *Journal of Agricultural Economics* 49(3), 306-320.

European Commission (2005) Agri-environment measures; overview on general principles, types of measures, and application. Brussels.

Greene, W.H. (2008). Econometric analysis. Prentice-Hall, Upper Saddle River.

Van Huylenbroeck, G., Jacobs, G. and Vanrolleghem, P. (2000). A simulation model to evaluate the impact of environmental programmes on dairy farms. *International Transactions in Operational Research* 7, 171-183.

Jones, D. (2005) Evaluating Agri-environmental policy in the OECD. In: OECD Evaluating Agri-environmental policies; design, practice and results. Paris.

Ozanne, A., Hogan, T. and Colman, D. (2001). Moral hazard, risk aversion and compliance monitoring in agri-environmental policy. *European Review of Agricultural Economics* 28, 329-347.

Peerlings, J. and Polman, N. (2004). Wildlife and landscape services production in Dutch dairy farming; jointness and transaction costs. *European Review of Agricultural Economics* 31, 427-449.

Vanslembrouck, I., G. Van Huylenbroeck, and W. Verbeke, 2002, Determinants of the willingness of Belgian farmers to participate in agri-environmental measures. *Journal of Agricultural economics* 51(3): 489-511.

Verbeek, M. (2004). *A guide to modern econometrics*. John Wiley & Sons, Chichester.

Wenum, J. van (2002). Economics Analysis of Wildlife and Conservation in Crop Farming. Dissertation Wageningen University.

White, B. (2002). Designing voluntary Agri-environmental policy with hidden information and hidden action: a note. *Journal of Agricultural Economics* 53(2), 353-360.

Wilson, G.A. and K. Hart, 2001, Farmer participation in Agri-environmental schemes: towards conservation oriented thinking? *Sociologia Ruralis* 41(2): 254-274.

Wynn, G., Crabtree, B. and Potts, J. (2001). Modelling farmer entry into the environmentally sensitive area schemes in Scotland. *Journal of Agricultural Economics* 52(1), 65-82.

Wooldridge, M.J., 2002, Econometric analysis of cross section and panel data. MIT, Cambridge, Massachusetts, 752 pp.