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**The asset specificity issue in the private provision of environmental services:  
Evidence from agro-environmental contracts<sup>1</sup>**

G eraldine DUCOS\* and Pierre DUPRAZ\*

\*French National Institute for Agricultural Research (INRA), Department of Economics,  
Rennes, FRANCE

**ABSTRACT**

The agro-environmental contract is a widely used policy-instrument in Europe dedicated to produce environmental services in rural areas. This is a contract between the State and the farmer who benefits a compensation to comply with environmental friendly practices he freely chooses. Since asset specificity has a major role on environmental outcomes, it is crucial to identify the driving factors of farmers' behaviour as regard to specific practices. Despite a large empirical literature on adoption behaviour, the choice over asset specificity has not been explored yet. This paper addresses this issues by assuming a utility maximizing farmer who compares practice compensation payment with compliance costs. Given that private transaction costs are not taken into account in the calculation of compensation payments, their variability across practices is expected to affect farmers' choice. By identifying conditions in which these costs vary, we derived testable propositions about these conditions' effect on the choice over asset specificity. The empirical analysis is based on a sample of 328 French farmers interviewed in 2005. Estimations support that distrust in the State, uncertainty stemming from the opacity of public decisions and the non-similarity of transactions have a significant negative effect on the probability farmers choose specific assets.

**Key words:** Agro-environmental contract, asset specificity, endogeneity, transaction costs

**JEL classification:** D23, Q12, Q28

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## **I. INTRODUCTION**

The agro-environmental contract is a widely used policy-instrument in Europe dedicated to produce environmental services in rural areas. These services are, for instance, water quality improvement (towards low nitrates concentration), landscape, or biodiversity. The State designs the form of offered contracts: flexibility<sup>2</sup>, duration, eligibility, menu of environmental friendly practices and corresponding compensation payment rates. The farmer's voluntary participation is compensated if he complies with more environmental friendly practices than what is mandatory. Every farmer is free to choose practices in a menu of pre-selected practices by the State according to their characteristics, among which involved specific assets have a major role. Indeed, specific investments permit cost savings to be realized but such investments are also risky, in that specialized assets cannot be redeployed without sacrifice of productive value if contracts should be interrupted or prematurely terminated (Williamson, 1985). This constitutes a hold up problem from which difficulties of writing contracts contingent on all important future events and the fact that these contracts can be renegotiated may lead to high transaction costs. Transaction costs should then be taken into account in the decision over what level of asset specificity to invest in.

For environmental objectives to be reached, it is crucial the farmer prefers specific investments such as timely and site adapted environmental friendly practices, specialized planting equipment, or advanced agronomic skills. Most of the time, these changes lead the farmer to fully adapt his farming production system, which represents an important and long term investment. Since the State is the only demander of environmental services in rural areas, the value of these investments highly depends on the State-farmer relationship and set both parties in a hold-up situation. At the present time, we observe a low adoption rate of agro-environmental contracts, and enrolled environmental friendly practices are low asset specific. Consequently, environmental outcomes are expected to be low. The objective of this study is thus to enhance the understanding of farmers' behaviour when they face agro-environmental contracts focusing on their choice over different environmental friendly practices associated to different asset specificity levels.

Several studies have examined factors influencing farmers' adoption. Four main determinants have been identified, namely (i) farmer and farm household characteristics, (ii) farm biophysical characteristics, (iii) farm financial/management characteristics, and (iv) exogenous factors such as information availability, sources of information, society social capital (Knowler and Bradshaw, 2007). However, except from Bekele and Drake (2003), none have distinguished different conservation practices and their related adoption factors. As regard to Bekele and Drake's work, they studied farmers' choice over different soil and water conservation practices but did not distinguish them from their asset specificity level and thus did not consider the possible hold-up issue and related transaction costs. The aim of this paper is to determine the role of asset specificity in farmers' choice and to identify what determines farmers' choice towards specific practices.

The empirical analysis is based on farmers' choice modelling. Facing different environmental friendly practices, with or without compensation payments, we assume each farmer select the practice that maximises his utility. However, in this present case study, the compensation payment only covers "operational costs", i.e. additional costs and profit foregone resulting from the farm technology adaptation to the commitment made. Transaction costs are thus not

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<sup>2</sup> A contract is said to be flexible when some terms are left open to ex post renegotiations.

included. With such a payment pattern, all proposed compensated environmental friendly practices are expected to attract a good share of farmers if transaction costs borne by the farmers are negligible. Given that the different practices are associated to different asset specificity levels, this should induce different levels of transaction costs borne by the farmer, and therefore should affect practice uptake rate. However, since transaction costs and asset specificities are endogenous in the farmer's decision, such differences are not directly observable but are expected to be revealed by the statistical effect of transaction cost determinants. The interpretation of the results requires thus a theoretical detour on transaction cost economics from which we identified five principal determinants of transaction costs, namely trust, bounded rationality, utility in the transaction, uncertainty and the similarity of transactions. Propositions such as "the more the farmer trusts in the State, the higher the probability he chooses specific assets, *ceteris paribus*" can then be stated to relate estimated effects of transaction costs exogenous determinants to asset specificity.

The estimation of a multinomial logit model with data collected among 328 French farmers in 2005 clearly supports that trust in the State, uncertainty and the similarity of transactions have a major role in farmers' choice over asset specificity. They allow to support that the higher the farmer trusts in the State, the higher the probability he chooses specific assets. They also support, but in a less rigid way, that uncertainty stemming from the opacity of public decision making and the non similarity of transactions reduce the probability the farmer chooses specific assets.

Very few studies tried to take the asset specificity endogeneity into account whereas it is asserted (Masten, 1995, Masten and Saussier, 2002) that the specificity of assets is itself a decision variable and should be treated as an endogenous variable. From what we know, three authors focused on that issue. Lyons (1995) observed the probability of buying-in specialized inputs is higher if the production technology is non specific, but only if there are economies of scale and scope. In coal procurement contracts, Saussier (2000) endogenizes site specificity and the carrier's transportation capacity with river characteristics, or the annual residual demand for coal. Finally, Hwang's 2006 theoretical model shows the variance of ex ante willingness to make specific investments with the magnitude of specific investments, the attendant quasi-rents, trust and time horizon. The first contribution of this paper is thus to widen the spectrum of hypothetical conditions of specific asset integration to those identified in the transaction cost economics literature. The second contribution is to test derived propositions in the field of agro-environmental transactions.

In section 2, we present the conceptual framework from which we derived propositions. Section 3 describes the hold up problem in the agro-environmental transaction and characterizes the different "contract types" or asset specificity levels the empirical analysis is based on. Section 4 provides data information and estimation results. Section 5 concludes.

## **II. THE CONCEPTUAL FRAMEWORK AND HYPOTHESIS**

### **II.1. Asset specificity: Theory and evidence**

Asset specificity is the most important and most distinguishes transaction costs economics from other treatments of economic organization. Transaction specific investments results in assets that have greater value when used to service a particular transaction, than they would have if that relationship broke down. This constitutes a hold up problem in which the

economic relationship is characterized by the existence of appropriable quasi-rents<sup>3</sup> that are available to parties to bargain over. Besides, as noted by Williamson (1985), “asset specificity only takes on importance in conjunction with bounded rationality/ opportunism and in the presence of uncertainty”. Therefore, when these conditions are gathered, transacting parties should be tempted to protect their relationship. They will be willing to write the most complete contract as possible, implement enforcement and monitoring designs,... which may lead to significant problems related to *ex ante* and *ex post* negotiations and maladaptation aspects and generate important transaction costs.

The literature on hold-up originated within transaction cost theory literature and more recently in the incomplete contract theory literature. Both “property right” literatures begin with Coase (1937) and have consistently focused on “the role transaction costs play in determining the distribution of property rights, broadly defined as all laws, rules, social customs and organizations that generate incentives for behaviour” (Allen, 1999). Every distribution of property rights has with it a set of production costs and a set of transaction costs. The distribution of property rights that maximizes the gains from trade net of all costs is the optimal distribution. This in fact is the grand hypothesis of transaction cost economics under the property right approach.

Williamson is the first to note the role quasi rents can play in causing contracting problems and incentives to vertically integrate. This idea is then popularised in Klein, Crawford and Alchian (1978). They emphasized on the presence of appropriable specialized quasi rents as likely producing a serious threat of opportunism and litigation which may turn out to be costly and ineffectual. They then assumed “as assets become more specific and more appropriable quasi-rents are created (and therefore the possible gains from opportunistic behaviour increases), the cost of contracting will generally increase more than the costs of vertical integration”. In other words, transaction cost economics prescribes market governance in the absence of specific assets because of its low cost and strong performance incentives. However, specific assets cause market governance to fail by increasing the cost of both demand and offer partner replacement, thereby creating a bilateral monopoly in which partners may engage in opportunism without being replaced. Hence, transaction cost economics prescribes nonmarket safeguards for relationships involving specific assets (Carson et al., 2006).

Asset specificity may have different forms. According to Williamson (1985), four types of asset specificity are usefully distinguished: “site specificity –e.g. successive stations that are located in a cheek-by-jowl relation to each other so as to economize on inventory and transportation expenses; physical asset specificity –e.g. specialized dies that are required to product a component; human asset specificity that arises in a learning-by-doing fashion; and dedicated assets, which represent a discrete investment in generalized (as contrasted with special purpose) production capacity that would not be made but for the prospect of selling a significant amount of product to a specific customer.” Masten et al. (1991) add a fifth type of asset specificity: time specificity, which is also relevant in the present case study. Indeed, “when timely performance is critical, delay becomes a potentially effective strategy for exacting price concessions. Knowing that interruptions at one stage can reverberate throughout the rest of the project, an opportunistic supplier may be tempted to seek a larger share of the gains from trade by threatening to suspend performance at the last minute. Even

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<sup>3</sup> The quasi-rent value of an asset is the excess of its value over its salvage value, that is, its value in its next best use to another renter. The potentially appropriable specialized portion of the quasi-rent is that portion, if any, in excess of its value in its second highest-valuing user (Klein et al., 1978)

though the skills and assets necessary to perform the task may be fairly common, the difficulty of identifying and arranging to have an alternative supplier in place on short notice introduces the prospect of strategic hold ups”.

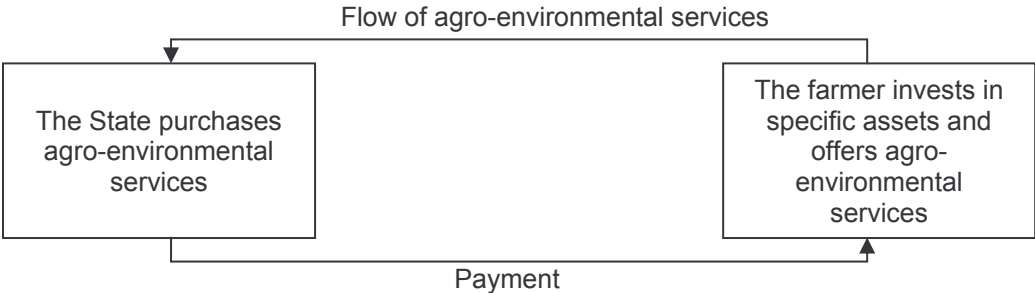
Even if the transaction cost economics approach is not linked with formal models, it offers an “empirical success story” in the sense that many empirical tests flourished and confirmed propositions on (i) vertical integration (Joskow, 1985; Masten et al., 1991), (ii) long term contracts (Crocker and Masten, 1988; Joskow, 1985), or (iii) price adjustments (Crocker and Masten, 1991; Joskow, 1988). As regard to the literature on environmental service transactions, the presence of transaction costs has also been widely demonstrated (Colby, 1990; Stavins, 1995; Kuperan et al. 1998; McCann and Easter, 1999; Falconer et al. 2001). However, as said in the introduction, the specificity of assets is usually treated as an exogenous variable whereas it is itself a decision variable. In other words, the level of specific investments and the nature of the contract dedicated to protect those investments are simultaneously determined. The incomplete contract theory implicitly recognizes this endogeneity issue since “the ex ante ownership arrangement is chosen based on its expected effect on the level of specific investment” (Sykuta, 2005).

Very few empirical studies have treated asset specificity as an endogenous variable. According to Masten and Saussier (2002), “the binding constraint is not technique, but data availability. As the number of provisions analyzed increases, the number of explanatory variables and the size of the data set needed for statistical identification multiplies. Often, sufficient numbers of observations to analyze more than two or three provisions at a time will simply not exist”. In this present study, we beneficiate from an original data base in which compensation payments do not cover transaction costs borne by the farmer. As the model presented in the next section attempts to show, this payment scheme allows to compare the costs derived from the profit function with transaction costs. Then, by identifying conditions in which transaction costs vary, we derive testable propositions about the choice over asset specificity.

**II.2. The model**

We consider two contracting parties, the State and the farmer. Next figure illustrates the economic relationship between these two parties.

*Figure 1: Contract description when trade occurs*



The State is the only purchaser of environmental services in rural areas. It offers pre-designed contracts<sup>4</sup> for environmental services performed by the voluntary farmer. A menu of environmental friendly practices, or contract requirements, the farmer can choose among is also provided with offered contract. From chosen environmental friendly practices, the farmer will make investments which may require specific assets.

The usual approach to explain farmers' participation in agro-environmental contracts assumes the standard maximization of farm profit. When the contract payment exceeds the profit forgone due to contract requirements, the farmer enrolls. The model can also take the farmer's preferences into account as a consumer (Dupraz et al., 2003). These preferences may then interact with farm management decision making. Especially, a higher environmental awareness may decrease the minimal contract payment that triggers the farmer's participation. The present contribution is based on similar assumptions, but focuses on farmers' adoption of environmental friendly practices involving different asset specific levels and thus distinguishes a transaction cost function from the usual model.

Our model is thus constructed as follows. We assume the farmer decides to enroll with given environmental friendly practices if the offered contract payment is higher than compliance costs. Compliance costs gather technology adaptation costs derived from additional costs (also called operational costs), income foregone resulting from the commitment made and transaction costs borne by the farmer. In line with the EU rural development regulation 1257/99, the implemented payment is based on operational costs and income foregone only<sup>5</sup>. They are per-hectare payments based on average operational costs and income foregone in each region and do not include transaction costs. Given that the specificity of a practice required investments is a factor of transaction costs, the variability of transaction costs from a practice to another is thus expected to affect their respective uptake rate, *ceteris paribus*. Farmers should then choose the environmental friendly practice which involves the lowest transaction costs. However, if we observe our case study's farmers, some of them prefer practices with higher levels of asset specificity. We thus suspect some conditions to lower or increase transaction costs associated to a practice and a level of asset specificity and, consequently, to impact on farmers' decision. These conditions and related hypothesis as regard to their effect on farmers' choice are presented in section II.3.

As implied by this choice framework, we thus need to define a utility function that expresses farmers' preferences for different asset specificity levels. We consider a utility maximizing farmer facing  $K$  environmental friendly practices, each of them being linked to a level of asset specificity. Offered per-unit payments are included in the  $K$ -dimensional vector  $q$ . The farmer selects the  $K$ -dimensional vector  $y$  of environmental service units for each practice, according to his preferences and budget constraint. These agro-environmental commitments last five years corresponding to a medium term time horizon. Utility is supposed to be non decreasing, continuous, differentiable and quasi-concave in the private consumption  $m$  and the vector  $y$ . Utility also depends on exogenous farmer's preferences. In the budget constraint, the medium term income  $m$  can not exceed the contract payment  $q \cdot y$  plus the short term profit  $\pi(\cdot)$  that depends on  $y$  and on prices of variable inputs and outputs  $p$ . The short term  $\pi(p, y)$  dually represents the technology. It is assumed linearly homogenous in

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<sup>4</sup> duration, renegotiation rules, eligibility, payments and sanctions are defined by the State.

<sup>5</sup> "Support in respect of an agri-environmental commitment shall be granted and be calculated on the basis of : income foregone, additional costs resulting from the commitment given, and the need to provide an incentive" (Council Regulation 1257/1999, Official Journal of the European Communities, 17 may 1999).

prices  $p$ , non increasing and quasi-concave in  $y$  (Dupraz et al., 2003). A transaction cost function is distinguished from the profit function, called  $T(\cdot)$ . This function is assumed to depend on exogenous determinants of transaction costs,  $x$ . (Next section is an attempt to characterize this transaction cost function).

$$\begin{aligned} & \underset{m,y}{\text{Max}} U(m, y) \\ & m \leq \pi(p, y) - T(p, y, x) + qy \\ & y \geq 0 \end{aligned} \quad (1)$$

As previously explained, the profit variation due to the farm technology adaptation is compensated by the contract payment, but it does not encompass transaction costs. Therefore, when asset specificity gets higher, we should observe effects stemming from the variability of transaction costs and utility only. Effects stemming from the profit function are thus theoretically non observable.

The solution of the maximisation programme (1) is noted  $(m^*, y^*)$ , with  $V(p, q) = U(m^*(p, q), y^*(p, q))$  being the indirect utility function. The vector  $y^*$  is the optimal combination of agro-environmental commitments which is selected by the farmer. Given the very high number of different practices, leading to many possible combinations of contracted practices, this decision making process is difficult to estimate directly.

In order to derive a tractable econometric specification, we assume a two stage decision making process, based on a partition  $Z$  of all possible combinations of practices distributed into  $J$  groups of combinations noted  $Z_j$ . The partition includes groups of non paid practices. These groups differ according to the asset specificity associated with the corresponding combinations of practices. Within each group, the maximal utility is:

$$V(p, q, Z_j) = \underset{m,y}{\text{Max}} \{U(m, y); m \leq \pi(p, y) + q.y; y \in Z_j\} \quad (2)$$

It follows that:

$$V(p, q) = \underset{Z_j}{\text{Max}} \{V(p, q, Z_j); Z_j \in Z\} \quad (3)$$

We consider the decision of the  $i^{\text{th}}$  farmer associated to the maximization program (3). His maximal indirect utility for the group  $Z_j$  is noted  $V_{ij}$  and is the solution of program (2). The econometric specification then relies on a random utility model:

$$V_{ij} = b_j x_i + u_{ij} \quad \forall j = 1, \dots, J \quad (4)$$

Where  $x_i$  is the vector of explanatory variables describing the exogenous determinants, i.e. factors of transaction costs (see next section for their effect details),  $b_j$  are the corresponding parameters to be estimated, and  $u_{ij}$  a perturbation which is assumed to have a Gompertz distribution ( $F(u_{ij}) = \exp(-\exp(-u_{ij}))$ ). Perturbations are assumed independent and identically distributed.



Let  $d_{ij}$  be the dichotomous variable describing farmer  $i$ 's choice over the different combination groups  $Z_j$ . In accordance with relation 3, the decision rule is:

$$\begin{aligned} d_{ij} &= 1 && \text{if } V_{ij} > V_{ij'}, \quad \forall j' \neq j \\ d_{ij} &= 0 && \text{otherwise} \end{aligned} \quad (5)$$

The relations (4) and (5) specify a multinomial logit model (Gouriéroux, 1989) where the probability of the  $i^{\text{th}}$  farmer to select a combination of the group  $Z_j$  is given by (6):

$$P_{ij} = \Pr\{d_{ij} = 1\} = \frac{\exp(x_i' b_j)}{\sum_{j'=1}^J \exp(x_i' b_{j'})} \quad \forall j \quad (6)$$

### **II.3. Conditions for choosing specific assets**

To understand how farmers choose the level of asset specificity, we have to determine which factors affect their decision. From the above specified model, these factors impact on farmers' utility function and transaction cost function. We here provide a first attempt to characterize the transaction cost function. Propositions are based on the theoretical and empirical transaction cost economics literature. As regard to the utility function, determinants such as environmental awareness or children were analyzed in Dupraz et al. (2003) and Delvaux et al. (1999) but they focused on the decision to enrol and did not distinguish environmental friendly practices between each other.

#### **II.3.1. Transaction cost factors**

##### *Trust*

As defined in Sako and Helper (1998), trust is an expectation held by an agent that its trading partner will behave in a mutually beneficial manner. Even if they conceptualize trust has not being a mere opposite of opportunism, for simplification, we will consider trust as the opposite of opportunism. A lack of trust may stem from the fear the co-contracting party might try to take unfair decisions, or suspicion on his use of given information, or distrust arising from non shared goals. According to Hwang (2006), a deterioration of trust exhibits a negative relationship to the willingness to make specific investments. Trust is thus expected to reduce the hold up pressure on the transacting parties. Consequently, we expect them to be less tempted to protect their relationship and we should observe a lower magnitude of transaction costs, other things being equal. Our proposition is straight forward:

**Proposition 1:** The more the farmer trusts in the State, the lower the magnitude of transaction costs and the higher the probability he chooses specific assets, *ceteris paribus*.

##### *Similarity of transactions*

The similarity of transactions can be defined as "those transactions that are similar to ones in which the firm is already engaged" (Masten et al., 1991). This characteristic will impact on internal organization costs, i.e. the costs of organizing and losses through management decision mistake, which we consider as transaction costs. Coase (1937) and Masten et al. (1991) assert that internal organization costs increase with an increase in the dissimilarity of

transactions<sup>6</sup>. Therefore, the costs related to efforts to adapt the farming production technology and management decisions with the agro-environmental transaction will be higher when the farmer is unfamiliar with what he commits.

We referred to Masten et al.'s study to set a relationship between the similarity of transactions and the specificity of involved investments. They observed that “workers with more specific skills are less costly to manage” and went to the conclusion that human specific assets were reducing internal organization costs. The objective of reducing internal organization costs may therefore be a reason for choosing more specific assets. By impacting on internal organization costs, the similarity of transaction may thus be a determinant of the choice over asset specificity.

In addition to this observation, it is important to highlight the effect of the similarity of transactions on economies of scale and scope<sup>7</sup>. Indeed, an activity the farmer is familiar with is technically close to other activities he is already having or used to have and should thus induce economies of scale and/or scope. If we go back to our model, the similarity of transactions is thus expected to impact on the profit function (via economies of scale and scope) and the transaction cost function (via internal organization costs). However, in this present case study, we are able to distinguish both effects thanks to the data basis. Indeed, the compensation payment being calculated on technology adaptation costs and thus taking economies of scale and scope into account, estimations are expected not to capture the economy of scale and scope effect but the effect of internal organization costs only.

Proposition 2: The more the agro-environmental transaction is similar to ones he is already engaged, the lower the internal organization costs and the higher the probability the farmer chooses specific assets, *ceteris paribus*.

#### *Bounded rationality*

According to Williamson (1985), bounded rationality is a semi-strong form of rationality in which economic actors are assumed to be “intendedly rational, but only limitedly so” (Simon, 1961, p.xxiv). Bounded rationality implies “economic agents do not know all the solutions to the problems they face, are unable to calculate the possible outcomes of these solutions, and cannot perfectly arrange these outcomes in order in their space of preferences. With regard to contracts, this means that they are unable to design the optimal solutions (behavioral rules) taking into account every relevant contingency without high, and sometimes prohibitive, costs and delays” (Brousseau and Fares, 2000). Therefore, if we assume decisions are time-consuming and costly and that agents can make mistakes, we can acknowledge more bounded rationality lead to more transaction costs, and we suggest the following proposition on the relationship between asset specificity and bounded rationality.

Proposition 3: The more the farmer has a bounded rationality, the higher the magnitude of transaction costs and the lower probability he chooses specific assets, *ceteris paribus*.

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<sup>6</sup> “Internal organization costs are likely to be higher for transactions that are differentiated – by either their location or characteristics – from other activities in which the firm is engaged, and for which there is a greater degree of uncertainty. Supervision and management of employees will be more difficult where managers are unfamiliar with the production process, while more complex or uncertain transactions demand a greater share of management’s limited attention and would therefore tend to be more expensive to administer” (Masten et al., 1991).

<sup>7</sup> In other respects, Lyons (1995) observed a relationship between asset specificity and economies of scale and scope. He showed that “economies of scale and scope are a significant motivation behind the decision to buy-in, but only in the absence of specific assets”, and that “specific assets are the overriding influence when scale or scope economies exist”.

### *Uncertainty*

Following Carson et al. arguments (2006), uncertainty may be associated to disturbances from two different origins, namely volatility and ambiguity related aspects. Volatility refers to “the rate and unpredictability of change in an environment over time, which create uncertainty about future conditions”. This conceptualization of uncertainty follows Williamson’s (1985) one, in which he distinguishes primary uncertainty from secondary uncertainty. The former is of a state-contingent kind and arises from random acts of nature and unpredictable changes in consumers’ preferences. The latter arises from a lack of communication among decision makers. Williamson precises that secondary uncertainty is of a rather innocent or non strategic kind, contrarily to behavioral uncertainty, which may be associated to opportunism.

Ambiguity refers to the metering problem, i.e. “the degree of uncertainty inherent in perceptions of the environmental state irrespective of its change over time”. It consists of lack of clear information, uncertainty about the importance of environmental variables, uncertainty of cause effect relationships between variables, and uncertainty about available courses of action and their potential effects (Daft and Macintosh, 1981; Thompson, 1967). The measurement ambiguity issue is treated in the “measurement branch” of transaction costs economics (Alchian and Demsetz, 1972).

Here, we associate uncertainty to volatility aspects. In other respects, ambiguity aspects are assumed to be a core component of bounded rationality. Indeed, this assumption is based on Daft and Macintosh (1981) paper where they assert that a key result of ambiguity is that firms can differ in their perceptions of the same environment and in their decisions about how to act. This refers to observability and verifiability notions<sup>8</sup>, which are part of the bounded rationality definition. As regard to the relationship between uncertainty and transaction costs, we base our proposition on Saussier’s (2000) study where he hypothesizes that “the greater the uncertainty level of the transaction, the more difficult, expensive, and risky it will be to establish a contract that aims for completeness (particularly because of the potential costs of being ‘trapped’ in a bad contract)”, these costs gathering transaction *ex ante* and *ex post* costs. We here hypothesize the following relationship between asset specificity and uncertainty.

**Proposition 4:** The more uncertainty surrounds the agro-environmental transaction, the higher the magnitude of transaction costs and the lower the probability the farmer chooses specific assets, *ceteris paribus*.

As pointed out by Carson et al. (2006), “both volatility and ambiguity make exchanges more conducive toward opportunism and increase its probability of occurring”. The correlation between uncertainty and opportunism/trust will thus have to be checked.

### **II.3.2. Utility factors**

In the case of public good transactions, non rivalry makes it possible for the farmer to derive utility from both the service he produces and the payment he receives accordingly. Utility in the transaction thus refers to the total value the farmer gives to environmental services he produces from the investments he decides to make. We argue this utility has two consequences. First, it may lead the farmer to have a positive willingness to pay for environmental services. An increased utility due, for instance, to environmental awareness, should thus reduce the compensation payment necessary to incite the farmer to enrol (Dupraz

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<sup>8</sup> The non-verifiability notion refers to the limited rationality of the authority in charge of enforcing the contract. In other words, this is judges’ inability to verify the relevant state of nature. There is non-observability when decisions are time-consuming and costly, agents can make mistakes and that they are victims of strong information asymmetries because they do not share a common vision of their present and future economic positioning (Brousseau and Fares, 2000).

et al., 2003). Second, from the asset specificity perspective, it provides an alternative value to specific investments outside the transaction with the State and, consequently, should reduce the appropriable quasi-rent. Therefore, the hold-up pressure should be reduced and transaction costs dedicated to protect the relationship should be lower. From this second observation, we derive the following proposition:

**Proposition 5:** The more utility the farmer gets from environmental services he produces through the agro-environmental contract, the lower the magnitude of transaction costs and the higher the probability he chooses specific assets, *ceteris paribus*.

This last proposition actually fits in the transaction cost factor section. However, given that the empirical analysis does not allow to distinguish the effect of utility and transaction cost for this factor type and that both effects are expected to be positive, we decided to keep them together.

### II.3.3. Synthesis

Next table presents a synthesis of expected effects of the determinants described above on the choice over asset specificity.

**Table 1: Synthesis of expected effects of determinants on the probability to choose specific assets**

Determinants	Chosen asset specificity level
Trust	+
Similarity of transactions	+
Bounded rationality	-
Uncertainty	-
Utility	+
-: reduced asset specificity +: increased asset specificity	

Even if the frequency or duration horizon, as explored in Hwang (2006) analysis, might have a significant effect on farmers' behavior, we did not consider its effect since data used for the empirical analysis does not show any frequency variability (every contracts have the same five-year duration).

## **III. AGRO-ENVIRONMENTAL CONTRACTS: AN EMPIRICAL TEST**

Data from a 2005 survey covering the Basse-Normandie region was analyzed using the theoretical model developed above. Within the survey area, 328 farmers were randomly selected and face to face interviewed using a structured questionnaire. The questionnaire addresses issues concerning farms, farmers' professional environment, farmers' relationship with institutions, farmers' perceptions on agro-environmental contracts and information on their income and hobbies. In addition, several questions were asked to contracting farmers on how they manage their agro-environmental contract and required environmental friendly practices. This section aims at characterizing asset specificity in agro-environmental contracts and at distinguishing different contract types as a function of involved asset specificity level.

### **III.1. Characterizing asset specificity**

In the agro-environmental transaction asset specificity may appear in three contexts. First, as Allen and Lueck (1998), we consider temporal specificity. Indeed, for environmental outcomes to be gained, most of environmental friendly practices must be operated on proper

periods as a function of meteorological conditions and natural cycles. Allen and Lueck, and many agricultural economists (for example, Brewster, 1950; Castle and Becker, 1962) argue “seasonality is the main feature that distinguishes farm organization from “industrial” organization” (Allen and Lueck, 1998)<sup>9</sup>. Even if skills and assets necessary to perform these tasks are common, it is very difficult for the State to turn to an alternative supplier in place on short notice, which may introduce strategic hold up.

In addition of being dependant on time aspects, environmental outcomes depends on agro-environmental practice localization too, which constitutes a second source of asset specificity. As for time specificity, skills and investments are easily redeployable, but environmental goals can't be reached if these tasks are implemented elsewhere. This is thus another opportunity for hold up. Both hold up cases mostly concern the State in that he should not be bargaining from a position of strength. However, these time and site requirements bring the farmer to adapt his farming production system and may lead him to be required to improve his agronomic knowledge and his material park. This new production system management is an important investment for the farmer, which has currently no other uses outside the agro-environmental contract with the State. The farmer thus becomes taken in a hold up position too. The third origin of asset specificity stems from human skills. Practices aiming at biodiversity or extensive management goals such as low pesticide inputs require advanced agronomic and ecological knowledge which does not find other valuable uses outside the transaction with the State. This constitutes another hold up case as regard to the farmer point of view.

Finally, in order to make a full description of the hold up problem in the agro-environmental transaction, uncertainty aspects and the two involved parties' characteristics (bounded rationality and opportunism) require to be evoked. The uncertainty may be qualified as very high. Indeed, on the one hand, farmers are subject to several sources of “primary uncertainties” such as the climate, the very fluctuating market prices and political changes. On the other hand, “secondary uncertainty” stems from the opacity of public decision making process, which is a particularity of the agricultural sector. As regard to the characteristics of involved parties, and particularly of the rationality aspect, both the State and farmers have a very limited knowledge on the adequate technology to reach environmental outcomes. Agro-environmental technologies are highly interacting with the natural environment and call for very complex biophysical mechanisms. This does not allow the contracting parties to write a contract on environmental goals but on mean/media objectives only which are much more easy to observe and verify but places the State in a risky position since it has no guaranty to get environmental outcomes from the media it contracts on. High uncertainty and bounded rationality thus make the hold up problem to arise in the agro-environmental transaction.

### **III.2. Description of the different “contract types”**

Farmers willing to subscribe an agro-environmental contract had the possibility to choose one or more environmental friendly practices among a set of about 170 different practices.

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<sup>9</sup> Holmes (1928) stresses seasonality in discussing the reason for the resilience of the family farm: “The most fundamental one [reason] is the peculiar seasonal nature of agricultural production and the consequent lack of continuous operations. Almost every line of endeavour on the farm must depend either upon the swing of the seasons or upon the periodic nature of some biological process. There are seed times and harvest times with their specific tasks which, in the main, are of short duration. There is also the case of livestock at the different stages of their development. In no case can a man be put to a single specific task and be kept at it uninterruptedly for a month or a year as is true in the factory”.

Collected data includes 45 different enrolled practices, which we classified into five groups of environmental friendly practices or “contract types” in order to simplify the econometric treatment. These groups were created according to chosen practice combinations with a Multiple Correspondence Analysis and a classification method. From these contract types, we distinguished 3 asset specificity levels: A, B and C. In addition to these five contract types, we created two non compensated practice types among non contracting farmers. They form contract type D. Table 2 presents the 7 contract types. The last column indicates the level of the compensation payments.

*Table 2: Description of contract types*

<b>Contract types</b>	<b>Nb. of farmers</b>	<b>Description</b>	<b>Environmental friendly practices</b>	<b>Average payment per farm</b>
<b>A1</b>	68	Important changes on meadows and landscape	Reconversion towards grazing systems + Extensive management of meadows Landscape maintenance	6324€
<b>A2</b>	20	Fauna protection	Meadow management towards fauna and flora improvement	9966€
<b>B</b>	43	Changes on arable lands and meadows	Reduce bare land in winter Extensive management of meadows	5683€
<b>C1</b>	28	Practice maintenance on meadows	Extensive management of meadows	6181€
<b>C2</b>	12	Changes on arable lands	Reduce bare land in winter Reduce pesticide and fertilization input	7189€
<b>D1</b>	76	More than 4 non paid actions	Significant environmental effort	0
<b>D2</b>	81	Less than 3 non paid actions	Low environmental effort	0

Contract types A call for assets which we consider as highly specific. A1 refers to constraining commitments such as production system reconversion towards grazing systems, extensive management of meadows and landscape maintenance. These practices lead the farmer to rethink his whole farming system so as to be able to honour his commitment in terms of dates, input quantities and practice localization. In addition, practices concerning landscape maintenance such as hedgerows or ponds, require a certain level of agronomical and botanical expertise, which involves the farmer to get advanced knowledge in these fields. These different investments do not have any value outside the agro-environmental contract. This is why A1 is assumed to be a highly specific contract. A2 contract focuses on fauna protection. This entails timing restrictions for certain operational tasks, such as mowing or ploughing, depending on natural cycles and ecological expertise. As for A1 contract, these investments do not have any value outside the agro-environmental contract.

Contract types C call for low asset specificity. C1 contract only concerns extensive management of meadow practices. It does not entail constraining requirements in terms of date, input quantities and practice localization, which does not lead the farmer to entirely change his farming system and thus to invest in a new production system management. C2

contract is different from C1. C2 contract entails changes on arable lands, such as covering bare lands in winter, and restrictions on pesticide and fertilizer input management, which lead the farmer to entirely revise his production system. This involves the farmer to highly invest in order to commit with his contract. However, contrarily to A contracts, these investments are redeployable on other transactions, namely quality labels and the new orientation of the Common Agricultural Policy (CAP). Indeed, the last CAP regulation calls for ecoconditionality requirements, among which, winter bare lands management, pesticide and fertilizer inputs requirements are included.

Finally, contract type B calls for average specificity. It is similar to C1 contract but requirements are more numerous and lead to higher investments. Some of them, such as covering bare lands in winter are redeployable, as referred to the new CAP regulation, but others are not.

As regard to non compensated contract types, D1 includes combinations of more than 4 non compensated environmental friendly practices, and D2 includes combinations of less than 3 specified practices, including none. In these both practice types, involved assets do not show any specificity.

It is important to note that the gradient of specificity levels among enrolled practices is narrower than the 170 initially proposed practices' one. To be more precise, farmers have chosen the less specific practices whereas proposed practices encompassed a whole gradient of practices from very specific ones, such as converting arable lands into meadows, to non specific ones such as winter covering of arable lands. This will have to be taken into account in the interpretation of the results.

## **IV. DATA AND RESULTS**

### **IV.1. Description of explanatory variables**

Among the 328 interviewed farmers, 171 have subscribed an agro-environmental contract and 157 have not. The sample is quite representative although contracting farmers are over represented on purpose in order to get better information on contracts.

Several types of variables were collected so as to capture the notion of the determinants previously described. They describe the farmer (education level, environmental awareness...), his production system (farm legal status, number of Full Time Equivalent workers...), his professional environment (involvement in agricultural organizations, administrative and technical external services,...) and his relationship with the State (trust in administrations, ...). In order to use relevant explanatory variables from the 634 variables collected in total, the primary data were gathered following different methods. Global variables were created using the MCA. In addition, ratio variables were created such as the number of FTE workers variables or land use variables, and continuous variables were added up. Finally, some other qualitative variables were gathered into classes of variables as general education levels (3 classes), age (3 classes).

These explanatory variables describe asset specificity determinants as presented in table 3.

**Table 3: Determinants of asset specificity and their respective explanatory variables**

<b>Determinants of asset specificity</b>	<b>Related constructed explanatory variables</b>	<b>Variable values<sup>10</sup></b>
<b>Bounded rationality</b>	Agricultural education ( <i>AGRI EDUC</i> ) General education	6 classes 7 classes
<b>Trust</b>	To trust the implementation process of agro-environmental contracts ( <i>TRUST IMPL</i> ) Goodwill trust in the State ( <i>GOODWILL</i> )	Continuous variable [-1;1] Continuous variable [-1;1]
<b>Uncertainty</b>	To regularly receive technical and administrative advices ( <i>ADVICES</i> ) To be involved in an agricultural organization ( <i>ORGA</i> )	Continuous variables [-1;1] Continuous variable [-1;1]
<b>Similarity of transaction</b>	Grassland share ( <i>GRASSLAND</i> ) Farm land area ( <i>UAA</i> ) Arable land share Labor ( <i>FTE</i> ) Animal population Milk quota Production system type (organic or conventional)	Continuous variable (%) Continuous variable (hectares) Continuous variable (%) 5 classes Continuous variable (Livestock units) Continuous variable (litre) 0=organic; 1=conventional
<b>Utility</b>	Environmental awareness ( <i>ENV AW</i> ) Children Free time dedicated in nature related hobbies	Continuous variable [-1;1] 3 classes Continuous variable [-1;1]
<b>Control variables</b>		
	Changes in the production system in the last 5 years ( <i>CHANGES</i> ) To have already enrolled an agro-environmental contract ( <i>EXPERIENCE</i> ) Age ( <i>AGE</i> ) NUT region Machinery ownership Land share in ownership Land share in long term tenant tenure Land share in short term tenant tenure Farm legal status	Continuous variable [-1;1] 0=no; 1=yes 3 classes 0=Calvados; 1=Manche; 2=Orne Continuous variable [-1;1] Continuous variable (%) Continuous variable (%) Continuous variable (%) 5 classes

We measure the similarity of transactions in the same way as Masten et al. did in their 1991 article studying the shipbuilding industry. They compared the initial low-technology and labor intensive tasks with the integration of high engineering-intensive tasks. Here, the similarity of transaction is measured from the characteristics of the farm production technology and the technology required by the different environmental friendly practices. For instance, the practice “extensive management of meadows”, will be qualified as similar to extensive grazing production systems whereas it will be different from a maize oriented production system.

Table 4 presents descriptive statistics of some of these explanatory variables.

<sup>10</sup> See annex for a more detailed description of how explanatory variables measure transaction cost determinants.



**Table 4: Descriptive statistics**

		<b>A1</b> <b>(%)</b>	<b>A2</b> <b>(%)</b>	<b>B</b> <b>(%)</b>	<b>C1</b> <b>(%)</b>	<b>C2</b> <b>(%)</b>	<b>D</b> <b>(%)</b>
UAA	<50ha	13,2	10,0	4,6	10,7	25,0	22,3
	50-100ha	48,5	50,0	53,5	57,1	16,7	49,7
	100-150ha	22,1	20,0	30,2	25,0	33,3	16,6
	>150ha	16,2	20,0	11,6	7,1	25,0	11,5
GRASSLAND	No grassland	1,5	0,0	2,3	0,0	41,7	8,9
	<55%	47,1	35,0	53,5	7,1	58,3	45,2
	55-100%	35,3	65,0	44,2	67,9	0,0	36,3
	Only grassland	16,2	0,0	0,0	25,0	0,0	9,5
FTE	<1	2,9	0,0	0,0	3,6	0,0	3,2
	1	19,1	10,0	16,3	35,7	41,7	28,7
	1-2	38,2	50,0	41,9	32,1	41,7	43,9
	>2	39,7	40,0	41,9	28,6	16,6	24,2
AGE	<40 years old	26,5	25,0	39,5	28,6	25,0	20,4
	40-55	51,5	45,0	51,2	46,4	50,0	54,1
	>55	22,1	30,0	9,3	25,0	25,0	25,5
AGRI EDUC	None	13,2	10,0	4,6	25,0	8,3	18,5
	Low secondary	30,9	50,0	32,6	25,0	41,7	25,5
	High secondary	36,8	30,0	44,2	35,7	25,0	35,7
	Higher education	17,6	5,0	16,3	7,1	16,7	11,5
	Other	1,5	5,0	2,3	7,1	8,3	8,9
ORGA	Not implied	21,0	25,0	18,6	32,1	16,7	28,0
	Rarely implied	22,1	35,0	16,3	32,1	25,0	24,8
	Sometime	26,5	20,0	39,5	17,9	25,0	23,6
	Always	30,9	20,0	25,6	17,9	33,3	23,6
ADVICES	Never	14,7	25,0	9,3	14,3	16,7	36,9
	Rarely	23,5	25,0	30,2	32,1	16,7	22,9
	Sometime	30,9	25,0	27,9	25,0	33,3	21,0
	Always	30,9	25,0	32,6	28,6	33,3	19,1
TRUST IMP	Weak	8,8	0,0	16,3	7,1	8,3	27,4
	Medium	23,5	15,0	32,6	10,7	16,7	27,4
	High	30,9	35,0	25,6	35,7	50,0	16,6
	Very high	36,8	50,0	25,6	46,4	25,0	14,0
GOODWILL	Weak	36,8	50,0	34,9	35,7	25,0	12,1
	Medium	26,5	10,0	25,6	25,0	33,3	25,5
	Good	23,5	30,0	25,6	32,1	16,7	22,9
	Very good	13,2	10,0	13,9	7,1	25,0	39,5

Generally speaking, C2 contractors have a larger land area. C1 contractors have a very high grassland share whereas C2 contractors have a very low grassland land share. A2 contractors have the highest labor rate whereas C2 contractors have the lowest. B contractors are the youngest farmers whereas A2 contractors are the oldest. B and A1 have the highest agricultural education. The implication in agricultural organizations and advices are very heterogeneous among contract types. Finally, the two categories of trust show almost opposite farmers' positions. Non contracting farmers have a lower trust in the implementation process than contracting farmers whereas non contracting farmers have a higher perception of the State's goodwill than contracting farmers.

As regard to the correlation between uncertainty and trust variables, between which a relationship is suspected to exist, we observe a positive correlation between "to receive regularly technical and administrative advices" and "goodwill trust in the State".

## IV.2. Estimation results

The different parameter estimations are gathered in table 5. Significant variables are presented only. The model has kept all observations. The reference contract is D2, which is the category of farmers when the farmer implement less than 3 non compensated environmental friendly practices. The reference farmer has an agricultural education level superior than the CAP<sup>11</sup> and has not subscribed an agro-environmental contract in the past. As regard to continuous variables, we took average values (grassland share is 53.65%, farm land area is 93.69ha. The model adjustment quality is medium as the Mc Fadden R<sup>2</sup> is 33.55.

Table 5: Logit multinomial estimations

Variable	A1 <sup>1</sup>	A2 <sup>1</sup>	B <sup>1</sup>	C1 <sup>1</sup>	C2 <sup>1</sup>	D1 <sup>1</sup>
Constant	<b>-1,91**</b> (0,87)	<b>-6,15***</b> (2,07)	<b>-2,30***</b> (0,91)	<b>-6,17***</b> (1,75)	-1,31 <sup>/</sup> (1,97)	-0,24 <sup>/</sup> (0,55)
<b>UNCERTAINTY</b>						
ADVICES	0,28 <sup>/</sup> (0,29)	-0,13 <sup>/</sup> (0,56)	0,18 <sup>/</sup> (0,29)	<b>0,98**</b> (0,48)	<b>1,40**</b> (0,76)	0,001 <sup>/</sup> (0,22)
ORGA	<b>0,49**</b> (0,25)	0,22 <sup>/</sup> (0,50)	0,38 <sup>/</sup> (0,29)	-0,05 <sup>/</sup> (0,39)	0,62 <sup>/</sup> (0,44)	0,10 <sup>/</sup> (0,23)
<b>SIMILARITY</b>						
UAA	<b>0,01**</b> (0,005)	0,01 <sup>/</sup> (0,009)	<b>0,008*</b> (0,005)	<b>0,01**</b> (0,008)	0,006 <sup>/</sup> (0,01)	<b>0,007*</b> (0,003)
GRASSLAND	<b>0,01**</b> (0,008)	0,02 <sup>/</sup> (0,02)	0,01 <sup>/</sup> (0,01)	<b>0,05***</b> (0,02)	-0,15 <sup>/</sup> (0,11)	-0,005 <sup>/</sup> (0,006)
<b>TRUST</b>						
TRUST IMPL	<b>1,61***</b> (0,31)	<b>2,17***</b> (0,68)	<b>1,26***</b> (0,31)	<b>1,59***</b> (0,38)	<b>2,20**</b> (1,06)	0,22 <sup>/</sup> (0,22)
GOODWILL	<b>0,41*</b> (0,24)	<b>0,62*</b> (0,41)	<b>0,44*</b> (0,27)	0,45 <sup>/</sup> (0,38)	-0,18 <sup>/</sup> (0,79)	-0,06 <sup>/</sup> (0,22)
<b>UTILITY</b>						
ENV AW	-0,23 <sup>/</sup> (0,21)	<b>-1,10*</b> (0,69)	-0,48 <sup>/</sup> (0,46)	-0,24 <sup>/</sup> (0,34)	-2,74 <sup>/</sup> (2,14)	0,22 <sup>/</sup> (0,19)
<b>BOUNDED RATIONALITY</b>						
LOW AGRI EDUC	<b>0,67*</b> (0,48)	<b>2,06**</b> (0,91)	<b>0,86*</b> (0,55)	0,19 <sup>/</sup> (0,72)	1,66 <sup>/</sup> (1,59)	0,29 <sup>/</sup> (0,42)
<b>CONTROL VARIABLES</b>						
CHANGES	<b>0,52*</b> (0,30)	<b>1,60*</b> (0,93)	<b>1,12***</b> (0,33)	-0,04 <sup>/</sup> (0,45)	-0,39 <sup>/</sup> (1,31)	<b>0,39*</b> (0,22)
EXPERIENCE	<b>-1,69***</b> (0,72)	<b>1,89***</b> (0,83)	<b>-1,84*</b> (1,10)	-0,27 <sup>/</sup> (0,63)	1,99 <sup>/</sup> (1,96)	-0,65 <sup>/</sup> (0,47)
Number of observations			328			
Log Likelihood			-424,15			
R <sup>2</sup> McFadden			33,55			
Estrella coefficient			79,62			
Estrella adjusted coefficient			64,21			

Standard Error in brackets

\*\*\* : significant 1% ; \*\* : significant 5% ; \* : significant 10% ; / non significant.

<sup>11</sup> Certificat d'Aptitude Professionnelle

The variability of parameters is presented in table 6.

*Table 6: Marginal effects (%)*

<b>Variables</b>	<b>A1</b>	<b>A2</b>	<b>B</b>	<b>C1</b>	<b>C2</b>	<b>D1</b>	<b>D2</b>
<b>UNCERTAINTY</b>							
ADVICES	0,50 (2,70)	-1,59 (1,49)	-0,43 (2,41)	<b>5,17</b> (1,68)	2,48 (1,93)	-3,09 (2,88)	-3,06 (2,83)
ORGA	<b>4,34</b> (2,22)	-0,06 (1,51)	1,34 (1,94)	-1,91 (1,99)	0,78 (1,39)	-1,42 (2,95)	-3,06 (2,72)
<b>SIMILARITY</b>							
UAA	0,03 (0,04)	0,01 (0,02)	0,01 (0,04)	0,05 (0,03)	0,00 (0,02)	0,02 (0,05)	<b>-0,12</b> (0,05)
GRASSLAND	0,12 (0,09)	0,03 (0,05)	0,06 (0,08)	<b>0,26</b> (0,07)	-0,30 (0,29)	-0,12 (0,13)	-0,06 (0,1)
<b>TRUST</b>							
TRUST IMPL	2,43 (2,99)	1,27 (1,29)	2,16 (2,34)	1,12 (1,78)	-0,66 (2,14)	<b>-3,94</b> (2,66)	-2,39 (2,48)
GOODWILL	<b>9,50</b> (2,47)	<b>4,06</b> (1,33)	2,15 (2,62)	<b>3,43</b> (1,69)	2,85 (1,60)	<b>-9,27</b> (2,57)	<b>-12,72</b> (2,55)
<b>UTILITY</b>							
ENV AW	0,97 (5,78)	-3,28 (4,62)	-2,68 (4,49)	0,01 (2,85)	-5,12 (3,40)	<b>7,96</b> (3,98)	2,15 (3,98)
<b>BOUNDED RATIONALITY</b>							
LOW AGRI EDUC	0,75 (5,56)	<b>6,85</b> (1,92)	3,03 (4,58)	-2,66 (2,76)	2,50 (2,13)	-2,86 (4,27)	<b>-7,62</b> (3,91)
<b>CONTROL VARIABLES</b>							
CHANGES	-0,17 (2,68)	<b>4,34</b> (1,79)	<b>7,18</b> (2,67)	<b>-3,64</b> (1,72)	-1,60 (1,95)	0,73 (3,02)	<b>-6,84</b> (2,05)
EXPERIENCE	<b>-16,15</b> (4,07)	<b>18,98</b> (5,13)	<b>-10,62</b> (3,60)	1,86 (4,18)	-2,31 (1,98)	-3,23 (6,73)	<b>11,46</b> (5,85)

### **Preliminary remark:**

Preliminary results (Ducos, Dupraz, 2006) on determinants of agro-environmental contract adoption using a probit model and the same data basis led to the conclusion that a large amount of variables was explaining farmers' behavior (26 in total), among which determinants of transaction costs such as "to regularly receive technical and administrative advice" or "to trust the implementation process of agro-environmental contracts" were predominant. In this present study, by distinguishing enrolled environmental friendly practices, we reduced the number of significant variables down to 10. It shows that the characteristics of enrolled environmental friendly practices and their associated level of asset specificity have a major role in farmers' choice.

Let's now observe these results in the light of our propositions.

We observe that among the ten significant variables listed in table 5 presenting logit multinomial estimations, six have expected signs. They support that determinants of transaction costs have a role in farmers' choice over asset specificity and they impact as the theory predict. They describe uncertainty ("to regularly receive technical and administrative advices" and "to be involved in an agricultural organization"), trust ("to trust the implementation process of agro-environmental contracts" and "goodwill trust in the State")

and the similarity of transactions (“grassland share” and “farm land area”). Among them, variables describing trust clearly distinguish contractors (contract types A, B and C) from non contractors (contract-type D) and let us think that trust has an important role in farmers’ decision to enroll and invest in the production of environmental services. This result thus highly support the existence of a transaction costs barrier, internal organization costs included, in the adoption of agri-environmental contracts. This may explain why farmers enrolled practices associated to rather low specificity levels compared to what was initially possible to choose.

If we look at the magnitude of these six expected variables estimated marginal effects (table 6), two of them allow to support our propositions. Namely, “goodwill trust in the State” and “to be involved in an agricultural organization” show higher coefficients for one or both specific contracts A. These two variables support, first, the higher the farmer trusts in the State, the higher the probability he chooses specific assets, second, the less uncertainty surrounds the agro-environmental transaction, the higher the probability the farmer chooses specific assets.

Beyond these observations, how to explain these six variables have “discontinuous” effect? Indeed, “to be involved in agricultural organizations” has a higher and significant effect on the specific contract A1 but has a non significant and negative effect on A2. The significancy effect is easily explained from the number of observations in contract A1 (68 observations) and A2 (20 observations). The coefficient difference comes from the fact that contracts in the same asset specificity level category are not homogenous on other significant aspects. However, it remains difficult to identify the origin of this effect.

Another discontinuous effect regards the variable “to receive regularly technical and administrative advices”. It only impacts on the non specific contract C1. This isolated effect may come from the fact that C1 requirements corresponds to the CAP orientation for the next coming years whereas the future of other contract types is far more uncertain. It is thus normal to observe that well informed farmers will prefer to enroll environmental friendly practices whose payment is less uncertain for a longer period.

Concerning variables describing the similarity of transactions and more particularly “grassland share”, whose effect is observable for the non specific contract C1 only, the explanation is certainly to be found in the compensation payment. Indeed, since it is calculated on average operational costs and profit foregone per region, the economy of scale and scope effect may be captured too in estimations. Following this reasoning, we should observe similar effects of the “grassland share” variable on both C1 and C2 contracts, but, this is not the case. This may come from the number of observations and the fact that contracts C differ in the technology they call. It is thus non surprising to observe that C2, which calls for non grassland farm technology, is not chosen by farmers with a high grassland share.

As regard to the four non expected variables, namely “environmental awareness”, “changes in the production system in the last 5 years”, “to have a lower agricultural education” and “to have already enrolled an agro-environmental contract”, we will only consider marginal effects. The farmers’ utility in the agro-environmental transaction, described with his “environmental awareness”, does not have any significant effect on his choice over compensated environmental friendly practices. However, it increases the probability he implements non compensated environmental friendly practices. This may be explained from the fact that environmental awareness is an overriding factor for non-contracting farmers to implement environmental friendly actions, whereas it is “competing” with other significant factors, such as the compensation payment, for contracting farmers.

To have a lower agricultural education has no effect on contracting farmers and a positive one on A2 contractors. This is explained from the characteristics of the agricultural education which used to be oriented towards productivity and did not give much attention to “green” production technologies. The positive impact observed in A2 contracts, is explained from farmers’ age. Indeed, this contract type gathers old farmers who did not receive any agricultural education.

Evolving production systems, observable through “changes in the production system in the last five years”, have a lower probability to enrol contract C1. The explanation has to be found in the contract technology requirements which correspond to farm production systems already existing: farms with high a grassland share. The variable “grassland share” supports this observation showing these farms have a higher probability to enrol contract C1. It is thus expected these farms are not in a dynamic of change since what contract C1 requires is what they are already doing.

Finally, the negative effect of the variable “to have already enrolled an agro-environmental contract” is easily explained from contract implementation dates. Indeed, except from contract A2, which originated in the 1992-reform of the Common Agricultural Policy, they all stem from the 1999-reform. Therefore, farmers with contract A2 could commit on a longer period than others

## **V. CONCLUSION**

The purpose of this paper was to identify conditions favouring farmers’ choice towards specific assets and to test propositions on these determinants. Results led to the conclusion that farmers’ trust in the State appears to be the most robust determinant of asset specificity. First, it distinguishes contracting farmers from non contracting farmers whereas variables describing the technology were expected to explain farmers’ behaviours but did not. Second, it highly supports the existence of a transaction costs barrier in the adoption of agri-environmental contracts, which may explain why farmers enrolled practices associated to rather low specificity levels. Finally, coefficients across practices allow to support that the higher the farmer trusts in the State, the higher the probability he chooses specific assets. In addition to trust, the effect of uncertainty was observed to negatively impact on farmers’ choice towards specific practices by increasing transaction costs but in a less rigid way. The similarity of transactions was found to have a significant positive impact on farmers’ choice towards specific practices by reducing internal organization costs, but coefficient across practices do not allow to confirm our proposition too. Non expected results were explained from (i) the calculation methodology of compensation payments which was based on average operational costs and profit foregone per region, and (ii) the heterogeneity of environmental friendly practices classes. Indeed, these classes are homogeneous on the asset specificity aspect, but they remain heterogeneous on technological, political and implementation calendar issues.

Keeping as an objective the production of environmental services in rural areas and low production costs, i.e. to enhance the adoption of environmental friendly practices involving specific assets, these results provide new outcomes for policy design. They particularly highlight the role of asset specificity and implied transaction costs and internal organization costs in the choice over different environmental friendly practices. In addition, by identifying

factors favouring the adoption of specific investments, recommendations are derivable to direct the State towards actions on these factors. For instance, knowing that farmers' trust in the implementation process has a major role, the State may work on the clarity of contract requirements so as to narrow its implementation interpretation spectrum. Trust may also be restored by balancing the State and the farmers' rights when a case is brought to private negotiation or to court. As regard to the uncertainty aspect, the State could improve its communication policy in order to reduce the opacity of its political actions. In practice, a better communication may go through an improved coordination between State agencies or a merging of agencies responsible for writing contracts, signing and paying. Finally, it is important to take internal organization costs into consideration when offering agro-environmental contracts and improving farmers' management skills by massively introducing computer systems, management software,... and associated education programs.

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## ANNEX

### Explanatory variables measuring “Trust”

#### TRUST IMPL

This variable encompasses farmers’ opinions (strongly disagree; somewhat disagree; somewhat agree; strongly agree; do not know) on the following statements:

- “The eligibility rules are fair”
- “The financial compensation is sufficient to cover the extra costs incurred by the farmer”
- “Compensation payments are always made on time”
- “The rules and requirements are easy to understand”
- “The measures can easily be implemented on my farm”
- “The intended environmental benefits are clear and easy to understand”
- “The current policy rules and regulations will remain constant over a longer period”
- “There is a lot of control when implementing measures”
- “The sanctions for not carrying out the contract are reasonable”

These statements were chosen because they tend to describe farmers’ expectation that the State will behave in a mutually beneficial manner (cf. section II.3.1). The global variable TRUST IMPL was created from these primary data using a Multiple Correspondence Analysis.

A positive TRUST IMPL is assumed to indicate the farmer trusts in the State. The higher it gets, the more the farmer trusts in the State.

#### GOODWILL

Similarly, GOODWILL gathers the following statements:

- “The procedures for contract applications are easy”
- “The rules and requirements are easy to understand”
- “It is easy to find the right person to contact in the administration when there are problems”
- “Regarding agro-environmental schemes, administration behaviour is fair and responsible”

A positive GOODWILL indicates the farmer trusts in the State. The higher it gets, the more the farmer trusts in the State.

### Explanatory variables measuring “Bounded Rationality”

#### AGRI EDUC

Bounded rationality is characterized with qualitative variables by creating classes of variables. Variables describing farmers’ education were assumed to measure their rationality since education is expected to provide solutions to problems and unable farmers to calculate the possible outcomes to these solutions (cf. section II.3.1).

The higher the education level, the less bounded the farmer’s rationality.

### Explanatory variables measuring “Uncertainty”

#### ORGA

This variable reports farmers’ membership and participation frequency in agricultural organizations. It was created using a Multiple Correspondence Analysis.

We assumed a farmer regularly meeting other farmers and people from the profession or involved in professional organizations better feel what is going on and what are policy orientations. This refers to the volatility aspect of uncertainty.

A positive ORGA indicates the farmer's perception about future conditions is rather clear and thus shows low uncertainty. The higher it gets, the less uncertain the farmer perceives future conditions.

#### ADVICES

This variable gathers information on organizations or persons farmers get technical, financial or administrative advices from. It was created using a Multiple Correspondence Analysis. ADVICES follows the same logic as ORGA, namely a positive ADVICES indicates the farmer benefice from conditions lowering uncertainty about future conditions. The higher it gets, the less uncertain the farmer perceives future conditions.

#### Explanatory variables measuring the "Similarity of Transactions"

Except from the production system type which is a qualitative variable, every variables describing the similarity of transactions are continuous.

As said in the body of the paper, the similarity of transactions is measured by comparing the initial technology with the technology required by enrolled environmental friendly practices. Therefore, from what we know about farm technology dedicated to the production of environmental services, the similarity of transactions is characterized as follows:

- the higher the grassland share, the more similar the transactions;
- the higher the farms land area, the more similar the transactions;
- the lower the arable land share, the more similar the transactions;
- the more labour force, the more similar the transactions;
- the bigger the animal population, the less similar the transactions;
- the bigger the milk quota, the less similar the transactions;
- An organic production system indicates similar transactions.

#### Explanatory variables measuring "Utility"

##### SENSI

This variable contains information on farmers' hobbies, readings and involvement in environmental associations. It was created using a Multiple Correspondence Analysis. We assumed a positive SENSI indicates farmers' environmental awareness and thus derive utility from environmental services. The higher SENSI gets, the more the farmer derives utility from environmental services.

We follow the same logic for the variable "free time dedicated in nature related hobbies". As regard to children, which gives the number and age of farmers's children, we assumed a farmer with young children will be more aware of environmental issues than farmers with no child.