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Farmers' Preferences over Conservation Contract Flexibility and Duration: An Estimation of the Effect of Transaction Costs Using Choice Experiment¹

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In this article, we analyze farmers' preferences for variations in three conservation contract attributes, namely flexibility, duration and bureaucratic tasks. Assuming farmers' preferences to be directly related to their profit variation, we present the different trade-offs associated to each attribute independently. We then show how the choice experiment methodology allows (i) to provide new empirical tests exempt from some endogeneity issues, (ii) to elicit the role of transaction costs on farmers' preferences, and (iii) to estimate and disentangle the effect of transaction costs on farmers' preferences. The empirical analysis is based on an experiment among 171 French farmers in 2005. Results highlight the role of transaction costs in farmers' preferences, among them, the effect of maladaptation costs is predominant.

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Farmers' Preferences over Conservation Contract Flexibility and Duration: An Estimation of the Effect of Transaction Costs Using Choice Experiment

1. Introduction

Environmental protection has traditionally been carried out using "command and control" and economic policy tools aiming at mitigating market failures to provide environmental goods. Besides the State, other kinds of actors, firms and consumers, are more and more involved in environmental protection. These policies involve public authorities at several degrees and private actors from the market and civil society. Those more participatory and co-operative policy tools differ from constraining approaches by promoting the voluntariness and environmental responsibility of uptakers. They rely on market forces and especially on the production of information enabling actors to take actions in favor of the environment.

The agricultural sector has experienced this evolution with the development of contractual approaches based on the free choice of farmers to undertake environmental-friendly measures. Policies such as EU agri-environmental schemes or the US Fish and Wildlife Service and non-profit land trusts give private landowners and land-operators the opportunity to enroll in a conservation program. Therefore, by giving a value to non-marketable goods such as landscape or biodiversity, these policies aim at influencing the trade-off of farmers between marketable goods and non-marketable goods towards more non-marketable goods². In European countries, agricultural conservation contracts have especially been administered at the European level. Several regulations have instituted conservation contracting (Regulation EU 797/87 (article 19), Regulation 2078/92, Regulation 1257/99) from which the agri-environmental contract has become the main instrument to encourage farmers to produce environmental services.

In this paper, we focus on this last scheme which is a voluntary five-year agreement between the State, represented by its local delegate, and the farmer who benefits a compensation to comply with given environmental friendly practices. Contract attributes such as contract

² A farmer produces both marketable and non marketable goods, i.e. he has a joint production system, since his farm is part of a natural environment.

duration are set by the regulation while others like the specific plot of land to enroll are left to the farmer. Given this contract design and the impact it may have on compliance and consequently on environmental outcomes, we suspect it to play a major role in the success of agri-environmental policies. The goal of this study is thus to add to the comprehension of the process of agri-environmental contract adoption by farmers. More precisely, we analyze farmers' preferences for variations in three contract attributes namely flexibility, duration and bureaucratic tasks. For that, we assume farmer's preferences are directly related to their profit variation when they choose a contract form instead of another. As will be presented later on, an original on-site experiment, called "choice experiment", provides us new type of data and allows to test our propositions.

We give special attention to the design of agri-environmental contracts for several reasons. First, this State-farmer relationship differs from the public-private partnership configuration where the government buys services to private agents whose main source of revenue are the tolls they can charge to users. In our case, we face a non marketable service which doesn't allow the farmer to charge a payment to users. Examples of environmental services among others are increased water quality (low nitrates), enhanced landscape and increased biodiversity. The farmer has thus no other source of revenue than the subsidy he perceives. Second, in addition to being dependent of biophysical conditions, environmental outcomes are linked to the interaction between numerous farmers in a given area. As such, an environmental service is a complex service and tends to be subject to several sources of uncertainties due to each farmer's behavior and environmental conditions. Thus, according to Bajari et al. (2001, 2003), these characteristics make the price coordination mechanism not efficient and contract design becomes a challenging issue.

In addition to specificities relative to the exchanged service, agri-environmental contracts deserve our attention for other reasons associated to the characteristics of the transacting parties and of the transaction environment (cf. Williamson terminology). First of all, environmental outcomes require site and time specific investments borne by the farmer. Indeed, significant and satisfying environmental outcomes highly depend on practice localization³ and timing according to climatic conditions and natural cycles. These specificities bring the farmer to improve his agronomic knowledge and his material park. For

³ It is important to note soil quality is a very heterogeneous production factor for farming purposes.

that, the State takes part in investments and provides several formations and technical services to farmers. Second, even if investments may be considered as observable⁴, it remains technically very difficult and very costly to link an environmental outcome to any of the investing parties. Therefore, contractual aspects are considered as unverifiable⁵. Finally, the agricultural sector faces frequent political changes with significant impacts on marketable good prices and, consequently on farmers' production system strategy, these being a source of maladaptation costs, i.e. opportunity costs, and decreasing non-marketable good contract incentiviveness.

We rely on previous literature analyzing the role of contract attributes in determining contracting parties' profit. To simplify the econometric treatment, we considered each attribute independently. In order to understand the farmer's choice when he faces contracts differing in their flexibility level, we set our analysis on Hart's model (1995) and the on-going work of Athias and Saussier (2006), which introduces maladaptation costs and renegotiation costs into Hart's trade-off. However, instead of comparing the total surplus attached to different investment levels we compare surpluses attached to different ownership structures, i.e. flexible or rigid contract, for the same level of investment. As such, we are able to observe changes incurred by flexibility level variations, *ceteris paribus*. Therefore, as regard to the trade-off on contract flexibility, the final model provides us with the following proposition: If we observe a higher probability to enroll when the proposed contract is flexible rather than rigid, the profit is higher and the effect of renegotiation costs is particularly low as compared to twice the effect of maladaptation costs.

As regards to the trade-off on contract duration we used previous theoretical and empirical research, which identify determinants of contract duration and the associated costs and benefits (Saussier 1998-1999, Joskow 1987, Crocker and Masten 1988). So, we argue that if we observe a higher probability to enroll when the proposed contract is shorter, the profit is higher for short-term contracts and the effect of maladaptation costs is higher than the effect of asset specificity.

⁴ There is symmetric information among partners. Indeed, in addition to on-site measure instruments, new technology developments provide satisfying control and monitoring tools as geographic information systems.

⁵ Hart (1995) defines unverifiability when there is uncertainty about the type of widget the principal requires. This uncertainty being resolved *ex post*. However, he defines observability as when parties have symmetric information throughout and when there is no uncertainty about parties' costs or benefits.

The level of the bureaucratic task attribute doesn't depend on a trade-off since we are only suggesting an empirical test to estimate these costs.

The choice experiment method offers tremendous possibilities for the study of preferences of agents for contract attributes. It was formerly set up for marketing research and recently in environmental economics to estimate consumers' willingness to pay for market and non marketable good attributes. Here, we use this method to estimate farmers' willingness to accept for agri-environmental contracts differing in their attribute levels. 171 French farmers were face to face interviewed in 2005. Although some forms of contracts are hypothetical, farmers get the opportunity to express their preferences over them and their attributes. As such, we believe this empirical application to be the first one to overcome the selection problem described by Masten et al. (1991) where "at best, one observes costs of the institution chosen so that direct comparisons with costs of alternative institutions are impossible". Moreover, the choice experiment allows to provide euro estimates of profit variations associated to different contract attribute levels and euro-estimates of bureaucratic costs. Finally, we use the choice experiment to highlight the role, the level and the type of transaction costs impacting on farmers' preferences. To our knowledge, except from Bajari et al. (2004) and Masten et al. (1991), very few papers propose such estimations.

Our main results show that (i) maladaptation costs have a higher effect than renegotiation costs in the trade-off between flexibility and rigidity, (ii) maladaptation costs have a higher effect than the costs of asset specificity in the contract length trade-off, and (iii) bureaucratic costs have a significant effect in the decision to enroll. This improved understanding of the effect of transaction costs in farmers' choice over contract attribute levels may serve to several applications, namely to improve preliminary comparison and screening across alternative policy instruments, or to enhance effective design and implementation of policies to achieve particular objectives, or also to evaluate current policies in order to improve their effectiveness (McCann et al., 2005).

The paper is organized as follows. Section 2 aims at showing that current agri-environmental contracts generate several transaction costs borne by farmers and attempt to describe their factors. Section 3 gives the different trade-off associated to each contract attribute and derived propositions. Section 4 presents the choice experiment method and the econometric model specification. In section 5, we present and discuss the results. Section 6 concludes.

2. Characterizing transaction costs of agri-environmental contracts

Agri-environmental contracts involve several types of costs such as (i) set-up costs, (ii) enforcement costs, (iii) maladaptation costs, and (iv) renegotiation costs, which may be described as follows⁶.

(i) The costs of writing borne by the farmer are the costs of looking for information on what contract requirements consist of. Some of them are more technical and complex and may require an external technician. As an example, measures concerning fertilization issues call for advanced agronomic knowledge, whereas those dealing with biodiversity call for ecological skills. Often farmers carry out a on-farm diagnostic too consisting of GIS mapping, soil analysis, etc...

(ii) EU regulation requires administrative controls carried out on all uptakers whereas 5% of farms undergo on-farm controls and controls following a risk analysis. Enforcement costs are mostly bureaucratic tasks. The farmer has to register every operation on a day-to-day basis and may be selected for an on-farm control.

(iii) Maladaptation costs are associated to a rigid contract in the face of unforeseen contingencies. They can also be considered as opportunity costs. We identify four types of factors that may play a role on these costs. *Climatic factors* refer to exceptional meteorological conditions. Concerning the measure called "late mowing of meadows", the payment is designed to cover losses in the quality and quantity of hay because of late mowing. However, compliance costs for farmers depend on climatic factors. A non renegotiable date does not take account of exceptional conditions and may put a damper on contract adoption. Note that some regions undertook initiatives that gather farmers and environmentalists to negotiate each year the mowing date as a function of weather conditions. *Market factors* refer to the evolution of input and output prices. Some requirements of agri-environmental contracts are specific to a production, for example "low fertilization for corn". Then, farmers cannot change production during contract length whatever the evolution of corn prices. *Farm structure factors* relate to changes in farm capital or legal status. For example, administrative

⁶ To fully relate the type of transaction costs involved in agri-environmental contracts, we met a member of ADASEA of Basse-Normandie, which is an organization entrusted with managing agri-environmental contracts, their content and their payment. We also conducted interviews with 30 contracting farmers in Basse-Normandie.

difficulties arise when individual farmers want to shift to another legal form like joint farming groupings, or when they buy or sell land plots. There are also *institutional environment factors*. Indeed, our interviews revealed that some farmers regretted their agri-environmental contract uptake since decoupled single farm payments (introduced by 2003 EU Common Agricultural Policy reform) were set as reference to their production in years where their production could have been higher were they not engaged in agri-environmental contracts. Other farmers experienced problems on leased land especially because the owner wanted to stop the lease arrangement.

(iv) Renegotiation costs are associated to a flexible contract or a rigid contract where parties cannot commit not to renegotiate. They are the costs and the time spent on administrative procedures to amend the initial contract and thus should mainly depend on the administrative organization. We could observe that, in our study area Basse-Normandie, about 50% of agri-environmental contracts had been modified or fully renegotiated in our study area because of non adapted requirements to unforeseen contingencies. In the case of agri-environmental transaction, the likelihood of contract renegotiation may have two dimensions. It is a dependent dimension when the farmer prefers to amend his contract than supporting high maladaptation costs. Whereas there are numerous other external factors which make this dimension independent. Firstly, they are political decisions, namely changes of the EU common agricultural policy, changes of land property rights where agri-environmental contracts are contracted, or changes of other policies like land takings for community facilities building. When taking occurs, farmers have to shift or remove hedgerows for which they receive a payment. Even if the farmer is often not accountable for changes in institutional parameters, administrative procedures are complex and time consuming and, agri-environmental contract payments are often suspended until a decision is reached. Then, there are cases of absolute necessity (external, unpredictable and irresistible) such as physical incapability proved by a doctor certificate, natural disaster acknowledged by the State, death, epizootic,...

It is thus obvious agri-environmental contracts involve non negligible transaction costs for the farmer. Next section aims at providing explanations on farmers' choice when contract differ in their attribute levels.

3. Model and Propositions

As regard to the methodology of the choice experiment⁷, we treat each attribute independently.

3.1. Trade-off associated with the choice of flexibility over rigidity

We rely on previous literature analyzing the role of contract flexibility level in determining contracting parties' profit. Even if recent developments in the agency theory allow to relax some of its assumptions, namely the “full control of communication channels” or the “full commitment” (Malin and Martimort, 2000), this branch of the literature which sets its analysis on asymmetric information and full rationality of judges was taken off. Moreover, since the farmer has residual control right over the way the service is provided and bargaining may take place over the splitting of the surplus, these characteristics impede the crafting of a complete contract. The framework proposed by the incomplete contract theory, which takes judges' bounded rationality into account, seems therefore to fit well with our transaction. However, the identified trade-off between two ownership structures in the model of Hart only considers the hold-up problem, i.e. the ex-post quasi-rent distribution issue, whereas transaction costs attached to both governance structures should matter too (cf. section 2). We will thus resort to the model developed by Athias and Saussier (2006). This model introduces some elements of the transaction cost theory, which acknowledges the role of transaction costs incurred *ex post* (renegotiation and maladaptation costs) in determining efficient contract designs, into Hart's trade-off.

We consider two contracting parties, the State and the farmer. Figure 1 shows the relationship between these two parties.



Figure 1: Contract description when trade occurs

⁷ See next section for further explanations.

The State offers a payment for agri-environmental services performed by the farmer. The farmer makes investments to produce these services (at a cost decreasing with his investment level). These outcomes are non contractible because the environmental outcome is uncertain most of the time. It is dependant on complex biophysical phenomenon, on the behavior of other farmers in the area also. It is then difficult for the State to induce farmers' behavior from observed environmental outcomes. The farmer invests e in the relationship whereas the State invests i . On the farmer' side, investments relate mainly to actions such as reducing fertilizer applications, mowing meadows in a certain manner, etc. Farmers' investments for such actions may be the purchase of specialized equipment that enable to reach a better environmental outcome. The State investment is related to efforts made to establish better diagnostics of the farm, to provide advice to farmers and to coordinate farmers in a given area. Although investments made by the State may be non-negligible, we focus on farmer's investment. We consider that parties may sign two kinds of incomplete contracts: a rigid and a flexible one. Let π^r (respectively π^f) be the farmer's profit when he enrolls a rigid and renegotiable contract (resp. a flexible contract). Before presenting the trade-off faced by the farmer, we introduce the variables and notations used in the model.

If trade occurs, the farmer's production costs are denoted by $C(e)$ with $C' < 0$ and $C'' > 0$ and her *ex-post* payoff is $p - C(e)$ whereas the surplus of the State is denoted by $R(i)$ with $R' > 0$ and $R'' < 0$ and her *ex-post* payoff is $R(i) - p$. If trade does not occur, the farmer will sell his agro-environmental services on the competitive spot market for p_0 but will have to make some adjustments to turn it into a general purpose service. The environmental services are non marketable because they have public goods properties. The outside option may however be a demand for environmental services by a local jurisdiction or by environmental associations such as land trusts although the system does not exist yet in France. However, the probability of an outside option is low and we expect p_0 to tend to zero. We consider the outside option price as constant. In the outside option case the farmer's production costs are denoted by $c(e)$ so that the farmer *ex-post* payoff is now $p_0 - c(e)$. Symmetrically, the State faces an outside option where it can buy agro-environmental services at price p_0 with a surplus denoted by $r(i)$ and an *ex-post* payoff that amounts to $r(i) - p_0$. In the outside option, the State will buy environmental services from a lower jurisdiction for example. We note $c(e) = \alpha C(e)$ the cost

of the outside option for the farmer in case of *ex post* contract breach ($\alpha \in [0;1]$ is a measure of the level of investment specificity), i.e. costs when agro-environmental services are used outside of the contractual relationship. We assume that when $\alpha \rightarrow 1$, there is high asset specificity. When asset specificity is high, the outside option costs are very high in case of contract breach.

We consider 2 types of *transaction costs*: costs due to unforeseen contingencies, and costs of enforcing contracts (Tirole, 1999)⁸, and specify them as follows.

Consider, first, transaction costs due to unforeseen contingencies. Let f be a measure of the adequacy of the contract to the states of nature and $(1 - \eta)$ the probability that a rigid contract is renegotiated. Like Athias and Saussier (2006), we distinguish maladaptation costs, f^m , from renegotiation costs.

f^m are the opportunity costs when a rigid contract is non efficient (when $f^m \rightarrow 0$, there are no maladaptation costs). We use the same assumptions as Masten and Crocker (1991), Crocker and Reynolds (1993) and Bajari and Tadelis (2001): maladaptation costs of a rigid contract are an increasing function of contract duration and uncertainty (endogenous uncertainty). We also argue “internal organization costs” studied in the paper of Masten et al. (1991) are part of maladaptation costs and assume they are an increasing function of the non similarity of the new transaction with existing ones.

f^r are the costs of haggling and friction due to *ex post* changes and renegotiation, including re-writing of the contract, when contracts are flexible (when $f^r \rightarrow 0$, there are no renegotiation costs). We assume as Crocker and Masten (1988) that the likelihood of contract renegotiation increases with contract duration. A rigid contract may be renegotiated for efficiency considerations and for political decisions (lobbying or specific political context) even though they are efficient. We consider that the probability of contract renegotiation $(1 - \eta)$ is exogenous. Renegotiation takes place when the farmer is renting land and when for example the owner of contracting tract of land claims his land. This landowner may be private but also public like a municipality who takes back the land for public infrastructures.

⁸ Tirole (1999) identifies a third type of transaction costs we do not consider in our analysis. It is the costs related to contract writing. We do not take account of fixed costs of writing the initial contract. However, when renegotiation occurs, the additional costs of re-writing the contract are not included in renegotiation costs, f^r .

Although renegotiation may take place for efficiency reason, we do not consider this possibility for simplification.

The second type of transaction costs is due to contract enforcement. These costs are additional variable costs and are included in $C(e)$ ⁹.

The timing of the model is indicated in figure 2.

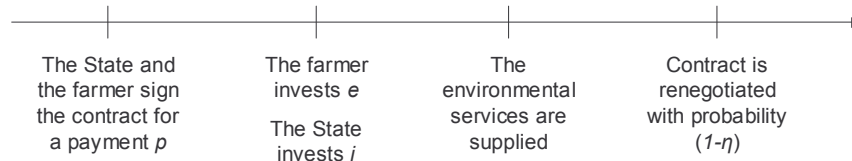


Figure 2: Timing

To analyze the trade-off between rigidity and flexibility, let us write the farmer's profits for each type of contract. When parties engage in a flexible contract, the contract is constantly adjusted to the state of nature so that no maladaptation costs are incurred but renegotiation costs. We assume that the farmer and the State have equal bargaining power in case of contract breach (Nash bargaining solution)¹⁰. The farmer's profit when he enrolls a flexible contract writes:

$$\pi^f = p_0 - \alpha C(e) - e + \frac{1}{2} \left[(R(i) - f^r C(e)) - (r(i) - \alpha C(e)) \right] \quad (1)$$

where p_0 is the price of agro-environmental services bought on the spot market from an outside supplier in case of contract breach, $\alpha C(e)$ is the cost of providing agro-environmental services when trade does not occur, $C(e)$ is the cost of providing agro-environmental services

⁹ This is a simplifying assumption. Guasch et al. (2005) consider for example that the probability of contract renegotiation depends on the level of expenses incurred to finance the functioning of an enforcement mechanism.

¹⁰ In certain circumstances, renegotiation of agro-environmental contracts is discussed in a commission where each party is represented (Commission Départementale d'Orientation Agricole). It is particularly true for negotiation concerning landowner claims on contracted land or change in farm status. However, our assumption of equal bargaining power does not hold for other types of contract renegotiation.

when trade occurs, $R(i)$ is the surplus generated by the investment i for the State, $r(i)$ is the outside option value, for the State, and f^r are renegotiation costs.

The farmer's profit when he enrolls a rigid and renegotiable contract writes:

$$\begin{aligned} \pi^r = & \eta(p - f^m C(e) - e) \\ & + (1 - \eta) \left(p_0 - \alpha C(e) - e + \frac{1}{2} [(R(i) - f^r C(e)) - (r(i) - \alpha C(e))] \right) \end{aligned} \quad (2)$$

where η is the probability that the rigid contract is not renegotiated and f^m are maladaptation costs.

The flexible contract is then strictly preferred to the rigid one when $\pi^f > \pi^r$ that is when the following function is positive:

$$\Delta(f^r, f^m) = \pi^f - \pi^r = \eta \left[p_0 - p + \frac{1}{2} (R(i) - r(i)) + \frac{1}{2} ((2f^m - f^r) + \alpha) C(e) \right] > 0$$

At this point, we make some assumptions that fit our empirical analysis to derive propositions to be tested. As is presented in the next section, the choice experiment allows to fix all the variables except the variables of interest, namely f^r and f^m . The problem boils down to the following: the farmer strictly prefers a flexible contract to a rigid one when:

$$(2f^m - f^r) > k \quad (3)$$

where $k = \frac{2(p - p_0) - (R(i) - r(i))}{C(e)} - \alpha$ is a constant.

We can derive a proposition from equation (3).

Proposition 1: If we observe a higher probability to enroll when the proposed contract is flexible rather than rigid, the profit is higher and the effect of renegotiation costs is particularly low as compared to twice the effect of maladaptation costs.

Making further assumptions enables us to simplify the analysis. Suppose that the State is benevolent and derives no profits from the relationship. Then $R(i) - p = 0$ and $r(i) - p_0 = 0$. Suppose further that there is no outside option that is $p_0 = 0$.

The constant k becomes $k = \frac{P}{C(e)} - \alpha$. And assuming that $p > C(e)$, k is positive.

Therefore, we can write the following relationship:

$$2f^m > k + f^r > f^r$$

We can refine proposition 1 :

Proposition 1bis: Assuming $R(i) - p = 0$, $r(i) - p_0 = 0$, $p_0 = 0$ and $p > C(e)$, if we observe a higher probability to enroll when the proposed contract is flexible rather than rigid, the profit is higher and the effect of renegotiation costs is lower than twice the effect of maladaptation costs.

3.2. Trade-off associated with contract duration and bureaucratic tasks

To our knowledge, except Crocker and Masten (1988), there are no studies attempting to specify the trade-off on contract duration. Their model differs from our problematic since they consider renewable contracts differing in their length. However, they point several variables of interest. They determine the optimal contract length as a trade-off between contracting for a period of time τ (incurring costs of contractual rigidities) followed by a day-to-day contracting for the period $T - \tau$ (incurring bargaining costs in each period) and contracting on a day-to-day basis during the entire period T (incurring bargaining costs in each period). Costs of contractual rigidities are "inflexibilities in the face of fluctuation in supply and demand". Bargaining costs represent costs of haggling over the quasi-rent distribution at the end of each contract (the quasi-rent is a function of asset specificity). As stated by Crocker and Masten (1998), "the optimal contract length reflects a trade-off between the costs of negotiating the terms of the trade on a period-by-period basis and the hazards of being bound to an inflexible agreement for an additional length of time". The empirical literature is more numerous. Joskow (1987) argues contract duration is an increasing function of asset specificity. Crocker and Masten (1988) and Saussier (1998, 1999) support Joskow's findings and provide evidence duration is also a function of uncertainty.

Thus, for our study, we derive a proposition based on two key variables, namely the costs linked with uncertainty (in our terminology, maladaptation costs) and those linked with asset specificity. It is interesting to note that flexible contracts enable to get rid of maladaptation costs, and are only influenced by asset specificity in the duration trade-off. We derive the following proposition:

Proposition 2: If we observe a higher probability to enroll when the proposed contract is shorter, the profit is higher for short-term contracts and the effect of maladaptation costs is higher than the effect of asset specificity.

A third type of contract attributes we want to test for is the effect of paperwork on farmers' decisions to enroll. The costs of enforcement borne by the farmer are bureaucratic tasks he has to fulfill in order to receive his premium. This attribute does not imply any trade off. Therefore, the expected result is straightforward: the more time bureaucratic tasks imply, the higher these costs.

4. Choice experiment and empirical specification

4.1. Using the choice experiment to estimate the magnitude of transaction costs

Initially developed in marketing, the choice experiment method has then been applied in environmental economics in order to estimate the societal demand of environmental services (Adamowicz et al., 1994). This is here applied to estimate transaction costs supported by the farmer. This method is similar to contingent valuation methods where "scenarios" are defined and presented to interviewed persons with given prices. In this study, scenarios are agri-environmental contracts that differ in their attributes only. More precisely, a scenario is a combination of 5 contract attributes with given levels. Table 1 presents contract attribute levels chosen for the application of the choice experiment in our agri-environmental transaction. The contract flexibility appears as two contract attributes: to have the possibility to choose which acre to enroll ("site flexibility") and the freedom to negotiate other requirements in the contract ("other requirement flexibility"). This should allow to distinguish costs attached to site specificity from others: the costs attached to time aspects.

Contract attributes	Number of levels	Attribute levels
Contract duration (years)	3	5; 10; 20
Site rigidity	2	Yes; no
Other requirement flexibility	2	Yes; no
Average paperwork per month	3	< 30 min; 30-75 min; > 75 min
Premium ^a	3	5%, 10%, 20%

^a % of the reference contract payment per year and per hectare

Table 1: Contract attributes and attribute levels chosen for the choice experiment

The farmer is presented with 4 sets of contracts. For each set, he is asked to choose 1 contract among 3 (see Table 2 for an example of set). Contract C is the reference contract presented in all contract sets to all respondents. It is a contract design the farmer is familiar with. This experiment includes 24 sets in total. The principle is thus to use the information brought by individuals' choices in order to infer the value of contract attribute levels considered in different contracts. The observation of this value is made possible by variations of proposed attribute levels and the observation of choices within these alternatives only. Nevertheless, this identification relies on simplifying hypothesis. In particular, interactions between attributes are assumed not to have any particular value for interviewed individuals¹¹, i.e. the value of a contract is the sum of its attribute level values. This hypothesis is true as far as interviewed farmers declare not to rank attributes¹². In addition, the utility is assumed to be linear in this value.

Contract attributes	Contract A	Contract B	Contract C
Duration per year	5 years	10 years	5 years
Site rigidity	No	Yes	Yes
Other requirement flexibility	Yes	Yes	No
Paper work per month	< 30 minutes	30 min – 75 min	< 30 minutes
Premium	10%	20%	0%
Chosen contract			

Table 2: Example of a set of contracts where contract C is the reference contract

¹¹ The attribute independency hypothesis can be relaxed thanks to more developed econometric models such as latent classes for instance.

¹² Cf. section 3.2 describing the hypothesis of the logit conditional model and section 4.2 describing the sample

As will be developed in the next section, the choice experiment method provides euro estimates of transaction costs and new types of outcomes. Indeed, empirical studies to date compare observed organizations which are confronted to a selection problem: transaction costs cannot be directly observed for organizational forms not chosen (Masten et al., 1991). The choice experiment allowing effective comparison between contract attribute levels, it resolves simultaneity and endogeneity issues. However, this method is based on revealed preferences and introduces behavioral bias as opportunism, risk aversion or status quo. Econometric treatments are then possible to improve estimations but won't be specified in this paper.

4.2. Empirical specification

The rationality of the choice experiment is that farmer i prefers a contract c in the set of contracts j ¹³:

$$U_{cji} = \text{Max} \{U_{1ji}, U_{2ji}, U_{3ji}\} \quad \begin{cases} c=1,2,3 \\ j=1 \dots 24 \\ n=1 \dots 171 \end{cases} \quad (4)$$

The farmer chooses the contract c among 3 contracts which brings him the highest utility U_{cji} . As the farmer is asked to express himself for constant investments, contract attribute levels tend to be the only changing variables.

Random Utility Models set as an hypothesis that the utility function is linear with a_{kej} , the level of the contract attribute k in the contract c of the set of contracts j , ρ_{jc} , the price (premium) of the contract c of the set j , α the basis utility level, and e_{cj} the independent random utility part.

$$U_{cji} \equiv \alpha_i + \sum_{k=1}^4 \beta_{ki} a_{kej} - \beta_{vi} \rho_{cj} + e_{cji} \quad (5)$$

Individual parameters β_{ki} and β_{vi} are associated to attributes k and prices v of the different contracts. They are assumed to depend neither on j nor on c , i.e. the value attached to a contract depends on its attribute values and its price only. Explanatory variables, a_{kej} and ρ_{jc} , are therefore choice-specific and not individual-specific, i.e. attribute levels vary but

¹³ The economic specification and the model estimation by the choice experiment method have been adapted from Bonnieux et al. (2004) and Ruto et al. (2004).

individual characteristics do not. Error terms, e_{cji} , are independent and identically distributed, and follow a Gumbel law (0, 1).

In the choice experiment, farmer i chooses the contract 1 in the set of contract j is and only if:

$$U_{1ji} - U_{cji} > 0 \text{ with } c = 1, 2, 3 \text{ and } c \neq 1$$

Therefore, only utility level differences enter in individual observed choices.

$$U_{1ji} - U_{cji} = \sum_{k=1}^4 \beta_{ki} (a_{k1j} - a_{kcj}) + \beta_{vi} (v_{1j} - v_{cj}) + \omega_{1ji} - \omega_{cji} \quad (6)$$

In this case, the probability that farmer i chooses contract 1 in the set of contracts j is given by :

$$P[y_{ji} = 1 / \beta_i, \beta_{vi}, a_{cj}] = P[U_{1ji} > U_{3ji}, U_{1ji} > U_{2ji} / \beta_i, \beta_{vi}, a_{cj}] \quad (7)$$

To simplify, we assume individual preferences are homogenous:

$$\beta_i = \bar{\beta} \text{ and } \beta_{vi} = \bar{\beta}_v.$$

The specification of this probability is then:

$$P[y_{cji} = 1 / a_{ji}, v_{ji}, \bar{\beta}_1, \dots, \bar{\beta}_K, \bar{\beta}_v] = \frac{\exp \left[\sum_k \bar{\beta}_k a_{kcji} - \bar{\beta}_v v_{cji} \right]}{\sum_c \exp \left[\sum_k \bar{\beta}_k a_{kcji} - \bar{\beta}_v v_{cji} \right]} = \frac{\exp[u_{cji}]}{\sum_c \exp[u]} \quad (8)$$

This is the expression of an alternative choice probability in a logit conditional or multinomial model (Mac Fadden, 1973, 1981). However, the logit conditional model is better adapted to our question since we seek to analyze farmers' choice as a function of alternative characteristics they are presented to, i.e. contract design described as a combination of attribute levels, whereas the logit multinomial model would allow analyzing farmers' choice as a function of their own individual characteristics. We are thus using the logit conditional model that we estimate with the maximum likelihood method.

The interpretation is as follows: when the farmer chooses a contract, we consider the farmer compares the utility the "reference contract" (contract C from the table n°3 and U_{3ji} in equation 4) brings him with the two other contracts' utility. He then chooses the contract with the highest utility. The estimation of the logit conditional model thus allows to identify significant contract attributes and to observe their effect on the probability farmers enroll an other contract than the reference one.

Parameter $\overline{\beta}_k$ is the positive or negative utility variation (utility units) attached to attribute k by comparing attribute k level with the reference contract. Parameter $\overline{\beta}_v$ is interpreted as $\overline{\beta}_k$. It is thus seen as the marginal utility of an additional euro premium (utility units per euro). Moreover, these two parameters allow to measure farmer i 's willingness to accept (WTA) for the attribute k level instead of the reference one by calculating the marginal rate of substitution between an attribute level variation and a money quantity variation:

$$WTA_k \equiv - \frac{\overline{\beta}_k}{\overline{\beta}_v}$$

Therefore, a positive WTA, in other words, a lower probability to enroll, must be understood as a supplement of premium that would maintain farmers' utility when the level of a contract attribute changes. The link is then straightforward with the framework presented in part 2.2.: the WTA corresponds to the farmer's profit variation when a contract attribute level varies, *ceteris paribus*. Therefore, a positive WTA reflects a negative profit variation, and *vice versa*. According to our model, this profit variation is thus dependent on transaction costs the model allows to disentangle.

5. Results of the choice experiment

5.1. The sample

171 farmers were face to face interviewed in 2005 in the French region "Basse Normandie". Farmers were asked to express themselves 4 times, which makes 684 observations and thus more than 28 observations per set of contracts. The reference contract is an agri-environmental contract with requirements the farmer is familiar with. Respondents being current contractors, this is thus one of their enrolled environmental friendly practices. The chosen reference contracts all have the same design (5-year duration, possibility to choose which acre to enroll, no possibility to choose any other requirements of the contract, less than 30 minutes per month of paper working). Even if they do not present the same requirements, they imply the same low level of investments and they are site and time specific. The annual premium per hectare of the average farmer is about 117€, knowing that the highest registered premium from the sample is 260€/year/ha and the lowest one is 30€/year/ha.

The sample is quite representative. The most frequent farming systems are, by decreasing order: dairying, combined grazing livestock, field cropping. This region is average farm intensive. Table 3 shows the main motivation of farmer's contract choice:

Premium	7.6%
Paper work time	5.9%
Contract flexibility	16.4%
Contract duration	16.4%
Best trade-off between contract attributes	45%
Other	2.3%
Non commitment ¹⁴	6.4%
	100%

Table 3: Farmers' choice main motivations

45% of farmers have chosen a contract because it presents the best combination of attributes and thus do not have any preference on a particular attribute. This supports the hypothesis on attribute independence and so the IIA hypothesis set for the conditional logit model.

Descriptive statistics are shown in Table 4.

Attributes	Attribute levels	Observation rate
Contract duration	5 years	61%
	10 years	23%
	20 years	16%
Site rigidity	yes	25%
	no	75%
Other requirement flexibility	yes	57%
	no	43%
Paper work	< 30 min	36%
	30-75 min	41%
	> 75 min	23%
Premium	0%	28%
	5%	19%
	10%	25%
	20%	28%

Table 4: Descriptive statistics

¹⁴ Non commitment refers to farmers non willing to enroll any proposed contracts.

Among the 684 observations, we got 41 non answers, i.e. the farmer couldn't choose a contract among those proposed. We therefore have 643 observations in total. Descriptive statistics show that 61% of farmers prefer 5-year contracts, 75% prefer to have the possibility to renegotiate site requirements and 57% the other requirements (fertilizing dates for instances). Surprisingly, 41% of farmers have chosen average paperwork and they equally prefer a subsidy equal to the current one as a subsidy 20% higher.

5.2. Econometric results

Table 5 indicates estimates of coefficients $\overline{\beta_k}$ and $\overline{\beta_v}$. Estimations are significant for all attributes¹⁵. The model adjustment quality is medium as the pseudo Mc Fadden R^2 is 0.14, which corresponds to a 0.3 R^2 .

As specified in our model, the WTA is calculated from the ratio $-\frac{\overline{\beta_k}}{\overline{\beta_v}}$. Besides, euro estimates are derived from the average farmer's premium, namely 117€/year/ha. It is important to remind this estimation is interpreted as a profit variation when contract design varies. From table (?) attribute signs must be read as follows. *Contract duration* corresponds to an increase of the contract duration of 1 year from a 5 years minimum. *Site rigidity* means to not have the possibility to negotiate land plot localization *ex post*. *Other requirement flexibility* refers to the possibility to negotiate contract requirements *ex post*. *More paperwork* corresponds to an increase in the time spent on administrative tasks per month from less than 30min span to a 30-75min span and to a more than 75min span. *Premium* refers to an increase of the proposed premium compared with the reference premium per hectare from 5% to 10% and to 20%.

¹⁵ In willingness to pay and willingness to accept elicitation methods, it is common to observe that people are reluctant to make changes and have a preference for their current contract. Environmental economics calls this behavior a status-quo bias in the method. When we consider that non responses correspond to preferences for the reference contract, attributes significance and signs remain unchanged. The pseudo Mc Fadden R^2 remains also the same.

Attributes	Parameter Estimations	Standard Error	Khi 2	Pr > Khi 2	WTA (%)	WTA (€)
Site rigidity	-0.53448	0.11838	20.3841	<.0001	8.87	10.38
Other requirement flexibility	0.59705	0.11503	26.9388	<.0001	-9.91	-11.60
Contract duration	-0.09766	0.01060	84.9318	<.0001	1.62	1.90
More Paper work	-0.28405	0.06491	19.1475	<.0001	4.72	5.52
Premium	0.06023	0.00784	59.0446	<.0001	–	–

Table 5: Results of the conditional Logit model

Our propositions enable us to interpret the results.

Let us consider first the trade-off between flexibility and rigidity. Two items enable to draw conclusions. The first is "site rigidity" and elicits $\pi^r - \pi^f$.

When farmers loose the possibility to choose land plots to enroll, they are willing to accept a higher premium. The increase is rather important as it reaches 8.87% of the premium. This means that farmers experience a negative profit variation.

As a result, the WTA of 10.38€ per hectare per year is at least a lower bound estimation of profit variation. These are additional costs to introduce in the premium calculation¹⁶ in order to maintain farmers' utility when a contract becomes rigid on the site issue.

According to proposition 1, the following interpretation is offered:

An increase in contract rigidity that leads to a negative overall effect on profit variation corresponds to the dominance of the effect of maladaptation costs over the effect of renegotiation costs.

Accordingly, farmers suffer more from additional costs due to unforeseen contingencies like exceptional bad weather conditions than the costs of amending the contract to adapt to changing conditions. In case of a rigid contract, the State chooses which tract of land to enroll in the offered contract. Suppose the State identified a tract of land on a given farm where adopting agri-environmental actions would lead to high environmental outcomes. In the production function of the farmer, the land is an input to market good production. This input is characterized by its soil quality (that determines the market good yields) and by its localization (that determines its vulnerability to climatic factors like floods for example and

¹⁶ Initially calculated up to 117€ per hectare per year.

its ability to be transferred to other landowners) . If the landowner accepts the contract and uses his tract of land primarily for environmental production then his maladaptation costs will depend on the evolution of market good prices, climatic conditions and opportunities to sell land.

The second item dealing with flexibility over rigidity is "other requirement flexibility" and elicits $\pi^f - \pi^r$. The parameter estimate leads us to the same type of conclusion. When farmers get the possibility to negotiate contract requirements, they are willing to accept a lower premium. The decrease is important as it amounts to 9.91% of the premium. This means that farmers experience a positive profit variation. As a result, the WTA of 11.60€ per hectare per year is at least a lower bound estimation of profit variation. These are costs to withdraw in the premium calculation¹⁷ in order to maintain farmers' utility when a contract becomes flexible. According to proposition 1, we come down to the same interpretation as for the site item.

Let us now consider the effect of an increase in contract duration. When farmers get the opportunity to contract for an additional year, they are willing to accept a higher premium. This increase is 1.62% of the reference premium. This means that farmers experience a negative profit variation. The WTA of 1.90€ per hectare per year is at least a lower bound estimation profit variation. These are the costs to add to the premium calculation in order to maintain farmers' utility when contract length increases by one year.

According to proposition 2, we interpretation is as follows:

The farmer experiences a higher profit for a shorter contract, which means the maladaptation cost effect is higher than the asset specificity effect. This supports the idea that asset specificity is rather low.

Finally, concerning bureaucratic tasks, when the farmer is asked to work for 45 minutes more on bureaucratic tasks, he is willing to accept a 5.52€ increase of the premium.

¹⁷ Initially calculated up to 117€ per hectare per year.

6. Conclusion

Our paper aimed at understanding agri-environmental contract adoption by farmers as a function of contract attributes. We considered two trade-offs faced by farmers: flexible vs. rigid contracts and short-term vs. long term contracts. We used an incomplete contract theory model based on Hart (1995) and Athias and Saussier (2006) to draw propositions to be able to interpret our empirical results. We conducted a survey on 171 French farmers in order to identify transaction costs attached to different contract designs. Each contract form is a combination of four attributes: site rigidity (the impossibility to choose which acre to enroll), other requirement flexibility (the possibility to renegotiate contract requirements), contract duration, and more paperwork. Our work uses the choice experiment to overcome selection bias and enables to highlight the role, the level and the type of transaction costs in farmers' decisions.

Our results show that (i) maladaptation costs have a higher effect than renegotiation costs in the trade-off between flexibility and rigidity, (ii) maladaptation costs have a higher effect than the costs of asset specificity in the contract length trade-off, and (iii) bureaucratic costs have a significant effect in the decision to enroll.

Moreover, we provided euro estimates of profit variations, roughly 22€ (11.60 + 10.38) per hectare per year when a rigid contract is proposed instead of a flexible one. At the moment, the reference contract is flexible for the site attribute but rigid for the other requirements and offers a premium of 117€. Thus, if the contract were entirely rigid, the premium would be roughly 128€ (117 + 10.38) per hectare per year in order to maintain farmer's utility. As regards to contract duration, the profit variation estimation is roughly 1.90€ per hectare for an additional year. Finally, the choice experiment provides euro-estimates of bureaucratic tasks too, that corresponds to a variation in enforcement costs (since the transaction costs related to this variable are exogenous). The lower bound estimate is 5.50€ per 45min or 7.40€ per hour. To get a better idea of what these figure refers to, consider the French 2006 minimum wage which is 8.5€ per hour.

From this type of results, public authorities may be able to identify what is responsible for farmers' profit variation when they decide to implement a contract design instead of another one. Therefore, in order to guarantee farmers' adoption, they might have three action possibilities: whether (i) they directly act on the premium level according to estimated profit

variations, or (ii) they act on contract attribute levels such as introducing negotiation devices and then relaxing some contract rigidities¹⁸, and finally (iii) they can have an indirect action by targeting their efforts on transaction cost factors. Indeed, in our case study, knowing maladaptation costs have a predominant effect on farmers' preferences and factors of these costs being identified (cf. section 2), public authorities may choose to act on market factors¹⁹ and adopt a more coherent policy between marketable and non-marketable good prices.

Our results also show that, concerning contract attributes, environmental objectives may be at odds with farmers' objectives. Two dimensions are important in environmental processes: space and time. Environmental outcomes are generally linked with a minimum number of enrolled acres (non linearity is pervasive in environmental processes because of threshold effects) and long-term considerations (environmental-friendly practices lead to higher environmental impacts only after a long delay). First, for space to be taken into account, public authorities should propose contracts for specific acres to enroll (for example, all acres along a river for buffer strips). The items in the choice experiments linked with a reduction of flexibility shows an increase of willingness to accept of about 10.38€ per hectare. Besides, a longer agri-environmental contract brings a higher level of environmental benefits but requires a premium increase of 1.90€ per year.

This research leaves a number of issues unresolved. We have focused on transaction costs borne by the supplier, but what about the State's transaction costs when we reduce farmers' transaction costs? This study is a first approach since chosen contract attributes cover several determinants of transaction costs and induce difficulties to disentangle effects. However, the theoretical analysis provides clues to refine contract attributes. For instance, future research might explore interaction effects between attributes. Finally, other determinants of transaction costs not considered in this analysis may have significant effect farmers' preferences notably how are contract attributes designed in the first place and by whom. Issues such as what organization participates in the forums may highly impact on contract adoption.

¹⁸ For instance, so as to lower the uncertainty linked to climatic factors, a system of yearly negotiation with the different stakeholders may be developed as it is currently observed in some water management contracts.

¹⁹ In the agricultural sectors, public authorities have lots of influence on marketable and non-marketable good prices.

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