Private forest owners' participation behavior related to an incentive conservation program: A case study of Natura 2000 contracts in France

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Abstract

Natura 2000 is a European Union network of protected areas. In France, all forest owners whose forests are located in a Natura 2000 site are eligible to enroll in a biodiversity conservation program by signing a Natura 2000 contract. In this case, the forest owner benefit from financial support that covers all additional costs for conservation and restoration measures and is also exempt from certain taxes such as land tax. Natura 2000 contracts were created as incentive-based conservation tools to enhance landholders' participation to improve some identified ecological outcomes. Since landowners are very heterogeneous in terms of their preferences and values, it is crucial to understand the determinants of participation for those who signed the proposed contracts. Our study has several objectives: first, to ascertain whether the conservation program is attractive for the private forest owners who want to conserve the biodiversity of their land; second, to investigate which types of forest owners are the most likely to participate; and third, to determine the type of region the most conducive to implementing Natura 2000 programs.

Keywords:

Forest; Natura 2000; incentive contracts; participation

JEL: C24, C25, Q57

I. INTRODUCTION

Natura 2000 is a European Union network of protected areas established under the EU's Habitats Directive (92/43/EEC) and Birds Directive (2009/147/EC). The objective of Natura 2000 is to ensure the long-term survival of threatened European species and habitats through the conservation of natural habitats and wild fauna and flora of interest to the EU. It is not a system of nature reserves that excludes all human activities but, instead, given that part of the land is privately owned, an initiative that aims at ensuring ecological and economically-sustainable management in the future.

With 10% of the European forest, France has a great responsibility in terms of EU forest biodiversity conservation. All forest owners in France whose forests are located in a Natura 2000 site are eligible to enroll in a Natura 2000 program. After enrollment, the forest owners benefit from financial support that covers all additional costs incurred by his participation in the program and is also exempt from certain taxes such as land tax. In fact, the French Natura 2000 policy was created as an incentive-based conservation program to enhance landholders' participation to improve some identified ecological outcomes. Since landowners are very heterogeneous in terms of preferences and values, it is very important to understand the determinants of participation for those who signed the proposed contracts. In fact, this work is crucial since very few private forest owners have actually signed contracts. Recent observations show that there is a real problem in France in drumming up the interest of potential private forest owners who are eligible to participate.[1] It is hoped that participation in

1 By 2010, 927 of the 1,747 Natura 2000 sites established in France were forestry sites. They covered 2.6 million hectares, with private forest owners representing 54% of the forest owner population in the protected zone. However, until the end of July 2010, there were only 52 contracts signed by private owners in France. In an attempt to understand why there are so many difficulties involved in implementing Natura 2000 program in France, it is essential to study the participation decision-making behavior of French landowners with regard to Natura 2000 programs.

some areas could be increased by identifying the factors affectiong the participate decision of private forest owners.

In this context, we constructed a database with technical and geographic information about participants in Natura 2000 program in France. Our study had several objectives: first, to ascertain whether the program is attractive for the private forest owners who want to conserve the biodiversity of their land; second, to investigate which types of forest owners are the most likely to participate; and third, to determine the type of region the most conducive to implementing Natura 2000 programs.

This paper first provides an overview of the current state of knowledge about factors that affect non-industrial private forest owner participation behaviors with regard to incentive conservation programs. In order to produce more general knowledge concerning the key determinants of the participation decision-making process, we combined the results of several studies in this field. Through our review of the literature, we identified three categories of determinants: landowner characteristics, land characteristics, and technical variables concerning the programs. We then constructed a participation model and analyzed the participation behavior of the private forest owners in the 35 communes in which at least one Natura 2000 contract actually exists, using a random sample of the forest owners' database. Finally, we applied a truncated regression model to study the intensity of participation through the analysis of contract payments.

II. A REVIEW OF THE LITERATURE CONCERNING PARTICIPATION BEHAVIOR IN CONSERVATION PROGRAMS

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- Our literature review makes it possible to identify the main determinants of participation, as well as the different models and estimation techniques used. In order to reduce the list of references and avoid double counting of the same methods and the same

determinants, we restricted our review to the period after 2000.[2] Table 1 lists 25 peer-reviewed publications related to farmer or forest owner participation in a conservation program that applied a quantitative technique. Table 2 presents the variables they chose to use.

- Three categories of determinants were identified on the basis of the literature on participation determinants of conservation programs: landowner characteristics, land characteristics, and some variables concerning the conservation programs. Since various models and techniques are used that lead to different results, we applied a rigorous method to review the literature[3] that allowed us to make a comparison and identify some of the strengths and weaknesses in the study of biodiversity conservation participation behavior. The vote counting technique is applied to key variables within each broad category: results are summarized by calculating the percentage of studies that used one identified variable, the percentage of studies that found a statistically significant effect for this variable out of all the studies that included this same variable in their analysis, and the percentage of studies that found a statistically significant effect out of all of the studies. For the same dataset, each variable counts only once in order to avoid overweighting the results from a single dataset. As opposed to meta-analysis, vote counting does not analyze effect sizes.

It is essential to understand and characterize participation behavior through the application of quantitative methods and survey data. Most studies rely on surveys of landowners, in conjunction with secondary data on land characteristics, financial and economic statistics. Almost half of the studies were carried out in the USA, the other half in the EU, and several in other areas (see Table 1). Most of them use econometric models to capture the effect of different variables. While discrete models are widely used (probit or logit), heterogeneity in landowners' preferences and values incite economists to use mixed logit to analyze their

[2] Our literature review began in 2000. However, when we found a reference from before 2000 using a new method, we included it in our review. This is the case of Wilson (1997).

[3] There are four methods for conducting a review of the literature: narrative review, descriptive review, vote counting and meta-analysis. Meta-analysis is considered to be the most rigorous (and quantitative) method, whereas narrative reviews focus on the conclusion of studies and are more interpretive in nature. (King and He,2005).

participation decision. Others use cluster analyses to distinguish the reaction of different groups (Bieling, 2004). More recently, the multi-linear regression was chosen because it makes it possible to easily compare the effect of one variable in different factors (Dolisca et al., 2006; Coulibaly-Lingani et al., 2011).

All of the studies chosen focus on the factors that influence the enrollment of landowners in Natura 2000 programs. For each study, we reviewed the text and tables to identify variables that fit into the three categories defined as personal characteristics, land characteristics and program characteristics. Exogenous variables such as personal characteristics and land conditions are good factors to explain this behavior. However, due to a lack of knowledge, program characteristics such as payment for participants or other regulation policies are either weakly significant or insignificant.

Few studies focus on landowners' preferences in terms of conservation program management: variables based on landowners' attitudes to environmental issues, preference as to contract governance (e.g., method of payment, authority preferred and means of communication) and motivation. In order to understand and to more directly integrate these aspects of landowners' preferences, qualitative techniques are increasingly used.

According to all those studies aimed at examining participation behavior, a common utility model (of the type: $U(X_i) = V(A(X_i), R(X_i)) + \xi_i$) is used when there are some observable and non-observable parts in the utility for each individual. X_i is a vector of attributes that characterize the landowner i, $A(X_i)$ is the landowner's profit i, $R(X_i)$ is the non-monetary utility of the landowner i, and ξ_i is the disturbance term. If the landowner decides to participate, his utility will be: $U(X_i) = V(A(X_i), R(X_i), T_i) + \mu_i$, where T_i is the payment for the incentive program.

- Landowner characteristics

Most recent studies have found that younger landowners with a higher level of education and income are more likely to participate (Fortney et al., 2011). These landowners are more likely to accept new methods of management, to try new ideas and to be more willing to join the program (Wossink and Wenum, 2003).

Education is an important determinant. An educated landowner is easier to communicate with since he can better understand the importance of a conservation program. Moreover, a landowner who has some forestry education is more likely to participate (Layton and Siikamaki, 2009). Past experience of participating in a biodiversity program also increases the likelihood of joining a program (Wossink and Wenum, 2003).

Many studies have analyzed the effect of landowners' income. The income from farming or from non-timber forest production, as well as income from non-traditional employment, tends to influence participation (Ezebilo, 2011). More exactly, forest income has a negative effect on participation (Bergseng and Vatn, 2009). A variety of income increases the likelihood that the landowner will join the program (Dolisca et al., 2006). The time the forest has been owned influences the likelihood of adopting the program (Matta et al., 2009). Langpap (2004) found that long-term ownership has a negative effect on the probability of joining the program due to the fact that it is more difficult for a long-term owner to change his way of management.

Landowners' attitudes towards the environment may affect their choice to participate or not. A "conservation" attitude has a positive effect (Bergseng and Vatn, 2009) and, in general, landowners who are more environmentally-friendly are more likely to participate (Mäntymaa et al., 2009). Those biodiversity conservation policies, which are combined with development issues, could encourage local people to participate (Ezebilo, 2011).

Social status (gender and marital status) can also explain landowners' choices. Women and married people are more willing to enroll (Matta et al., 2009). Membership in a group and location play some role: the probability of participation increases if the landowner is a

member of a local group (Dolisca et al., 2006). If the forest owner lives on the property, the probability of enrollment increases (Coulibaly-Lingani et al., 2011).

The variables describing landowners' motivations to own their land are the most important determinants. Landowners who are less concerned about their profit are more likely to join the program (Langpap, 2004), as well as landowners with more non-forest income (Layton and Siikamäki, 2009). Owners with production objectives tend to be less likely to participate, while owners with multiple objectives, e.g., recreation and hunting, tend to be more likely (Kline et al., 2000; Broch et al., 2011). Land speculators can consider the program as a tax shelter (Dye, 2007), and potential benefits to conserve nature are yet another reason to enroll (Fortney et al., 2011). Instead of focusing on the big landowners, it is more effective to focus on the mixed-use landowners, especially residential ones because they are more likely to join the program (Kauneckis and York, 2009).

- Land characteristics

Much less attention has been paid to how participation is influenced by spatial variation in the provision of ecosystem goods and services (Brouwer et al., 2010). Several studies found that spatial data have no significant influence on the forest owner's interest in ecosystem management, whereas their attitude toward environmental issues and incentives is more likely to influence their decision (Jacobson, 2002). It was generally observed that land area had a strong negative effect on the landowner's final choice (e.g., Mäntymaa et al., 2009). Some researchers have suggested that some programs should be created in favor of small land owners (Horne, 2006). Big landowners can probably play a larger role, but small landowners make up the majority of owners (Jacobson, 2002).

Land location is another key variable that explains the landowner's likelihood to participate, which increases with distance from the city (Matta et al., 2009.) and decreases with urban development (Suter et al., 2008). Land suitability for some profitable activities

(e.g., agriculture in Cheng and Boisvert, 2009) increases the opportunity costs of a conservation program and thus decreases the probability of enrollment (Suter et al., 2008), whereas the level of biodiversity of a region can influence landowners to join a program (Layton and Siikamäki, 2009).

- Program characteristics

- Contract flexibility plays an important role on the probability to participate: contract duration, the percentage of the land involved (Layton and Siikamäki, 2009), the fact that the entire plot has to be enrolled (Cheng and Boisvert, 2009), the impossibility to cancel the contract (Horne, 2006), the degree of involvement (Espinosa-Goded et al., 2010), and the average time spent on administration (Ruto and Garrod, 2009) are linked to lower flexibility and tend to decrease participation likelihood.

At the same time, the level of the payment plays an important role in participation since it is the main incentive for many forest owners to participate. Landowners always try to use their private information about opportunity costs to increase their compensation claim. Instead of bargaining truthfully, forest owners with environmentally-friendly attitudes may have an incentive to behave strategically and indicate untrue preferences in order to obtain money for preservation, whereas they would be willing to preserve the stand without any compensation (Mäntymaa et al., 2009). Increasing the payment or shortening enrollment requirements generates higher enrollment (Layton and Siikamäki, 2009). Payment has a positive effect up to a certain level from which the effect is constant (Wossink and Wenum, 2003). On the other hand, without increasing the amount of payment, the variation in the payment can enhance enrollment. From the point of view of some forest owners, the reliability and the continuity of the payment is highly significant (Ziegenspeck, 2000). Therefore, the payment of a basic amount would sufficiently reward ecologically-sound silvicultural activities over the long-term. Instead of using a variable payment, a fixed payment could substantially reduce the

overall payment (Espinosa-Goded et al., 2010). Lump sum payments as well as yearly payments increase participation rates (Duos et al., 2009). However, Suter et al. (2008) found that one-shot payments are preferred over annual payments, and increasing the payment in the middle of the program is less effective than increasing the payment at the beginning.

Employment opportunities in the region increase the likelihood of participation (Coulibaly-Lingani et al., 2011), while the fact of receiving other subsidies decreases it (Chang and Boisvert, 2009). In fact, this indicates the positive impact of the economic context based on some potential household-generating income, micro-economic activities, job opportunities, and benefits from the forest. It could also be interesting to know the effect of other variables such as local GDP, wood price, tree planting price, etc.

According to recent studies, the first reason for non-participation is that the landowner is not aware of the program. It is a surprise that in the case of some of the programs (e.g., ESA regulation), a new regulation in the contract does not have any significant effect on the participation choice. Obviously, the landowner's knowledge about the incentive program is very limited. The lack of communication is a major reason why landowners do not join a program (Fortney et al., 2011). Communication, which influences several factors such as information and co-operation, is one of the relevant factors determining willingness to enroll. Lynch and Lovell (2003) showed that information received from neighbors has a positive effect, whereas newspapers have a negative effect on their participation. Some personal and direct means of contact such as letters, public meetings or personal visits can increase their awareness. Communication is not only responsible for presenting the programs and answering farmers' questions, but also involves famers in the decision-making process (Schenk, al., 2007).

The communication mechanisms can increase the degree of trust. Farmers' perceptions of risk and equity are determined by the degree of trust they have in the program administrators. Consistent with the embeddedness theory, using communication mechanisms that are

anchored in trust, such as third parties or embedded ties may reduce the farmer's reluctance to participate and reduce the transaction cost (Breetz et al., 2005). Educational programs are more effective when differentiating among groups of people and objectives (Fortney et al., 2011).

Communication is not only a good way to let the landowners more effectively understand the meaning and value of their enrollment, but it is also an important tool to build trust between landowners and the authorities. A landowner's involvement in the development of the program increases his likelihood to enroll. To make the program more acceptable and sustainable, the participation of landowners in the decision-making process is essential (Coulibaly-Lingani et al., 2011), revealing the importance of interactive communication.

To study the landowner's behavior and enhance participation, more attention should be paid to internal characteristics in order to learn more about preferences, interests and values. Maximizing the utility function of the landowners is a good way to speculate on their participation since the utility function includes not only the economic gain of the landowners, but non-monetary values as well. Incentive programs only play a minor role in landowners' decisions. Landowners will choose to join the programs only if they sincerely desire to contribute to the environment. The key issue should be how to increase their awareness about the importance of environmental and social responsibility. Furthermore, few studies have analyzed the effect of the socio-economic environment. However, landowner participation could be strongly affected by local economic factors such as the importance of the agricultural economy, the level of land value and the wealth of the local population. Thus, in our study, it would be interesting to find new variables in order to capture these effects.

III. A SIMPLE ECONOMIC MODEL OF PARTICIPATION

Business-as-Usual (BAU)

Forest owner i maximizes a weighted sum of revenues and amenities from his privately owned forest:[4]

$$\max_{M_i} U(M_i, X_i) = \alpha U_I(I(M_i, X_i)) + (1-\alpha) U_A(A(M_i, X_i)) \qquad (1)$$

where α is the weight given by the forest owner to income (and thus to consumption), while $(1 - \alpha)$ is the weight given to forest amenities (or environmental preferences): $\alpha = 1$ refers to a profit-maximizing industrial forest owner; $\alpha = 0$ refers to a forest owner who does not consider potential income that could be obtained from his forest; U_I is the utility of income or consumption $I(M_i, X_i)$, and U_A is the private utility that the forest owner obtains from the amenities $A(M_i, X_i)$ his forest provides. Both functions have standard properties. In a simplified version, it can be assumed that: $U_I = I(M_i, X_i)$ and $U_A = A(M_i, X_i)$.

The forest owner's income $I(M_i, X_i)$ is composed of current forest profit $\Pi(M_i)$ and outside income OI_i. M_i is a vector of forest management practices (rotation length, harvest intensity, species choice, labor used, implementation of recreational facilities, etc.): $M_i = (M_{i1}, \dots, M_{iJ})$. X_i is a vector of attributes that characterize the landowner i.

$A(M_i)$ is a vector of forest amenities (carbon sequestration, biodiversity, recreation, water quality and quantity, etc.): $A(M_i, X_i) = (A_{i1}(M_i, X_i), \dots, A_{iI}(M_i, X_i))$.

The forest owner chooses his forest management practices to maximize his utility, which gives the vector of optimal forest management practices M_i^*, implying profit $\Pi^* = \Pi(M_i^*)$ and amenities $\mathrm{A}^* = \mathrm{A}(M_i^*)$. Those management practices are implicitly given by:

$$\alpha \frac{\partial U_I(I(M_i, X_i))}{\partial I(M_i, X_i)} \frac{\partial I(M_i, X_i)}{\partial M_i} + (1-\alpha) \frac{\partial U_A(A(M_i, X_i))}{\partial A(M_i, X_i)} \frac{\partial A(M_i, X_i)}{\partial M_i} = 0 \qquad (2)$$

[4] Note that we consider a simplified static model, while forest management usually implies dynamic profit maximization (e.g. Faustman (year)). The utility function may thus be considered as the current utility that may be derived from dynamic maximization. Indeed, we do not explicitly consider utility maximization, but only compare two situations in which utility maximization is already done.

which means that the forest owner equalizes his marginal utility from income and from forest amenities.

Implementation of Natura 2000

Natura 2000 proposes a contract that consists of receiving a fixed payment, T_i, so that the forest owner increases the quality of his forest's biodiversity (denoted by $A_{i1}(M_i, X_i)$). The contract is input-based: upon agreeing to be part of Natura 2000, the forest owner commits himself to implementing new management practices, M_i. It is then assumed that the biodiversity is then supposed to increases as follows: $A_{i1}(\overline{M_i}, X_i) > A_{i1}(M_i^*, X_i)$. The payment received is composed of a share, $T(X_i)$, that depends on the forest owner's characteristics (e.g., size of land owned), and a share, $H(\overline{M_i})$, that depends on the new forest management measures that are implemented.

The forest owner's decision is thus twofold. First, the owner decides whether to join the program or not. He then decides on the intensity of participation, i.e., the amount of new management practices, M_i, to be implemented.

Intensity of participation

If he decides to participate in the program, the forest owner must decide on the intensity of his participation. He then chooses his management practices to maximize his net payoff:

$$\max_{M_i} U(M_i, X_i) = \alpha U_I\big(I(M_i, X_i) + T(X_i) + H(M_i)\big) + (1-\alpha)U_A(A(M_i, X_i)) \qquad (3)$$

The first-order conditions implicitly determine the equilibrium level of participation, $\overline{M_i}$, that is implicitly given by:

$$\alpha \frac{\partial U_I\big(I(M_i, X_i) + T(X_i) + H(M_i)\big)}{\partial (I(M_i, X_i) + T(X_i) + H(M_i))} \left[\frac{\partial I(M_i, X_i)}{\partial M_i} + \frac{\partial H(M_i)}{\partial M_i}\right]$$

$$+ (1 - \alpha) \frac{\partial U_A(A(M_i, X_i))}{\partial A(M_i, X_i)} \frac{\partial A(M_i, X_i)}{\partial M_i} = 0 \qquad (4)$$

Participation decision

The forest owner chooses to join the program if there is no cost for him in terms of utility, which defines the following participation constraint:

$$U(M_i^*, X_i) \leq U(\overline{M_\iota}, X_i, T_i)$$

This participation constraint can be rewritten as:

$$\alpha U_I\big(I(M_i^*, X_i)\big) + (1 - \alpha) U_A\big(A(M_i^*, X_i)\big)$$

$$\leq \alpha U_I\big(I(\overline{M_\iota}, X_i) + T(X_i) + H(\overline{M_\iota})\big) + (1 - \alpha) U_A\big(A(\overline{M_\iota}, X_i)\big) \qquad (5)$$

The actions required by the program are assumed to have a cost for the forest owner: they either decrease his profit or they decrease some other amenities that he enjoys (e.g., hunting or recreation). Therefore, non-participation by the forest owner i is due to the fact that payment, $T(X_i) + H(\overline{M_\iota})$, is considered to be too low to compensate for the loss of utility induced by the actions to be undertaken, $\overline{M_\iota}$.

Proposition: *Non-participation in Natura 2000 is due to an underestimation of the forest owner's utility in the BAU scenario, or an overestimation of his utility if he participates in the program. It follows that non-participation may be due to:*

- *Underestimation of the true impacts of the new management practices on income. These impacts may come from intra-forest owner effects, i.e., management-specific ($H(\overline{M_\iota})$ underestimated); or they could come from inter-forest owner effects, depending on the forest owners' characteristics ($T(X_i)$ underestimated)*;

- *Overestimation of the forest owners' environmental preferences:* α*;*
- *Underestimation of other amenities on which new management practices will have a negative impact:* $A_{ij}(M_i^*, X_i) > A_{ij}(\overline{M_i}, X_i), j \neq 1$.

IV ECONOMETRIC MODELS

In this paper, our objective was to predict the decision of forest owners in France to participate in a conservation program and to explain the intensity of their participation. To do this, we attempted to identify the determinants of forest owners' participation in Natura 2000 contracts (i.e., the selection equation) as well as factors that explain variations in contract payments (i.e., the outcome equation).

Observation of participation in Natura 2000 is biased because we only have information about the participants since our database is composed of signed Natura 2000 contracts. Hence, in terms of information concerning contracts, our sample is limited to those forest owners who have participated. Because of this lack of information, a truncated distribution with only the participants must be used in the estimation of the payment model. A sample selection bias may exist because of the low rate of participation in the Natura 2000 program and the fact that forest owners do not systematically participate due to specific factors. In this case, a simple regression test of the null hypothesis of no sample selection bias can be implemented. If the null hypothesis is rejected, a two-step Heckman model should then be estimated.

The selection equation: analyzing participation behavior with a probit model

The first step is based on a probabilistic choice, and it is assumed that individuals choose a single alternative that maximizes their utility from a set of available alternatives (McFadden, 1986). The model is based on the random utility theory that describes the utility of each

alternative (U) as the sum of systematic and error components. The systematic component, v_i, is a vector of observable individual and alternative specific attributes. The existence of the error term ε_i constitutes the random choice and includes all the effects and factors that affect the choice but that are not observable (Louviere et al., 2000).

According to the random utility theory, an individual *i* chooses an alternative *k*, from the choice set C_i, if the indirect utility of *k* is greater than that of any other choice *l*. This notion is defined by the following equation:

$$U_{ik} > U_{il} \Rightarrow v_{ik} + \varepsilon_{ik} > v_{il} + \varepsilon_{il}, \quad \forall l \neq k; l \in C_i \qquad (6)$$

In this context, a probit model may be applied. The individual's utility is either participation ($y = 1$) or non-participation ($y = 0$), and their functions are $y_{i1} = v_{i1} + \varepsilon_{i1}$ or $y_{i0} = v_{i0} + \varepsilon_{i0}$. The probability that a private forest owner will participate is: $P(y_i = 1) = P(v_{i1} + \varepsilon_{i1} > v_{i0} + \varepsilon_{i0}) = P(\varepsilon_{i0} - \varepsilon_{i1} < v_{i1} - v_{i0}) = F(v_{i1} - v_{i0})$, where F is the cumulative distribution function for $\varepsilon_{i0} - \varepsilon_{i1}$.

This yields $P(y_i = 1) = F(V_i\beta)$ if $v_{i1} - v_{i0} = V_i\beta$, where V is the explanatory variable and β the associated parameter vector. Our choice for error distribution of ε_{i0} and ε_{i1} is normal. $\varepsilon_i = \varepsilon_{i0} - \varepsilon_{i1}$ is then normally distributed. Normalization of the variance of ε_i gives a standard normal distribution and, therefore, a probit model, written as:

$$P(y_i = 1) = P(\varepsilon_i < V_i\beta) = \Phi(V_i\beta) \qquad (7)$$

where Φ is the standard normal cumulative distribution function.

The output equation: analyzing participation intensity with a truncated regression model

The next step is to analyze the contract payment variation of the beneficiaries with a truncated model. The dependent variable is the payment specified in the contract. According to our literature review, 91% of the studies that found a significant result with the "cost"

variable found that the payment of the contract could have a positive effect on participation, according to Table 2.

Suppose X_i represents the characteristics of the contracts, and that Z_j represents the spatial characteristics of the forests covered by the contract. Y_{ij} is the dependent variable, i.e., the contract payment. Our model is therefore:

$$y_{ij}^* = \alpha_0 + \alpha_i X_i + \alpha_j Z_j + \mu_{ij}, i \in \{1,2,\dots,I\}, j \in \{1,2,\dots,J\} \quad (8)$$

where α are the parameters to be estimated and μ the error term. If $Y_{1j} < Y_{2j}$, then forest owner 1 is more willing to participate than forest owner 2.

Since there is no information available about non-participants, our model will be a truncated regression model:

$$Y_{ij} = \begin{cases} y_{ij}^* & \text{if } y_{ij}^* > 0 \\ - & \text{otherwise.} \end{cases} \quad (9)$$

V DATABASE DESCRIPTION AND SAMPLING METHOD

To construct a database of Natura 2000 contracts that is accurate and specific to our study, we collected all relevant information concerning the Natura 2000 network in France. This database contains technical, environmental and socio-economic indicators of all Natura 2000 contracts signed in France from 2002 to 2010. We attempted to analyze the effectiveness of incentive mechanisms by determining the influence of factors that affect participation, thus identifying the most effective levers for increasing the number of signed contracts and improving the protection of biodiversity within forests.

Our database is based on three resources:

- The EMIN2K spatial database ("Efficient incentive mechanisms in the Natura 2000 project), built by LEF (Laboratory of Forest Economics), which contains the geographic and socio-economic characteristics of all Natura 2000 forest sites in France. This database is

constructed from the MEEDDM (Minister of Ecology) database, the Natura 2000 database, as well as the OSIRIS database.[5]

- The OSIRIS database, which contains information about all Natura 2000 contracts, except for the personal information about the beneficiaries and contractors.
- The database built with the "*Fichiers fonciers*" database provided by the French Tax Administration (DGI).

After collecting the database, we were faced with several problems concerning a lack of information:

- The ID of forest owners in the OSIRIS and DGI databases is not designated in the same way. It is therefore impossible to combine them. Some contracts are signed by a group of forest owners, in which case it is also impossible to identify all the contractors. Moreover, it is not possible to precisely locate the area covered by the contracts. In the absence of individual data, we decided to use the individual and contract information at the level of the commune.[6]
- Information about the contracts is sometimes problematic. The measurement of the output of Natura 2000 contracts is not universal. For example, the same action within a contract may be measured with different units (m3, ml, ha), depending on the sub-actions identified. Moreover, the price per unit often differs from one region to another. We do not have access to some detailed contract information such as the precise description of services provided by the contractors. Nevertheless, the identification of actions and their observed scale (or unit) makes it possible to describe the output quite correctly.

[5] OSIRIS is a unique integrated tool for the management and monitoring of funding for rural development. It provides instruction for funding applications and payment, financial and statistical monitoring, and monitoring of on-site inspections and return output indicators.

[6] Suter et al. (2008) had the same problem of a lack of information at the individual level. They thus estimated the proportion of eligible riparian acres reported for each commune and regressed it on the basis of commune-level factors and conditions.

- Information about the private forest owners (participants/non-participants) is very limited. All the personal information such as their location, sex, income, size of family, and profession is unknown.

We tried to understand the variation of participation behavior at the individual level. However, the problem is that we have no information about the participants or the non-participants. Other studies have attempted to address this problem in different ways. Lynch and Lovell (2003) were faced with the problem that they had no information about the non-participants, so they collected information about some of the non-participants using a stratified random sampling. Suter et al. (2008) used a sample of 218 communes instead of landowners to analyze the percentage of eligible acres reported per commune.

We therefore performed our analysis of private forest owners' participation on the basis of a sample of 35 French communes with forest owners that had signed a Natura 2000 contract. Using the DGI data, we were able to obtain the number of private forest owners in each commune. The INSEE (French National Institute of Statistics and Economics Studies) database makes it possible to collect data on the social and economic characteristics of all French communes.

Our sample consisted of 44 Natura 2000 contracts signed by private forest owners in 35 communes. The crucial issue was then to select a comparison group (comparable in terms of observable characteristics) from a sample of non-participating landowners, closest to the participating forest owners. Since the number of non-participants (i.e., the number of forest owners located in each commune) is extremely large and information is only available at the commune level, it is not possible to use all non-participants as a control group. In such a case, a randomly selected comparison group is sufficient to analyze the choice of enrollment in the conservation program. Our sample was constructed as follows:

- First, we applied a proportionate random sampling with 4% of the private forest owners within the 35 communes as non-participants. The objective was to reach a non-

participant set size that would exceed the number of participant observations by a factor of four to ten, as suggested in the literature (Lukesch and Schuh, 2010);

- Second, we merged the observations of the non-participants with the 44 private participant contracts that currently exist in France, according to Lynch and Lovell (2003). Using this method, we constructed a sample of 292 observations of both participants and non-participants.
- Finally, on the basis of the study of Suter et al. (2008), we used the average social and economic characteristics of each commune as the socio-economic characteristics of the forest owners.

In this way, we were able to analyze the relationship between the participation behavior of private forest owners and the characteristics of the social environment and geography of their forest at the level of the commune. Table 3 presents the variables that we chose.

According to our literature review, the social environment of a commune for a conservation program depends on its population characteristics, e.g., total population, population density, income per household. The type of commune (urban or rural) is also important. According to the INSEE standard, a rural commune must be independent and have less than 2000 citizens.

Economic characteristics can also effect participation, including the number of agricultural jobs, the percentage of agricultural jobs, the number of industrial establishments and the number of construction establishments. We found no data at the commune level for two variables - the sum of total production in the forest sector and productivity in the forest sector - so we used data at the department level instead.

The geographic characteristics include Natura 2000 site characteristics such as the number of activities and forestry management activities that affect the conservation program, dummy variables representing each type of site (special areas of conservation (SAC) and special

protection areas (SPA)). Moreover, we also added dummy variables for Natura 2000 sites as fixed effects to capture non-observable heterogeneity.

Judging from most of the recent studies, contract payment is another key variable and is assumed to play a leading role in an incentive program. In order to analyze the payment variation with a truncated model, we also chose the characteristics of the contracts: the cost of the contract, the typologies of beneficiaries, and a set of socio-geographic characteristics. Variables are described in Table 3.

VI ESTIMATION RESULTS

Observations are not totally independent on the basis of the definition of our sample. In fact, observed contracts are spatially grouped within communes and Natura 2000 sites. Typically, we have to assume that errors are "clustered", i.e., observations within a certain group are correlated in some unknown way, inducing correlation in errors within this group. In the presence of clustered errors, standard estimation methods (such as OLS or MLE) yield unbiased estimates, but standard errors may be biased (leading to incorrect statistical inference). In this case, we can either use fixed effects or apply cluster-robust standard errors. In our study, we used dummy variables for Natura 2000 site-specific effects and corrected standard errors for clusters of communes.

Furthermore, we applied a simple test of sample selection bias (Heckman, 1979). First, we estimated the participation choice with our probit model. The estimated parameters were used to calculate the inverse Mills ratio, constructed from the probability that a forest owner would be in the sample. The inverse Mills ratio was then included in the truncated model as an additional explanatory variable. The test of the selection bias is a significance t-test of the nullity of the estimated parameter of the inverse Mills ratio. If the null hypothesis is rejected, there is no selection bias. Our result indicated that a selection bias did not exist (p-value of

0.332). We therefore did not need to use a corrected covariance matrix of the parameters in the second stage regression.

Estimation results of the probit model

Table 4 presents the estimation results of the probit model used to explain participation in Natura 2000 contracts. The value of pseudo-R^2 indicates that our probit model matches 25.85% of the variation in the sample. Obviously, the variables of the social and geographical environment are important but not sufficient to explain the behavior of participation of private forest owners. To improve our results, we needed additional information such as data on personal characteristics and contract details.

The variable, "number of agricultural establishments of a commune", is negatively significant at the 5% level. If a forest owner's forest is in a commune where there are more agricultural establishments, then he is less willing to participate. The total departmental "land value tax" is negatively significant at the 1% risk level, which implies that forest owners are less interested in the incentive conservation program in departments where the value of land is high. The "house income" is positively significant at the 10% level. This level of income tax can infer the level of wealth of a department, allowing us to hypothesize that it will be easier to carry out a conservation program in a region where the total revenue level is high.

The number of big private forest owners has a significant positive effect on participation at the 1% level. This means that for communes where there are a large number of forest owners, the conservation program is more difficult to implement. However, the private forest owner is more likely to participate if there are more big private forest owners in the commune where his forest is located. Among the five types of Natura 2000 sites (see definition in Table 3), type 1, type 2 and type 3 are significantly positive at the 1%, 5% and 10% levels, respectively.

This shows that the participation rate is relatively higher in these types of sites compared to the others.

Estimation results of the truncated regression model

Even if we did not have information about the non-participants, their existence should still be accounted for in the estimation. Truncated regression provides consistent and unbiased estimates of the coefficients of the independent variables, as well as their standard errors. Assuming that all the private forest owners provide an environmental service, and that costs of conserving or restoring biodiversity are negative or zero for non-participants, we consider that our sample is truncated at zero. Estimation results are presented in Table 5. The McFadden pseudo-R^2 is 0.4655 for our truncated model. This means that the model has 46.55% of variation in our sample.

We found that the type of beneficiaries has a significant effect on contract intensity. Taking non-industrial private owners as a reference, the variable, "private company", has a significant positive effect on the cost of the contract at the 1% level. This means that private companies are more willing to sign bigger contracts than the other types of beneficiaries. The variables "hectare" and "unit" measure the level of output and are all positively significant at the 1% level. As expected, if a contract contains actions that are measured with "hectare" or "unit", an increase in the number of hectares or units will make the contract more expensive.

The "land value tax" has no significant effect on participation intensity although it is significant in the participation model. This implies that the total amount of "land value tax" in a department has a positive effect on participation but cannot change the quantity of environmental services that the forest owners want to offer after their enrollment. The total house income in a commune has a positive effect on the size of contracts at the 5% level. This

means that participants are willing to contribute more for conserving biodiversity in their forest in high-income communes.

There are five different actions that lead to a decrease of the total payment: (1) if the contract includes the creation or restoration of glades or barren forest stands to benefit species or habitats; (2) if some of the actions in the contract are to naturally regenerate the forest; (3) if actions for the creation of riparian and floodplain forests are included in the contract; (4) if the contract contains actions for informing people about biodiversity protection; and (5) if the forest owner intends to apply uneven aged forest management. Finally, among 26 Natura 2000 sites in our database, there are two sites where the contract payment is significantly higher than for the other departments at the 5% level.

VII DISCUSSION

Review of the methods used in the empirical application

In this paper, faced with a lack of data concerning non-participants, we built a new database with a random proportionate sampling method for selecting non-participants in the communes where contracts actually exist in order to study the determinants of participation in Natura 2000 conservation contracts. On the basis of this sample composed of participants and non-participants, a probit model was applied. The results of this model reflect the different choices that private forest owners would most likely make within different socio-economic and geographic environments. In a second step, we used a truncated regression model with only the participants' information to analyze the intensity of participation. The analysis of our truncated model is focused on the relationship between the cost of the contract and its characteristics. Combining the results of both models, we were finally able to provide an

explanation for some participating decision variations, as well as an explanation for contract payment.

Discussion of results

Our three main objectives in this paper were: (i) to ascertain whether the conservation program is attractive for private forest owners; (ii) to investigate which types of forest owners are the most likely to participate; and (iii) to determine the type of region that is the most conducive to implementing Natura 2000 programs.

First, we are able to point out which types of private forest owners are more willing to participate. Compared to the other types of forest owners, private companies are willing to contribute more after enrollment because their contract payments are higher. This implies that once they consider that the participation is profitable, they are ready to become more involved in the conservation program. It is rare that a Natura 2000 program includes private companies in France whereas, in principle, they are not really against it. The difficulty for firms to participate is not the quantity of work they need to do but the enrollment procedure itself, e.g., the complexity of the documents required for application, the obligation to schedule the tasks over the five years of the contract and upon submission of the application, etc.

Second, on the basis of the estimation results, we can deduce what type of area is more conducive for implementing a Natura 2000 program. Our first set of results is related to socio-economic characteristics. In our literature review, we found that few studies have focused on local economic factors. It is therefore interesting to observe that in France, local economic factors can affect the participation behavior of private forest owners. According to our participation model, the number of agriculture establishments in a commune has a significant negative effect on participation. Participation in conservation programs will therefore be lower in a region where there are more agriculture activities. A high number of agriculture

establishments indicates that land use is generally reserved for agriculture production. According to Cheng and Boisvert (2009) and Suter et al. (2008), if the land is suitable for agricultural activities or if the land is appropriate for some profitable business, forest owners have more resistance to the conservation program. Our results show that French forest owners have the same reaction concerning Natura 2000.

The participation model also highlights the fact that in the communes where the total income tax is higher, the conservation program may encounter more difficulties. This result could highlight a type of environmental Kuznets curve: biodiversity conservation tends to be of less interest in higher-income areas. However, the model that estimates participation intensity shows that the contracts are significantly bigger in these "rich communes". The threshold effect may explain this phenomenon: once the forest owners in the rich commune are satisfied by the incentives, they are willing to become more involved in the conservation program.

Furthermore, the number of big forest owners in a commune has a significant negative effect on participation. Among the studies referenced in our literature review, two-thirds of the significant results are negative (see Table 2). According to our result, the communes with more big private forest owners have more difficulties in carrying out a conservation program as well. In reality, it is not only because the big owners often have more tasks to carry out after signing the contract, but also because the procedure before signing the contract is longer. For example, a list of the tasks scheduled for the five-year contract period is required for the Natura 2000 application, which is obviously more complicated for big forest owners.

Finally, we determined what is of interest in the Natura 2000 policy for forest owners who want to conserve the biodiversity of their forests. Natura 2000 is a tax incentive program. The forest owners who join the program can benefit from the exoneration of "land value tax", a type of property tax. First, out of the 44 contracts that exist at this time, 32 contractors benefit from the tax exoneration through their participation in a Natura 2000 program. This shows

that most of the participants use Natura 2000 contracts as a tax shelter, attracted by the tax exoneration. Second, our participation model shows that people are more willing to participate if the land value in their department is higher. At the same time, our truncated model indicates that the tax incentive has no effect on the intensity of participation. These results imply that in departments where the total "land value tax" is higher, forest owners participate more to avoid the tax. However, after enrollment, the tax incentive cannot make them contribute more (or less). Results of previous studies have shown property taxes to have a large impact on landowner land use and management decisions (Jacobson, 2002; Kilgore et al., 2009). This result suggests that tax savings may be one of the main reasons for forest owners to enroll in the program.

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Annexes

Table 1: List of references for the literature review

Studies	Institution location	Country studied	Model and technique
Bergseng and Vatn, 2009	Norway	Nordic countries	Logit model
Broch et al., 2011	Denmark	Denmark	Mixed logit model vs. probit model
Brouwer et al., 2010	Netherland	Spain	Mixed logit model
Chang and Boisvert, 2009	Taiwan and US	US	Multivariate probit model
Coulibaly-Lingani et al., 2011	Sweden	Burkina Faso	PCA, OLS, multiple linear regression analysis
Defrancesco et al., 2006	US	Italy	Multinomial logit model
Dolisca et al., 2006	US	Haiti	PCA, OLS, multiple linear regression analysis
Duos et al., 2009	France	10 EU countries	Probit model
Espinosa-Goded et al., 2010	Spain	Spain	Multinomial logit model
Ezebilo, 2011	Sweden	Nigeria	Multinomial logit model
Fortney et al., 2011	US	US	Probit model
Horne, 2006	Finland	Finland	Multinomial logit model
Jacobson, 2002	US	US	Probit model
Kauneckis and York, 2009	US	US	Logit model
Kline et al., 2000	US	US	Logit model
Langpap, 2004	US	US	Probit model
Layton and Siikamaki, 2009	US	Finland	Probit model vs. OLS
Lynch and Lovell, 2003	US	US	Probit model
Mäntymaa et al., 2009	Finland	Finland	Probit model
Matta et al., 2009	US	US	Multinomial logit model
Sorice et al., 2011	US	US	multinomial logit model
Shultz, 2005	US	US	Logit model
Suter et al., 2008	US	US	OLS
Wilson, 1997	US	US	Chi-square test
Wossink and Wenum, 2003	The Netherlands	The Netherlands	Probit and tobit model
Total = 25	US=15 EU= 9 International=1	US=12 EU=10 International=3	

Table 2: Results of vote counting

Factors / Studies	Personal characteristics										Land characteristics					Technical/Program characteristics			
	Gender	Age	Education	Income	Values	Family	Profession	Membership	Already enrolled	Years owned	Land use	Location	Size	Population	Geographic conditions	Process	Payment/cost	Information/communication	Regulation policy
Bergseng and Vatn, 2009	n	n	n	-	+/-							-	-			+	n		
Broch et al., 2011					+/-						+			-	n		+		
Brouwer et al., 2010	n	n	n	n		n	n					+/-			+		-		
Chang and Boisvert, 2009		n	n	n	n	n	n		-	+	-	+/-	-	+/-	+		n		
Coulibaly-Lingani et al., 2011	+	n	n	n	n	+		n						n	-	-		n	+
Defrancesco et al., 2006	n		n	+/-	n	+/-			+/-		+/-		+/-		+/-		+/-	n	
Dolisca et al., 2006	-	+	-	+		+/-					+					-			
Duos et al., 2009		n	+		+			n			n	+/-			+	+		n	
Espinosa-Goded et al., 2010																+/-	+/-		
Ezebilo, 2011		n		+/-								n				n			
Fortney et al., 2011		-	n	+						n	+/+	n	n						
Horne, 2006											+/-					+/-	n		
Jacobson, 2002					n							n	n	n	n				
Kauneckis and York, 2009			+					-	n		n		-	-	-/-				
Kline et al., 2000		+/+	-	-							-/+		-				+		
Langpap, 2004		-	n	n	+/-			+	-	-	n		-		n			n	n
Layton and Siikamaki, 2009	-	-	-	+			-					-			-	-	+		
Lynch and Lovell, 2003			n	-		+				+		+	+		+			+/-	
Mäntymaa et al., 2009			+	n	+						+/-		-			n	n		
Matta et al., 2009	n	+	-	-				-		-	-			-	n	n	+		
Sorice et al., 2011				+											-	-/-	+		-
Shultz, 2005									+		n				n		+/+		
Suter et al., 2008				n									n	-		+	+		n
Wilson, 1997		-	+	+/-		-							+			+/-	+	+/-	
Wossink and Wenum, 2003		n			-	n			+		n	n	n		+				
Total = 25	7	14	16	17	10	8	3	5	6	5	14	10	13	7	15	13	15	6	4
Total significant	2	7	7	11	6	5	1	3	5	4	9	6	9	5	10	10	11	2	2
Percentage chosen	28%	56%	64%	68%	40%	32%	12%	20%	24%	20%	56%	40%	52%	28%	60%	52%	60%	24%	16%
Percent significant	29%	50%	44%	65%	60%	63%	33%	60%	80%	80%	64%	60%	69%	71%	67%	77%	73%	33%	50%

Notes. -: negatively significant; +: positively significant; +/+: a group of variables are positively significant; -/-: a group of variables are negatively significant; +/-: a group of variables, some are positively significant and others are negatively significant; n: not significant; PS: the significance is at least on the 10% level.

Table 3 Description of variables

Probit Model	Sampling level	Description of variables	Information source	Categories of variables
Participation	commune	Dependent variable. Dummy variable equal to 1 if participation; 0 if non-participation	OSIRIS+DGI CETE	contract
Number of agricultural establishments*	commune	Number of agricultural establishments in the commune	INSEE	socio-economic
Land value tax	department	Total "land value tax". Values are in logarithms (log).	INSEE	socio-economic
House income	commune	Total house income of the commune where the site is located. Values in log.	INSEE	socio-economic
Big owner	commune	Number of big forest owners who have more than 50 hectares of forest in the commune.	INSEE+DGI CETE	socio-economic
Type of site	site	Type 1 = The SAC site only contains a SAC zone independently Type 2 = The SAC site contains a SAC zone that is included in two sites Type 3 = The SPA site contains a SAC zone totally within it Type 4 = The SPA site contains part of a SAC zone Type5 = The SAC site contains part of an SPA zone	Natura 2000 database	geographic
Truncated Regression Model	Sampling level	Description of variables	Source of information	Categories of variables
contract cost	commune	Contact payment = The total of EU and French government funding and self-funding. Values in log.	OSIRIS	contract
typologies	commune	4 types of beneficiaries Typology1 = association Typology 2 = private forest owner Typology 3 = forestry group Typology 4 = private company	OSIRIS	contract
ha	commune	If one of the actions in the contract is measured with "hectare", then the number of hectares	OSIRIS	contract
unit	commune	If one of the actions in the contract is measured with "unit", then the number of units	OSIRIS	contract
contract's action	contracts	15 dummy variables for 15 different actions of contracts.	OSIRIS	contract
depart	department	18 dummy variables for 18 departments where the Natura 2000 contracts are signed (depart1 to depart18).	INSEE	geographic
site	Natura 2000 site	26 dummy variables for 26 Natura 2000 sites where the Natura 2000 contracts are signed (site1 to site26).	Natura 2000 database	geographic

Table 4 Estimation results of the probit model

Y= participation	Coefficient	Cluster-robust standard error	Significance level
nb of agriculture establishments	-0.0073	0.0033	**
land value tax	0.4660	0.1412	***
house income	-0.0194	0.0121	*
nb of big forest owners	-0.4026	0.0577	***
type1	0.9736	0.2882	***
type3	0.6990	0.3897	*
type4	0.5597	0.2836	**
Constant	-7.0925	1.9876	***
Pseudo-R^2	0.2585		

Notes. Number of observations = 292; number of clusters = 35.
Significance level: ***: 1%; **: 5%; *: 10%.

Table 5 Estimation results of truncated regression model

Y=contract payment	Coefficient	Cluster-robust standard error	Significance level
typology4	1.5620	0.4366	***
hectare	0.9760	0.2399	***
unite	0.6935	0.0733	***
land value tax	0.0513	0.0685	
house income	0.0640	0.0309	**
nb of big forest owner	-0.3314	0.0971	***
f22701	-1.2214	0.4806	**
f22703	-0.7354	0.4155	*
f22706	-0.6067	0.3295	*
f22714	-1.7673	0.3409	***
f22715	-1.0896	0.4346	**
site24	1.1995	0.4930	**
site25	0.5460	0.2483	**
Constant	6.7313	1.4407	***
sigma	0.5528	0.0596	***
Pseudo-R^2	0.4655		

Notes. Number of observations = 44; number of clusters = 35.
Significance level: ***: 1%; **: 5%; *: 10%.