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Biodiversity protection in private forests: PES schemes, institutions and prosocial behaviour

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Abstract

The overall research question addresses the effectiveness of incentive mechanisms in policies enhancing private forest owners' biodiversity protection. In particular, the project focuses on the link between forest owners' motivations, incentives, and institutions and questions the incentives of the current biodiversity protection policies. Our hypothesis is that the purely monetary nature of the incentives can cause a "crowding out effect", i.e. forest owners may reduce their voluntary contribution to biodiversity protection that is driven by pro-social motivations (altruism, self-image, etc.). On this background as well as knowledge obtained in this project about forest owners' motivations, we are searching for combinations of "incentive mechanisms" (monetary and non-monetary) and "institutions" (national and local authorities, NGOs etc) which are most effective in making forest owners adopting biodiversity protection measures in their forests.

PES, Prosocial behavior, crowding out, biodiversity, choice experiment, forest owners

1. Introduction

In this paper we analyse empirically designs of voluntary biodiversity protection schemes. In In this paper we analyse empirically designs of voluntary biodiversity protection schemes. In particular, we investigate which role institutions, prosocial behaviour and potential crowding out may influence participation in protection schemes based on survey of private forest owners in France and applying a discrete choice experiment following Peterson, Smith, Leatherman, Hendricks, & Fox,(2015). The results shows that the results are highly depended the institutional framework (the organisation offering the contract). While we did not find statistically significant crowding out effect of monetary compensation we found for a share of the interviewed land owners social norms are important determinant of their choice of forest management strategy.

Much biodiversity is found on private land, including private forests. Conservation of biodiversity thus requires the design of policies which influence the decision-making of foresters (Hanley, Banerjee, Lennox, & Armsworth, 2012). Voluntary contracts with forest owners have been suggested one approach to make private forest owners consider biodiversity protection in their management and a large, recent literature consider the payment for ecosystem services (PES) schemes (Börner, Baylis, & Wunder, 2017; Engel, Pagiola, & Wunder, 2008; Wunder, 2015; Wunder et al., 2018). In

France, private forest owners with land in Natura2000 zones are offered a contract defining protection measures to be implemented against an economic compensation (Hily, Garcia, Stenger, & Tu, 2015). However, the uptake of contracts by private forest owners have been relative limited.

It has been suggested that a low uptake of PES measures could be explained by the fact forest owners management motivations are not only profit-maximization (Petucco, Stenger, & Abildtrup, 2015). Therefore the literature on intrinsic motivations and social norms should be mobilized (Banerjee & Shogren, 2012). Intrinsic motivations relate to a person's deep desire to perform a task, regardless of monetary compensation. The introduction of monetary rewards (extrinsic motivations) can weaken the individual's intrinsic motivations by diverting him from his initial willingness to perform the intended task; this effect is called eviction. This raises the question, how to design PES schemes which account for landowners may have intrinsic motivation for biodiversity projection (Rode, Gómez-Baggethun, & Krause, 2015). This is important for two reasons. First, if forest owners stop protecting biodiversity if they are offered a contract with financial compensation and secondly, if forest owners already protection the biodiversity may accept a contract with financial compensation. While it from an equity point of view may acceptable that a forest manager is obtaining compensation for conservation which she would have done even without an economic compensation, this will charge (public) conservation budget without any added protection. Furthermore, accounting for intrinsic behaviour and social norms may also reduce the need for enforcement of protection measures which is in particular important in situations where asymmetric information between land owner and regulator is important (Chervier, Le, & Ezzine-de-blas, 2017).

Crowding out has been analysed in with respect to voluntary forest contracts in Finland (Primmer, Paloniemi, Similä, & Tainio, 2014) showing that forest owners having an altruistic approach to forest management were less likely to have entered a contract. Prosocial behaviour have, for example, been analysed in a developing country context (Kerr, Vardhan, & Jindal, 2012) and Chervier, Le, & Ezzine-de-blas (2017) analyse Cambodian PES scheme and participants' motivations. They conclude that a program with monetary compensations may have consequences on the program long-term effectiveness, as individuals emphasizing money-related values reported significantly more frequently that they would break conservation rules after an eventual end of payments.

Rode et al. (2015) review the empirical evidences of crowding out in the conservation literature and conclude that it is crucial to assess existing intrinsic motivations and expected changes in people's motivational structures prior to large-scale implementation of economic instruments. They divide the methods for assessing motivation crowding effects into framed field experiments, natural field experiments, and natural experiments. However, as in Peterson et al., (2015) we test potential scheme design empirically in a stated discrete choice model (DCE). DCE have become a popular mean to test different PES scheme designs (Beharry-Borg, Smart, Termansen, & Hubacek, 2012; Broch & Vedel, 2011; Greiner, Bliemer, & Ballweg, 2014; Vaissière, Tardieu, Quétier, & Roussel, 2018; Vedel, Jacobsen, & Thorsen, 2015). We contribute to the literature with an assessment of the role of the institutional framework for forest owners' engagement in biodiversity conservation based on a sample of forest owner in the Regional Nature Park of the Vosges Balloon. Furthermore, we show how a DCE can be designed to identify the interaction between programme attributes and prosocial motivation through the design of attributes and split samples. Finally, we show that the effects of programme attributes targeting the owners prosocial behaviour is heterogeneous over the sample.

Data and methodology

A discrete choice experiment is used to reveal forest owners' preferences for an alternative commitment to nature protection. The first step in designing the DCE is to define the alternatives and the attributes: First, the attributes used to characterize forest owners' commitment in biodiversity conservation were identified. It is important that the selected attributes allow the relevant assumptions to be tested and that the attributes are relevant to the forest owners' choices. An important contribution to the definition of attributes comes from the analysis of a collaborative workshop (World Café) we had with stakeholders. In Table1 below, we report the selected attributes and their definition.

Attibutes	**Level of attributes**	**Statu quo** (Aucun commitment)
Organization / person with whom we can be involved -	- Forest professionals (syndicates, Cooperative,...) - Environmental Protection Association - Administrations (Prefet, regional administration...) - Local collectives (Municipalities, Communities of Municipalities, Regional Natural Park...) - Family or civil society (communal school class, retirement home, local associations or clubs...)	No commitment
- Your commitment is private or public - -	- Your commitment is public  - Your commitment is private 	The commitment of others is public The commitment of others is private
Reward	- Free inventory  - None 	none
Monetary compensation	- 0 Euros/ha/year - 25 Euros/ha/year - 50 Euros/ha/year - 75 Euros/ha/year - 100 Euros/ha/year - 125 Euros/ha/year	0 Euros/ha/an

TABLE1 : ATTRIBUTES AND THEIR LEVELS IN THE CHOICE EXPERIMENT

As the main objective of this study is to identify the institutional factors influencing commitment, it was decided not to let protection action as such be an attribute. The objective was not to estimate

the opportunity costs of forest owners to implement different protection measures but to estimate how an institutional factor would influence the probability of commitment and how these factors can influence the demand for monetary compensation. However, in order to assess the impact of institutional factors on the decision to initiate it, it was necessary to define relevant and applicable protective measures for all forest owners from the smallest surface to the largest. In addition, they should be easy to explain in a questionnaire. It was decided to propose two protection actions:

- Leave more dead wood on the ground or standing (diameter > 30 cm) than you do today during a harvest (minimum 5 trees per hectare);

- Keep more very large live wood (more than 70 cm in diameter) than you do today (minimum 2 trees per hectare).

Before the experiment, respondents are asked which of these two biodiversity protection actions is most relevant to their forest. The most relevant is therefore used as a protective measure in all subsequent commitment choices. The hypothesis is that the impact of institutional factors does not depend on which of these two measures is chosen by forest owners. The reason for proposing two protection measures and leaving the choice to the owner is that it will reduce the risk that a forest owner will not accept any commitments and therefore not provide any information on institutional preferences.

The first attribute is the organization with which the forest owner engages (see Table 1). Four alternatives were chosen, mainly based on the inspiration of our World Café. The second attribute indicates whether the commitment is public or private. If a commitment is public, it will, for example, be published on the website of the Parc Naturel Régional des Ballons de Vosges and/or on a panel installed at the entrance to the forest explaining the commitment made. If the commitment is not public, it remains anonymous to the general public, only the organization with which the owner is involved is aware. The third attribute indicates whether the commitment provides access to a non-monetary incentive defined as a reward through a free biodiversity inventory or a calculation of the biodiversity index (PBI) of their plot. Finally, monetary compensation has been included. This has been defined as an annual compensation paid per hectare by the government (0-125 Euros). However, a monetary incentive was not included if the commitment was with the family or civil society because it was not considered credible to have a monetary payment if the commitment was with the family.

The second step of our choice experiment consists in defining combinations of alternative commitments and their combination in choice situations. We decided to let each respondent participate in two DCE: the first DCE did not include the monetary incentive attribute (see Figure 1) while the second DCE included monetary and non-monetary incentives (Figure 2).

CHOIX 1	Pas d'engagement de votre part	Engagement 1	Engagement 2	Engagement 3	Engagement 4
Organisme/personne avec qui on s'engage		Engagement avec des professionnels de la forêt	Engagement avec l'administration	Engagement avec des élus locaux	Engagement avec famille/société civile
Engagement rendu public ou qui reste privé	 L'engagement des autres est public	 Votre engagement est public	 Votre engagement est privé	 Votre engagement est privé	 Votre engagement est public
Récompense		 Aucune	 Aucune	 Inventaire gratuit	 Inventaire gratuit
COCHEZ UNE CASE →	☐	☐	☐	☐	☐

Figure 1 : Choice situation without monetary compensation

CHOIX 14	Pas d'engagement de votre part	Engagement 1	Engagement 2	Engagement 3	Engagement 4
Organisme/personne avec qui on s'engage		Engagement avec des professionnels de la forêt	Engagement avec l'administration	Engagement avec des élus locaux	Engagement avec famille/société civile
Engagement rendu public ou qui reste privé	 L'engagement des autres est public	 Votre engagement est public	 Votre engagement est public	 Votre engagement est privé	 Votre engagement est privé
Récompense		 Inventaire gratuit	 Aucune	 Aucune	 Inventaire gratuit
Rétribution monétaire		50 Euros/ha/an	125 Euros/ha/an	100 Euros/ha/an	0 Euros/ha/an
COCHEZ UNE CASE →	☐	☐	☐	☐	☐

Figure 1 : Choice with monetary compensation

If the respondent knows that a commitment could potentially have monetary compensation, he or she will be less reluctant to accept a commitment without monetary compensation. To test this hypothesis, we let the respondent first choose commitments without mentioning anything about potential monetary compensation. The first part included 12 choice situations and the second part 16 choice situations. A total of 28 choices were considered too important for an individual to agree to complete the questionnaire. Two versions of the questionnaire were then developed with 6 and 8 choice situations assigned to each of the two versions, and then randomly distributed to the respondents. The combination of attribute levels is done using a so-called d-efficient model that seeks to maximize the information that can be derived from respondents' choices and thus reduces

the sample size required to estimate the underlying decision model (Scarpa & Rose, 2008). A pretest of the design was carried on a simulated dataset to verify that it would be possible to test the hypotheses.

The third step consists in an introduction to the choice experiment and follow-up questions. A crucial element of a choice experience is to explain it to respondents. The questionnaire included a section presenting the attributes of the commitments. Then, it is explained that the commitment would last at least 20 years but they could leave the commitment if they repaid any reward they may have received. It was also explained that if the property changed ownership, the new owner would be free to choose whether or not to keep the contract. Half of the respondents, selected randomly, are told that they would be the first in their municipality to have one of the proposed commitments and the other half that they should imagine that half of the forest owners in their municipality have already committed to one of the proposed commitments. Respondents are reminded that they can always choose "no commitment" if they find no commitment attractive. Following these responses, there were some follow-up questions where, it was asked if the respondent had taken all attributes into account when making their choices and for respondents not choosing a contract in any of the 14 choices were asked why they did not choose a contract.

In addition to the choice experience, the questionnaire included several other questions that facilitate the interpretation of the results of the choice experience. For example, we asked direct questions about the organization with which they prefer to interact and why. While the choice experiment makes it possible to estimate how forest owners make trade-offs between different attributes (for example, to estimate how the required monetary compensation changes with different organisms) these questions can help explain why forest owners make these trade-offs.

The questionnaire includes relatively few questions about the forest and the forest owner since the forest owners interviewed had already participated in a telephone interview and we therefore already had this information. While the attributes of the choice experiment were selected and defined based on the experience of the so-called world-café with forest professionals (forest owners, forest consultants, forest owner organizations etc.) and a focus group with forest owners organized by the participating natural par. The questionnaire was tested within the project group (which includes sociologists having carried out qualitative interview with forest owners) and in face-to-face testing of the questionnaire with forest owners.

The questionnaire has been implemented on the web, programmed with Limesurvey free software and hosted by an INRA server. E-mails were sent to 214 forest owners with two reminders (postal and telephone). E-mail addresses were obtained by a previous telephone interview where the respondents were asked if they would participate in a follow-up survey. This approach allowed us to have 99 usable questionnaires. Comparison of the sample obtained with the distribution of respondents' forest area in the telephone survey (Table 2) shows that the sample obtained is not statistically different (Pearson's Chi-Square test: $X2 = 2.7$; p-value = 0.60).

Size classes	S	M	L	X	XL
Area	0,05ha - 0,74ha	0,75ha -1,99ha	2ha - 3,99ha	4ha - 9,99ha	10ha and +
Telephone interviews (%)	21.4	21.5	21.7	20.9	14.5
DCE survey (%)	26.2	17.9	16.7	21.4	17.9

TABLEAU 2 : COMPARISON OF FOREST SIZES IN TELEPHONE AND DCE SURVEY

The Econometric analysis

The results from the choice experiment will be analysed using a random utility (profit) model (McFadden, 1974). Utility of contract *j* for forest owner *I* is defined:

$$v_{ij} = \beta_f x_{fij} + \beta_{kP} x_{kij} + \beta_P x_{Pij} + \beta_{NM} x_{NMij} + \beta_M x_{Mij} + \beta_{MP} x_{Mij} x_{Pij} + \beta_{NMP} x_{NMij} x_{Pij} + \varepsilon_{ij}$$

where

x_{fij}: forest protection measure in contract j demanded of forest owner i (will be a vector of dummies – one for each action considered)

x_{Pij} : 1 if contract j is published for forest owner i, 0 otherwise

x_{mij}: Monetary compensation for contract j offered to forest owner i

x_{nmij}: Non-monetary compensation for contract j offered to forest owner i

x_{kij}: other contract attributes in contract j offered to forest owner i (institution)

ε_{ij} : is an random term not observed by the researcher

And β are the parameters to be estimated – here the marginal impact on utility or profit of the different contract characteristics.

The forest owner will choose the contract *j* that will give the highest utility: $v_{ij} > v_{ik}\ where\ k \neq j$

Test of crowding out: if parameter of interaction term β_{MP} is negative indicates that with a published contract the utility of money compensation is negative (because money paid will show the forest owner as a greedy person). Furthermore, our hypothesis is that non-monetary compensation will not imply crowding out, i.e. $\beta_{NMP} = 0$.

The sign of the β_P is not clear from theory. People will be more likely to make a contract if they think that it will contribute to a positive social image. However, a public contract will reduce the possibility of moral hazard, as all visitors of the forest may observe if owner complies with contract. By estimating an econometrical model allowing for preference heterogeneity, e.g. a latent class model we may be able to identify groups of owners that are likely to make a contract if they are public while another group is less likely to make a contract if public contract.

Crowding out associated to owners with prosocial behaviour determined by altruistic behaviour and which are not influenced by others view of them can be identified as a test of linearity of the marginal utility of income (compensation), i.e. a dummy variable which takes the value of one when the payment is zero. If this is positive and significant different from zero we have that there is a disutility of being economically compensated. However, this is a rather weak test as this is based on

the assumption that utility is linear in income. This test has not been carried out in present version of the paper.

2. Results

We applied the random utility model and first using conditional logit (McFadden, 1974) to analyse respondents' preferences for different institutional factors. In the tables below, the parameters represent the marginal utilities related to the attributes. A positive parameter of an attribute implies that this attribute contributes positively to the utility obtained through commitment while increasing the probability that a forest owner will engage. These attributes are divided into three components: the institutional factor, the type of reward (inventorying or monetary reward) and whether or not to make the commitment public. Thus, the first four attributes represent different organizations or institutions with which the forest owner could engage.

In the model, attributes are defined as dummy variables. This implies that the parameters express the marginal utility of a commitment with one of the four institutions in relation to the absence of commitment.

i/ Result: *The type of institution plays a role in the decision (probability) of commitment of owners*

A priori, we can expect these parameters to have a negative sign because a commitment implies an opportunity cost for the forest owner to leave dead wood or keep large trees in forests that could otherwise be exploited. Table 3 below provides estimates of a first model for all respondents. The negative sign is confirmed for all institutional attributes except for "Forest Professionals". In the latter case, the parameter is positive, indicating that on average, forest owners do not consider engaging with forest professionals to be a cost to them, but this parameter is not significant. Nevertheless, other institutions are less preferred, and therefore reduce the probability of commitment, than "Forest Professionals" with a high degree of significance. The hierarchy is "Local authorities", "Family or civil society" and then "Administration".

The other results show that, on average, making public commitment is not statistically significant, while monetary and non-monetary compensation has a significant positive effect but only at a level of significance of 10%.

This first model, for all respondents, gives indications but is not very significant overall.

Attributs	**Paramètre**	**S.E.**	**z**	**prob**
Forest professionals (= 1 if commitment with them)	0,112	0,087	1,280	0,199
Administrations (=1 if commitment with administrations)	**-2,221**	**0,154**	**-14,400**	**0,000**
Des collectives locales (=1 if commitment with them)	**-0,794**	**0,101**	**-7,880**	**0,000**
Family or civil society (=1 if commitment with them)	**-1,788**	**0,129**	**-13,850**	**0,000**
Public commitment (=1 if public)	0,082	0,064	1,270	0,203
Rewards with an inventory (=1 si récompense par un inventaire)	**0,160**	**0,082**	**1,950**	**0,051**
Monetary compensation (Euros/ha/year)	**0,002**	**0,001**	**1,940**	**0,053**
N=99, choix= 1385, pseudo R =0,18				

TABLE 3: ESTIMATION «CONDITIONAL LOGIT » FOR ALL RESPONSES.

Among survey respondents, about 20% of forest owners will not commit even with the highest monetary compensation of 125 Euros / ha / year for the proposed measures or whether or not to publicize their commitment. Following the experience of choice, we asked them why they had never chosen a commitment. Their responses show that they do not consider it possible to implement the proposed measure in their forest (keeping dead wood or large wood on the plot) or that they refuse them regardless of the commitment characteristics. The above estimate includes these 21 forest owners who refused any commitment in the 14 choices they made.

Therefore, it can be argued that these owners have not made any trade-offs between the different attributes of the choice experience and should therefore be excluded from the statistical analysis. The sample is now 78 people.

ii/ Result: *Engaging with "forest professionals" increases the likelihood of commitment*.

Table 4 shows the results of the same model but only for forest owners who are considering a commitment. The results confirm the preferences estimated above for the institutions with which to engage: "Forest professionals" are always preferred. This variable is now significant and indicates that there is a positive utility in engaging with forest professionals in relation to not having any commitment. Equally significant is the disincentive to commitment if it is done with an Administration or the Family. In addition, we note that non-monetary and monetary compensation is now statistically significant at a level of 5%.

Attributs	Paramètre	S.E.	z	prob
Forest professionals (= 1 if commitment with them)	**1,034**	**0,113**	**9,140**	**0,000**
Administrations (=1 if commitment with administrations)	**-1,299**	**0,171**	**-7,610**	**0,000**
Des collectives locales (=1 if commitment with them)	0,129	0,124	1,040	0,297
Family or civil society (=1 if commitment with them)	**-0,809**	**0,145**	**-5,570**	**0,000**
Public commitment (=1 if public)	0,100	0,070	1,420	0,155
Rewards with an inventory (=1 si récompense par un inventaire)	0,220	0,089	2,480	0,013
Monetary compensation (Euros/ha/year)	**0,005**	**0,002**	**2,830**	**0,005**
N=78, choix= 1105, pseudo R =0,20				

TABLEAU 4 : CONDITIONAL LOGIT WITH RESPONDENTS WHO HAVE CHOSEN AT LEAST ONCE TO ENGAGE.

iii/ Result: *lowest willingness-to-accept to engage with forest professionals, an administration or the family.*

Although our project focuses on modalities that facilitate commitment in terms of ownership size and therefore probability, in Table 5 below, we present the results of the estimation to assess the willingness to pay/receive in euros/ha/year to engage. They reflect how forest owners, on average, make a trade-off between monetary compensation and other attributes. On average, forest owners would pay a significant positive amount for a commitment with forest professionals (222 euros / ha / year) while requiring very significant compensation if the commitment is with the administration (279 euros / ha / year) or the "Family" (174 euros / ha / year). Several interpretations are emerging: an expectation of income induced by engaging with forest professionals in the form of advice, for example, a refusal to engage with the administration or a misunderstanding of the "Family" institution. The current results of this model therefore require further analysis. In addition, we note that a forest owner reduces, on average, his claim for compensation with 47 Euros / ha / year if he receives a free inventory.

Attributs	Consentement à recevoir (euros/ha/an)	S.E.	z	Prob
Forest professionals (= 1 if commitment with them)	**-222**	**92,82**	**-2,39**	**0,02**
Administrations (=1 if commitment with administrations)	**279**	**93,42**	**2,98**	**0,00**
Des collectives locales (=1 if commitment with them)	-28	32,15	-0,86	0,39
Family or civil society (=1 if commitment with them)	**174**	**66,75**	**2,60**	**0,01**
Commitment public	-21	16,68	-1,28	0,20
La récompense par un inventaire	**-47**	**22,39**	**-2,11**	**0,04**
N=78, choix= 1105,				

TABLEAU 5 : CONSENTEMENT MARGINAL A RECEVOIR SELON LES ATTRIBUTS

iv/Result : *The type of protection action proposed affects the probability of commitment: the coarse wood measure is more favourable to commitment*

In Table 6, we consider whether the probability of committing depends on the action taken to improve biodiversity (dead wood or coarse wood). This was tested by adding an interaction variable between commitment and a "coarse wood" dummy variable. The first term 'commitment' is equal to 1 if there is a commitment and zero if there is no commitment. The second term is equal to 1 if the forest owner has chosen to implement the "large wood" action. We find this interaction term to be positive and statistically significant. This indicates that owners who have chosen coarse wood measurement are more likely to engage and need less compensation. This may correspond to a lower opportunity cost for them.

v/Result: *Advertising of commitments with an asymmetric effect: the commitment of other owners in the neighbourhood does not have an impact on the probability of owners to commit... but make it known that you are the first to commit, yes!*

Before proceeding with the experiment of choice, respondents were asked to imagine that they could be the first owners in the municipality to commit or that half of the owners in the municipality already had a commitment. Respondents were randomly assigned to one of these two contextual statements. In Table 6, we did not find a statistically significant effect of context on the probability of commitment. Thus, knowing that other owners in the neighborhood are already involved in biodiversity protection action does not affect the likelihood of owners becoming involved. However, we found that asking the respondent to imagine that he or she is the first to get involved in the municipality has a positive impact if the involvement is public (significant only at the 10% level). Apparently, if an owner is the first to commit, he wants to show it. This result is interesting because it suggests the potential effect of a leader who would be more willing to relay information.

Attributs	**Paramètre**	**S.E.**	**z**	**prob**
Forest professionals (= 1 if commitment with them)	0,715	0,157	4,550	0,000
Administrations (=1 if commitment with administrations)	-1,620	0,203	-8,000	0,000
Des collectives locales (=1 if commitment with them)	-0.191	0.165	-1.160	0.247
Family or civil society (=1 if commitment with them)	-1.130	0.181	-6.230	0.000
Public commitment (=1 if public)	-0.002	0.092	-0.020	0.985
Rewards with an inventory (=1 si récompense par un inventaire)	0.220	0.089	2.480	0.013
Monetary compensation (Euros/ha/year)	0,005	0,002	2,830	0,005
Constant pour commitment x Action large wood	**0,447**	**0,172**	**2,600**	**0,009**
Constant pour commitment x first in the municipality	0,190	0,177	1,070	0,285
Commitment public x first in the municipality	**0,244**	**0,142**	**1,720**	**0,086**
N=78, choix= 1105, pseudo R =0,21				

TABLE 6 : EFFECT OF NEIGHBORHOOD AND TYPE OF ACTION ON THE PROBABILITY OF COMMITMENT

vi/ Result : *Choice experiment confirms that social norms do not lead to eviction*

We also tested whether the effect of monetary and non-monetary compensation is influenced by making the commitment public by including interaction terms between the compensation attributes and the public commitment dummy variable. These interaction terms are not significant, indicating that social norms do not lead to eviction. This result is consistent with the results of the telephone survey investigation (Polomé, 2016).

vii/ Result: *Forest owners are heterogeneous in their commitment decisions*

To characterize the heterogeneity of forest owners' behaviour we now consider a random utility model with a random parameter logit model (Train, 2009). This model assumes that each forest owner has a unique utility function, i.e. that forest owners do not have the same preferences for the institutional factors of a commitment, for example. We estimated the model assuming that distributions of forest owners' utility parameters are described by normal distributions.

The first part of Table 6 below describes the estimates of the average of these distributions, while the last part describes the standard deviation of these distributions. The results confirm the results of the previous model, i.e. that the mean distributions have the same signs and are significant. In addition, we find that standard deviations of parameter distributions are statistically significant, i.e., preferences are heterogeneous with respect to forest owners.

This heterogeneity is present on all attributes, in fact the estimate of the standard deviation of all parameters is very significant.

Moreover, this heterogeneity is observed with the standard deviation of the parameter on the publication of the commitment which is highly significant. This implies that although, on average, this attribute is not statistically significant, it is significantly positive for one part of the sample while it is significantly negative for another part of the sample. It can be said that the publication of the commitment has an opposite effect on the probability of commitment following these two populations.

Attributs	Paramètre	S.E.	z	prob
Moyenne des distributions de paramètres				
Forest professionals (= 1 if commitment with them)	1,879	0,289	6,490	0,000
Administrations (=1 if commitment with administrations)	-3,299	0,529	-6,240	0,000
Des collectives locales (=1 if commitment with them)	-1,094	0,337	-3,250	0,001
Family or civil society (=1 if commitment with them)	-1,381	0,309	-4,470	0,000
Public commitment (=1 if public)	**0,096**	**0,177**	**0,540**	**0,588**
Rewards with an inventory (=1 si récompense par un inventaire)	0,470	0,186	2,520	0,012
Monetary compensation (Euros/ha/year)	0,017	0,005	3,550	0,000
Std dev				
Forest professionals (= 1 if commitment with them)	**3,937**	**0,463**		**0,000**
Administrations (=1 if commitment with administrations)	**3,220**	**0,449**		**0,000**
Des collectives locales (=1 if commitment with them)	**2,653**	**0,275**		**0,000**
Family or civil society (=1 if commitment with them)	**1,893**	**0,248**		**0,000**
Public commitment (=1 if public)	***1,511***	***0,185***		***0,000***
Rewards with an inventory (=1 si récompense par un inventaire)	**1,269**	**0,200**		**0,000**
Monetary compensation (Euros/ha/year)	**0,026**	**0,005**		**0,000**
N=78, choix= 1105				

TABLE 7 : "*RANDOM PARAMETER LOGIT*" TO TAKE INTO ACCOUNT THE HETEROGENEITY OF FOREST OWNERS

viii/ Heterogeneity and Identification of effective attribute pairs

An alternative approach to take into account heterogeneity in the sample is to apply a latent class model (Greene and Hensher 2003). In this model, it is assumed that there are a number of different groups of forest owners. The owners of a group have homogeneous preferences, but the preferences vary from one group to another. In Table 8 below, we estimated our model by assuming three different classes given our reduced sample size of 78 respondents with commitment.

The first class (42% of the sample) is characterized by a clear positive preference for commitment with forest professionals. The non-monetary compensation is not significant and the monetary compensation is only slightly significant. The effect of public commitment is positive and highly significant. This indicates that this group of owners is much more likely to engage if the commitment is public.

The second class (55% of the sample) prefers commitment with local communities or forest professionals. In addition, the presence of compensation, both monetary and non-monetary, has a significant impact on the likelihood of commitment. Making the commitment public does not have a significant impact on the likelihood of commitment of this group. In the third class (3% of the

workforce), commitment has a negative and statistically significant impact on utility regardless of the type of institution. In fact, it can be concluded that they often refuse the undertaking unless there is an exception. Monetary compensation is not statistically significant, while non-monetary compensation is positive and weakly statistically significant. The first two classes engage preferentially with forest professionals but with different attributes of compensation and publicity of the commitment. This shows the usefulness of offering a choice to owners where both modalities are present.

Attribut	Paramètre	S.E.	z	prob
Classe 1				
Forest professionals (= 1 if commitment with them)	**4,926**	**0,681**	**7,240**	**0,000**
Administrations (=1 if commitment with administrations)	0,635	0,694	0,920	0,360
Des collectives locales (=1 if commitment with them)	-0,366	0,792	-0,460	0,644
Family or civil society (=1 if commitment with them)	-0,491	0,856	-0,570	0,566
Public commitment (=1 if public)	**2,071**	**0,476**	**4,350**	**0,000**
Rewards with an inventory (=1 si récompense par un inventaire)	0,392	0,398	0,980	0,325
Monetary compensation (Euros/ha/year)	0,018	0,010	1,880	0,061
Classe 2				
Forest professionals (= 1 if commitment with them)	**1,115**	**0,245**	**4,540**	**0,000**
Administrations (=1 if commitment with administrations)	-0,099	0,289	-0,340	0,733
Des collectives locales (=1 if commitment with them)	**1,538**	**0,243**	**6,340**	**0,000**
Family or civil society (=1 if commitment with them)	-0,145	0,284	-0,510	0,610
Public commitment (=1 if public)	0,003	0,109	0,030	0,979
Rewards with an inventory (=1 si récompense par un inventaire)	**0,423**	**0,146**	**2,890**	**0,004**
Monetary compensation (Euros/ha/year)	**0,012**	**0,003**	**3,670**	**0,000**
Classe 3				
Forest professionals (= 1 if commitment with them)	**-1,100**	**0,236**	**-4,660**	**0,000**
Administrations (=1 if commitment with administrations)	**-5,168**	**1,027**	**-5,030**	**0,000**
Des collectives locales (=1 if commitment with them)	**-2,294**	**0,313**	**-7,330**	**0,000**
Family or civil society (=1 if commitment with them)	**-1,253**	**0,213**	**-5,890**	**0,000**
Public commitment (=1 if public)	-0,076	0,167	-0,460	0,647
Rewards with an inventory (=1 si récompense par un inventaire)	0,442	0,219	2,020	0,044
Monetary compensation (Euros/ha/year)	0,004	0,003	1,360	0,174
Effectif de la Classe 1	42,2%			
Effectif de la Classe 2	55,4%			

TABLEAU 8 : "LATENT CLASS" ON 3 CLASSES.

3. Conclusion

A main objective of the present study was to assess which institutional factors influence the commitment in a biodiversity projection scheme. We find that the organisation with whom the contract is concluded is very important. Forest owners prefer forest organisations that they already know. The need of payment reduces significant if a contract is concluded with the preferred organisation/authority.

We also tested to which degree monetary compensation could lead to crowding out. We found that making engagement public did not have a statistically negative effect on the utility of obtaining monetary compensation. However, we did find that for some forest owners that making the commitment public has a positive impact on the probability of commitment, in particular in the treatment where the forest owner is told that they are the first to conclude a contract in the neighbourhood.

Private forest owners are heterogeneous in their behaviour, which indicates that there is no "universal" contract with the same capacity to attract everyone.

About 20% of the forest owners in the survey will not commit even with the highest monetary compensation of 125 Euros / ha / year for the proposed measures. They do not consider it possible to implement any of the proposed measures in their forest (keeping dead wood or large wood on the plot) or to refuse them regardless of the commitment characteristics.

The type of protection action proposed affects the probability of commitment. The measurement of maintaining large wood on the plot is more favourable to commitment in our analyses. Owners are more likely to be involved in this action and need less compensation. This may correspond to a lower opportunity cost for them.

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