Drivers of cooperation for environmental goods: Evidence from a national survey on French private forest owners

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Abstract

Forests as natural resources provide both private and public benefits and goods. Maintaining sustainable level of these goods along with increasing timber harvesting is a challenge for public policies. Facing with changes in the forest landscape, cooperation is needed among private forest owners to achieve this goal. Preferences for cooperation are linked to organisations and costs transaction issues. Assuming that timber production and decision to cooperate are linked, we estimate recursive bivariate probit models to identify the main drivers of the stated-preference to cooperate or not. We use data obtained from a mail survey of forest owners in France done in last 2010. We showed that the willingness to cooperate for production activity and environmental purposes is impacted by the intention to commercialize timber. We found that one of the key factors of cooperation whatever the objectives is the forest management delegation. We also found that when a private forest owner plans to sell timber, cooperation either for production objectives or public goods provision may represent a supplementary cost and gains from cooperation do not overcome the benefits of timber production.

Keywords: cooperation, collective action, forest, environmental public goods, bivariate probit

JEL Classification: Q5, D1

1 Introduction

Forests as natural resources provide many benefits and goods. They contribute to collective welfare in producing positive externalities such as preservation of water quality, reduction of risk of flood, maintenance of landscape attributes, preservation of biodiversity or carbon sequestration. These externalities can be seen as local and global public goods. As a consequence, they are considered as common-pool resources. In a well-defined property right context, forests can also be considered as a private good as a private property representing different values such as patrimonial capital or source of individual income. Their management are a key element for sustainable provision of both public and private goods. Provision of these services constitutes a goal for environmental policies and governments address "forests as a mean to meet this increasing demand for forest services" (Serbruyns and Luissaert, 2006).

However governments face with new challenges. Urbanization expansion, agriculture activities decline and bequest phenomena continuously change the forest landscape. Such changes induce a higher level of the forest properties fragmentation and a modification among the private forest owners who are in greater numbers and with very different profiles[1]. Consequences are both economic and environmental. Because of economies of scale, small properties are no more profitable for production purpose and the absence of management can affect ecological functions and has an impact on environmental and recreational amenities. Small (privately owned) woodlands are more and more recognized for their contribution to the landscape fabric and ecological health (Erickson et al., 2002). Deepering this concern, collective welfare is affected by social changes and forest area modification.

Coordination of forest management is needed to achieve objectives for both production and environmental issues. Cooperation is recognized to create benefits at different scales, for different purposes including production as well as public goods provision (Kittredge, 2005). However, coordination between private forest owners is a difficult task considering their differences in terms of ownership (property size, species composition), in individual preferences (on timber and amenity productions) and thus in their management choices.

Agents cooperation leads to organization and transaction costs issues. Cooperation is

[1]Private forest owners, in particular in France, often belong to very different socio-professional categories, not in relation with forest management skills.

actually a choice among many other alternatives for an agent and preferences for cooperation are influenced by institutions and organization (Vatn, 2007).

Agents coordination and cooperation are not a new topic in the forest sector. Suppliers and buyers are already organized through different forms (resulting from horizontal and vertical integration) and self-organisation has been observed. But cooperation seems not to be a first choice for private forest owners[2], even if the smaller properties could benefit a lot from it. One can wonder whether self-cooperation has a chance to emerge in a well-defined property right context. What are the determinants of cooperation between private forest owners? Are the drivers of cooperation the same for both private and public benefits from natural resources?

In this paper, we want to know which type of objectives (private or public) is important to motivate potential cooperation among private forest owners. We compare two objectives of cooperation: cooperation for production objectives and cooperation for public good provision (establishment of area protection or recreation area). Moreover, individual timber production decisions play a role in the willingness to cooperate. For this purpose, we realized a study over French private forest owners to study the willingness to cooperate between private forest owners. From an organizational economics framework, we analyze cooperation decision as a result of a cost analysis : a private forest owner is willing to cooperate if the cooperation situation presents a cost reduction important enough compared to the individual situation. We focus in particular on the impact of cooperation organization on the transaction costs reduction. This is why we analyze the joint decision to sell timber production and to cooperate. The following section presents the literature concerning private forest owners behaviors and the approach used to analyze cooperation in the forest sector. The third section describes the economic model and the estimation approach. Estimation results are given and discussed in the fourth section. The last section concludes.

[2]Regarding French figures on cooperation, only 13 % of the forest area is managed through forestry cooperatives. For more details see section 2.2.2.

2 Drivers of private forest owners decision

2.1 General concerns

Analyzing the cooperation in the forest sector leads to study management decisions and choices of nonindustrial private forest (NIPF) landowners. NIPF landowners comprise close to 70 % of land ownership in many U.S. states and significant land holdings throughout Europe (Amacher et al., 2003). In France, almost 75 % of the total forest land is private and 96 % of private landowners are nonindustrial. NIPF landowners have been showed to be more multi-objective by nature than industrial landowners: they give more importance to standing timber and forestland for the amenity values they provide (Newman and Wear 1993). Among analyses on the forest landowner behavior, the household production framework recognizes the benefits associated with forest amenities, as used first by Binkley (1981). These non-market services are jointly produced with timber and enter as an argument in the landowner's utility function. In this article, we investigate the production decisions for NIPF landowners using a micro-econometric household production model..

Many studies focused on determining drivers of decisions to harvest or not, the willingness to enter in some specific management plan using microeconometric analysis.[3] Common drivers as property size, age, debt and previous harvest are positive variables for the harvest decision, contrary to bequest intention, level of education, which play more in favor of amenity production and harvest reduction.

The literature highlights an important common point : private forest owners face with a trade-off between timber production objectives and amenity production. This trade-off is assumed to be present in cooperation decisions too.

2.2 Cooperation in the forest sector

2.2.1 Willingness to cooperate

Cooperation is a very general term to describe different types of agreements, contracts and commitment. Cooperation is established between private individuals, between individuals and public organizations or between public administration themselves. These relationships

[3]For a review of these models, see Amacher et al. 2003 and Beach et al. 2005.

are bilateral or shaped in a more complex structure.

Main cooperation decisions studied in the forest sector concern the willingness to enter in a future management plan (Stevens et al. 1999, 2000) usually for a protecting area but also for some joint management with their neighbors (Vokoun 2005, Vokoun et al. 2010). Stevens et al. (1999) show that private forest owners are willing to implement self-management as much as joint management. In their studies, Stevens et al. (2000) found that the age, the income, the costs and the size area dedicated to an ecosystem program management are the main drivers of an agreement to the program. Vokoun (2005) analyzed the following decisions to cooperate considering forest stock interdependencies between forest owners neighbors : cooperation for harvesting at the same time given a price incentive, willingness to enter into a joint agreement to create a wildlife cover and to create an area for protection. In particular, it shows that the stock level decision of a landowner depends on the spatial interdependencies between his own stock and stocks in adjacent stands in terms of amenity valuation, as well as the type of cooperation undertaken by the forest owner. A private forest owner is more likely to cooperate for environment when he gives a high value to amenity on his own and adjacent forests. Another interesting result is that harvest coordination does not seem to be linked with prior cooperation contrary to the willingness to enter in joint management with environmental objectives.

2.2.2 Organisation, cooperation and impacts on costs

Many of the previous studies present results concerning coordination acceptation, through incentive programs for production (harvest at the same time) or for environmental protection. Hence, the choice deals with the decision to join or form a group or a program already existing. In this work, cooperation will refer to *spontaneous* movement of cooperation between private forest landowners. We assigned to this behavior the potential for cooperation in a group.

"Cooperation" in the French forest sector refers also to different kinds of organization forms. Like in other sectors, these forms are defined according to specificities such as legal aspects, resources and information flows, authority and control relationship and decisions rules (Milgrom, 1997).

First, forestry cooperatives are associations (rural code) who provide technical and man-

agement services. These groups (27 over the national territory) manage 13 % of the French private forest with 96,500 members (among 3,4 millions of owners). Other advisory organizations can be found in the forest sector who do not provide any service except information service. They can play an important role in connecting private forest owners with buyers, expert, etc. Secondly, private forest owners can also create non-profit associations, for production and technical purposes, and union associations. In this case, activities extent (harvest, sale, etc.) depends on the organization status, which also determines the legal status of owners (between private law entities and public entities). A last case of cooperation is the grouping of owners with a property right transfer. In this case, the group as a whole becomes the owner of the forest and each private forest owner becomes a shareholder of the forest property.

These different types of collective organizations present important differences: the two last cases, result from individual and collective initiative from private forest owners themselves, while forestry cooperative and advisory organization are institutions supported by government (origin and financial support). Moreover, in the two last cases, new legal entities are created and decision power is shared among the group members while membership of a forestry cooperative does not modify a private forest owner authority of decision.

In the analysis, because of data constraint, we only focus on the first case presented above in the following sections: organizations who provide information and formation only ("ADV" variable) and those (mainly named "forestry cooperative") who provides both services (management, technical) and information ("SERV" variable).

According to these two types of membership, the required levels of commitment are different: being member of a forestry cooperative implies supply constraint, timber production is sold through the cooperative, while membership to an advisory body is only a supplementary cost (membership fees). This also implies different costs: membership has potential consequences on production costs but also on transaction costs (e.g., information costs, contracting costs).

Theory assumes that a manager selects among governance association in minimizing his transaction costs (Williamson 1985, Vernimen et al. 2000). Hence, we assume that the choice of a private forest owner to belong to an organization results from a cost analysis and especially from a reduction of transaction costs. Furthermore, we assume that the willingness

to cooperate for private purpose and for public objectives also depends on a cost analysis. Finally, cooperation with neighboring forest owners is another potential opportunity that may affect the structures of costs. Hence, we assume that the willingness to cooperate depends on the effective way of organization a owner chose and his management choices.

The main objective of this paper is to analyze the drivers of potential cooperation among individuals for private as well as public good provision. Because the decision takes part in a set of management decisions, we develop a joint decision model of timber production and cooperation. In particular, we analyze two types of motivation for cooperation (for timber production and environmental objectives).

3 The model

3.1 Economic theory and econometric model

In order to analyze drivers of willingness to cooperate, we model NIPF landowners' preferences over two decisions. We assume that willingness to cooperate are linked to harvest behavior.

In the literature on NIPF landowners, recent models of timber supply have included non-monetary returns or amenities (Binkley 1981, Dennis 1990). The idea is to apprehend the trade-off between timber harvesting and amenity benefits. In the framework of household production function, the landowner i is represented by a utility function of the total income and non-pecuniary attributes:

$$U_i = U(R_i, p, H_i, C_i, A_i, \theta_i), \tag{1}$$

where the total revenue of the non-industrial forest owner is composed of an exogenous revenue denoted R_i and an income from timber harvest (H_i) sold to the price p. The variable θ_i captures observable individual heterogeneity (i.e., owner characteristics). Moreover, the forest owner bears costs to manage his forest. The cost function can be written as:

$$C_i = C(H_i, A_i, Z_i), \tag{2}$$

where Z_i represents exogenous variables, which will be detailed below. The forest owner also consumes forest amenities A_i. Amenities depend on timber stand S_i after harvesting:

$$A_i = S_i - H_i \tag{3}$$

The forest owner maximizes his utility U_i with respect to H_i. This gives an optimal harvest (supply) of timber. Reporting it in the amenity function leads to an optimal choice (demand) of amenities. The indirect utility is obtained by inserting both timber supply and amenity demand in the utility function (1), such that:

$$V(R_i, p, C_i, S_i, \theta_i, \epsilon_i), \tag{4}$$

where ϵ_i is the error term. We assume that a private forest owner is willing to sell timber harvest if he derives a better utility from this choice. Within this framework, if we denote V_{i1} and V_{i0} the utility derived by respectively the intention to sell his production or not, we assume the probability of the choice is determined by the difference of the utilities derived from this alternative choice. We model this choice from a random utility model (RUM, McFadden 1973):

$$V_1(R_i, p, C_i, S_i, \theta_i, \epsilon_{i1}) > V_0(R_i, p, C_i, S_i, \theta_i, \epsilon_{i0}), \tag{5}$$

The binary decision of the forest owner i is represented by the variable Y_{1i} that takes the value one if a private forest owner is willing to cooperate with his neighbors, and zero otherwise. Denoting Y_{1i}^* the difference of utilities as $Y_{1i}^* = V_1 - V_0$, the probabilistic decision rule modeled by a probit is:

$$\Pr(Y_{1i} = 1) = \Phi(X_{1i}\beta_1), \tag{6}$$

where Φ is the cumulative distribution function of standard normal, $X_{1i} = \{R_i, p, C_i, S_i, \theta_i\}$ and β_1 the vector of associated parameters to be estimated. We can also write the following selection equation: $Y_{1i}^* = X_{1i}\beta_1 + u_{1i}$, with u_{1i} the new error term.

Cooperation will mainly affect structure of the individual cost function. We assume that the general form of the private forest owner cost function is composed of different costs:

$$C_i = PC_i + TC_i + OC_i \tag{7}$$

where PC_i is the production cost, TC_i represents transaction costs and OC_i opportunity cost. As explained above, if cooperation arises, then modification in the cost structure occurs such as some production costs are shared among cooperators. Cooperation implies modification in organisational structure, so that transaction costs are newly defined and borne by the different cooperators. Hence, the cost function depends on timber harvesting and timber stand but also on the organizational structure of cooperation and the number of cooperators.

Let C_i^c and C_i^{nc} be the cooperation and non-cooperation costs for forest owner i and let κ_i be the predisposition to cooperate that represents his specific preferences. The private forest owner i is assumed to cooperate if:

$$C_i^{nc} - C_i^c > \kappa_i \tag{8}$$

i.e., he cooperates if the cost differential exceeds his predisposition to cooperate. The predisposition to cooperate, κ_i, summarizes his receptivity for the cooperation, and can thus be either positive or negative. We assume that κ_i is a function of the characteristics of the forest owner θ_i and the costs of entering in the cooperation structure (denoted $Cost_i$) :

$$\kappa_i = \alpha\theta_i + \delta Cost_i + v_i, \tag{9}$$

where v_i is the error reflecting unobservable random factors.

In our model, the cost differential is a latent variable $Y_{2i}^* = C_i^{nc} - C_i^c$, such that one observes the choice of cooperation ($Y_{2i} = 1$) when $Y_{2i}^* > \kappa_i$. Denoting W_i the vector of arguments of the cost function (2), the decision rule can thus be rewritten $W_i\gamma + \nu_i > \kappa_i$ or $W_i\gamma - \alpha\theta_i - \delta Cost_i + \nu_i - v_i > 0$. The error term $u_{1i} \equiv \nu_i - v_i$ is assumed to be $N(0,1)$, so that we have the following probit model:

$$\Pr(Y_{2i} = 1) = \Phi(X_{2i}\beta_2), \tag{10}$$

where $X_{2i} = \{W_i, \theta_i, Cost_i\}$.

3.2 Estimation approach

Two types of cooperation were offered: cooperation for production aims, and for recreation and environmental purpose. Other management decisions were investigated as the timber marketing intention. Cooperation impacts these choices as we precise above, for production aspects as well as for recreation. In our analysis, we assume that these two decisions are linked and can not be examined independently. As a consequence we choose a pairwise analysis of the three following decisions: willingness to cooperate for production purpose (coopPROD), willingness to cooperate for environmental and recreation objectives (coopENVRE) and timber marketing intention for the next years (intmarket). We also assume that the intention to sell timber is a variable influencing directly the willingness to cooperate. Thus, we test the assumptions by using a recursive bivariate probit in the following form:

$$\begin{cases} Y_{1i}^{*} &= X_{1i}\beta_1 &+u_{1i} \\ Y_{2i}^{*} &= X_{2i}\beta_2 + \gamma Y_{1i} &+u_{2i} \end{cases} \tag{11}$$

where the u's are jointly standard normally distributed with correlation coefficient ρ. This model structure has been introduced by Heckman (1978) and studied by Maddala (1983). if X_2 includes all the variables of X_1, Maddala (1983, p.122) points a problem of identification. Wilde (2000) highlights the fact that the identification problem only results from a lack of variation in data. However, our economic model does impose some exclusion restrictions recalled in the data section. Cost structure and especially transaction costs are not observable variables. Thus we use proxy variables such as the membership of cooperative organizations to illustrate the level of costs borne by a private landowner. Moreover, we use property size and leisure activity on the property as indicators of recreation services provision.

4 Results

4.1 Data

4.1.1 Methodology

The French case is a typical example of the importance of small forests privately owned: 75 % of the French forest area is privately owned and 20 % of the private forest land is composed of properties less than four hectares.[4]

We use data obtained from a mail survey of private forests owners over five French administrative regions (i.e., Bourgogne, Pays de la Loire, Auvergne, Lorraine and Provence-Alpes-Côte-d'Azur). Over 3.5 millions of private forest owners, a questionnaire was sent to a sample of 15,000 private forest owners. The sample was drawn from the French private forest owner association database.According to a size stratification method, private forest owners were chosen randomly. Details about the study are presented in appendix 1. Because of the importance (in quantity) of small properties, contrary to many studies (Karpinnen 1998, Conway et al. 2003, Bieling 2004 , Vokoun et al. 2006, Størdal et al. 2007) no size threshold was used to exclude properties from the sample.

The response rate is 5 % with a total of 590 fulfilled questionnaires. The questionnaire involved three parts giving information about the properties characteristics, the timber production and commercialization, and socio-economic attributes and objectives of the private landowners. Questions were asked concerning their insertion in the forest-based sector and concerning their management decisions and objectives (harvest during the past five years, reasons of no harvest during last five years, willingness to cooperate, willingness to sell timber for the next five years).

Specifically, we ask whether a private forest owner is willing to cooperate with his neighboring forest owners. If the stated preference answer was "yes", the owner was asked to precise the purpose of cooperation: forest production, protection area establishment, recreation area establishment, hunting activities or other. For convenience and because the number of data, both the protection area's (global public externality) and recreation area establishment's (local public externality) purposes were gathered to form what we refer to the cooperation

[4]Chiffres clés de la forêt privée 2008-2009.

for public externalities, compared to the cooperation for production objectives.

Table 1 presents a comparison between the study sample and the national characteristics[5] of the French private forest owners. More descriptive statistics concerning the sample are presented in the appendix section.

Table 1: Comparison between study's sample and national statistics (% of private forest owners)

Variables	Sample characteristics	National characteristics
Property size average - ha	73	9
Level of segmentation (number of wood lots in average)	12	5
Age	65	–
Private forest owners retired*	61%	57%
Inherited property*	65%	75%
Property from plantation*	22%	25%
Time spent in their property*: $\geqslant 8$ days	53%	66%
Call upon third-part management*	18%	25%
Forestry cooperative membership*	20%	3%
Management plan (PSG, or other document)*	45%	27%
Certification (PEFC)*	28%	0.5%
Knowledge about forest neighborhood*	55%	n.d.
Willingness to cooperate for production objectives*	15%	n.d.
Willingness to cooperate for environmental objectives*	8%	n.d.

* percentage of private forest owners

The study sample is not representative of the French private forest owners. In particular, small private properties are under represented. The pitfall of small properties' non-response happened. In particular, we observe a high mean of property size in our sample comparing to the national mean. Concerning the other characteristics, we also note a substantial difference for the cooperative membership and the presence of a management plan: private forest owners of our sample seem to be more involved in the forest sector and in the institutions that we can observe on the national scale. The high level of management plan is a direct consequence of the size of the property: properties with one woodlot of 25 ha are obligatory managed with an official plan.

[5]References: La Forêt Privée, website june 2011, Les chiffres clés de la forêt privée 2008–2009

For 43 % of the properties, the property is parceled out with an average of 12 woodlots. Comparing to national average (the average size of properties is 8,8 hectares, parceled out in 5 woodlots[6]) , we have a dominance of large properties, even if the fragmentation seems to be more important than in the national context. Forests are owned for 27 years in average.

31 % of the private forest owners surveyed are retired and 41 % of them were executive or highly-educated professional, 16 % were business manager and 17 % were farmers. Education level is quite high: 22 % have the A-level, and 32 % reach the master level. Household income levels are consequently quite high too in our sample: 21 % of the private forest owners earn between 35, 000 euros and 50, 000 euros a year and 23 % earn more than 50, 000 euros a year. 62% of the properties were inherited for a part at least and 47 % of the properties were created by buying new parcels. Only 55 % is aware on their forest neighborhood and for those private forest owners, one has in average 5 neighboring landowners (adjacent forest properties).

More than half of the private forest owners spend between one and twenty-five days a year in their property. The large majority (69 %) of private forest owners manage them selves their forest, 12 % leave the task to an forest expert and 18 % call upon third part for management advice (institutions, professionals). A third of them sell the standing wood and the buyer realize of the forest works (felling, skidding or forwarding). More than half of them have harvested during the last five years and 43 % have the intention to sell their timber production during the next five years. The reasons of no harvesting is mainly linked with the wood maturity and the personal use of the wood.

Concerning cooperation organizations, 34 % of the landowners are member of advisory structures and 20 % to a forestry cooperative. Concerning the willingness to cooperate, 29 % of the private forest owners are willing to cooperate: 15 % for production purpose, and 8 % for environmental and recreation purposes.

4.1.2 Assumptions and expected results

As we precise above, two stated preferences concerning cooperation are studied in this paper: the willingness to cooperate for timber production and the willingness to cooperate for environmental and recreational purposes. Production choices was also analyzed over the

[6]Chiffres Clés de la Forêt Privée 2008–2009.

intention of selling timber in the next five years. Following the model presented in the previous section, we assume the intention depends on previous harvest (harvest), property size (superf), total income (income), amenity consumption (actleis), membership of organization (ADV and SERV), bequest intention (bequest) and objectives of private forest owners (objV, objW, objleis). We use the property size variable as a proxy of amenity production. This set of explanatory variables is consistent with previous literature.

Membership are considered as a pre-determined variable: belonging to an organization is a past choice compared to the new opportunity to cooperate with some neighbors. This variable may have two contrary effects. On the one hand, as an organisation with rules, it could be considered as a knowledge of cooperation mechanism and landowners could be more prone to having a new experience, reducing the "entry" cost. On the other hand, membership represents an occurring cost: new cooperation could be associated with a new expenditure and therefore reducing the willingness to cooperate.

We also assume same factors such as property size, total income and membership influence the willingness to cooperate. However, other variables can play an important role specifically for cooperation either for production or for environmental objectives. Type of management also gives an indication of cost. We focus on two types of management the delegation of management (Mexp) and direct management with calling upon third-part advice (Mext). Delegation represents a cost. But because a forest expert is the agent the most experienced to the management task compared to the private forest owner, the last still benefits from the choice of delegation. Age of landowner may influence cooperation in general. The origin of the property in particular the fact that it was purchased or not can be seen as a proxy for investment, thus, contributing to the cost structure function.

Finally, knowledge about the forest properties neighborhood (vois) may have an impact on the willingness to cooperate (for production as well as for environmental objectives): ignorance of the neighborhood could be a brake to cooperate. This variable is an indicator on the level of the local social network: depending on the harmony of these relationship, the knowledge about the neighborhood could play in a positive or in a negative way.

Concerning cooperation for production, we assume that certification (cert) as a voluntary initiative may reflect some predispositions to cooperate. Concerning cooperation for environment and recreation, we assume that environment concerns may

be possibly linked with future generation concern. Hence, we expect an effect from the number of heirs associated to the forest management. We assume the implication of the future generation could influence positively the willingness to cooperate for environment.

5 Results and discussion

5.1 Estimation results

Results of the two bivariate recursive probit models are presented in Table 2 and 3. The test of exogeneity of the intention to sell timber production ($H0 : \rho = 0$) is rejected at the 10 % level for both models (cooperation for production and for environment). The intention of selling timber production has a significant negative effect on both types of cooperation. Previous harvest, property size and leisure objectives are also significant variables for the intention of timber marketing equation in both models. A landowner who has previously harvested is more likely to market his production in the future. Moreover, a landowner who plans to sell his production is less likely to cooperate with adjacent forest owners.

Surprisingly, membership of an advisory structure is significant in the timber marketing equation only in the first model (Table 2). Membership appears to have no impact on the intention of marketing when the decision is jointly estimated with the willingness to cooperate for environmental and recreational aims. Income and bequest intention have no significant impact on the intention to market in our study.

The size property was used as a proxy for the production of amenities. Its coefficient is significantly different from zero and has a positive sign. This means that a private forest owner is more likely to market timber production in the future when he has a large property. This result may capture two effects. First, the bigger a property is, the more important the amenities production is. We can deduce that there is no competition effect between the two productions (timber and amenity). A second effect is due to economies of scale (cost-benefit analysis): larger properties are more profitable from the timber production point of view.

The amenity consumption (represented by the variable actleis) is non significant in the production cooperation model but appears as a important variable in the environment co-

Table 2: Recursive bivariate probit - Cooperation for production and timber marketing intention

	Equation 1 : coopPROD		**Equation 2: intmarket**	
Variable	Coefficient	(Std. Err.)	Coefficient	(Std. Err.)
intmarket	-0.871*	(0.416)	–	–
superf	0.093	(0.065)	0.916**	(0.193)
income	0.044	(0.051)	0.077†	(0.045)
actleis	0.100	(0.191)	0.272	(0.175)
ADV	0.617**	(0.211)	0.353*	(0.183)
SERV	0.394†	(0.214)	0.031	(0.200)
vois	-0.355†	(0.193)	–	–
cert	0.258	(0.218)	–	–
age	-0.011	(0.007)	–	–
pres	0.038	(0.077)	–	–
Mexp	0.525*	(0.261)	–	–
Mext	0.793**	(0.222)	–	–
PURCH	0.267	(0.184)	–	–
harvest	–	–	0.506**	(0.178)
objleis	–	–	-0.38*	(0.177)
objV	–	–	0.315	(0.169)
bequest	–	–	-0.025	(0.208)
Intercept	-0.907	(0.606)	-1.176**	(0.265)
ρ			0.494†	(0.256)
likelihood-ratio test of ρ=0			χ^2=2.80	Prob> χ^2=0.094
N				296
Log-likelihood				-262.225
$\chi^2_{(22)}$				107.94

Significance levels : † : 10% * : 5% ** : 1%

Table 3: Recursive bivariate probit - Cooperation for environmental purpose and timber marketing intention

	Equation 1 : coopENVRE		**Equation 2: intmarket**	
Variable	Coefficient	(Std. Err.)	Coefficient	(Std. Err.)
intmarket	-2.106**	(0.373)	–	–
superf	-0.036	(0.103)	0.801**	(0.182)
income	0.107†	(0.065)	0.076	(0.047)
actleis	0.790**	(0.240)	0.348†	(0.182)
ADV	0.691**	(0.237)	0.303	(0.187)
SERV	0.686**	(0.243)	0.137	(0.207)
vois	-0.300	(0.211)	–	–
age	-0.002	(0.009)	–	–
nher	0.083	(0.055)	–	–
PURCH	0.371	(0.249)	–	–
Mexp	0.527†	(0.313)	–	–
Mext	0.178	(0.264)	–	–
harvest	–	–	0.623**	(0.188)
nobequest	–	–	-0.208	(0.217)
objleis	–	–	-0.465**	(0.177)
objW	–	–	-0.002	(0.186)
Intercept	-1.720*	(0.801)	-1.113**	(0.308)
ρ			0.863†	(0.210)
likelihood-ratio test of ρ=0			χ^2=3.31	Prob> χ^2=0.0686
N				266
Log-likelihood				-192.165
$\chi^2_{(21)}$				127.535

Significance levels : † : 10% * : 5% ** : 1%

operation one. This variable positively acts both on future timber marketing (significant at 1 %) and environment cooperation (at the 10 % level).

Concerning cooperation decisions, membership to both forestry cooperative and advisory body has a significant and positive impact on the cooperation for both models. According to this result, these two types of membership enhance the willingness to cooperate in reducing the costs borne by the private forest owner. This result is consistent with the assumption that this kind of institutional structures makes it possible costs reduction, in particular in terms of transaction costs.

Moreover, knowledge about adjacent forest properties (-), management by an expert (+) and calling upon third-part advice (+) are significant in the cooperation for production equation. However, only the management by an expert has a positive impact on the willingness to cooperate for environment purpose. The sign concerning the forest property neighborhood knowledge is quite surprising: we expected that knowing his neighbors could enhance the willingness to cooperate with them. The effect of number of adjacent properties would have been an important data to compare with this result, nevertheless, we were enable to use it because of the high number of missing data. This variable is not significant for the willingness to cooperate for environment. Finally, the variables age, certification and time spent in the forest do not appear as significant variables in our study.

Concerning the second model (Table 3), the private forest owner's age is found not to be significant. Moreover, regarding the previous assumptions, the knowledge about the forest neighborhood and the number of associated heirs were without effect in our model. Hence, we can not reinforce previous assumptions on the effect of these characteristics of a private forest owner on willingness to cooperate for environment aims.

5.2 Discussion

Intention to market timber seems to reduce the willingness to cooperate for environmental objectives as well as production objectives. The negative relationship with cooperation for environment ties up with the individual trade-off between the provision of private good and public good. The possible gains from cooperation does not overcome the production choice benefits. The negative impact of the intention to produce on the cooperation for production

aspects may have the following meaning: if a private forest owner plan to sell his timber production, he does not have any interest to cooperate with other landowners. Indeed, costs of cooperation may represent a supplementary constraint. This result may also reflect the problem of bounded rationality: cooperation has potential benefit that a private forest owner is enable to anticipate.

Membership's types play a role in the willingness to cooperate. Contrary to the idea that usually cooperative organization enhance timber production more than other management objectives, membership seems to play a significant role on the willingness to cooperate for environmental purpose as well as timber production. Existing structures allow more information diffusion (technical information as well as general information), resulting in a better offer of management possibilities and increase the knowledge available for the private forest owners. These points influence specifically the transaction costs such as the information cost that an individual private forest owner is facing.

Moreover, third part management seems to play a role in the willingness to cooperate for production contrary to the environmental cooperation. The fact to entrust an expert to forest management may improve the willingness to cooperate: a private forest owner seems to be more willing to cooperate if he is not directly involved in negotiation or other tasks the expert is in charge of. In other terms, cooperation is costless when there is management delegation. These results concerning membership and management delegation are very important: cooperation decision may depend more on negotiation costs than on financial costs.

The negative impact of the knowledge of adjacent properties on the willingness to cooperate for production may result from unobservable context characeristics. Social connectedness and social capital in a region may influence individual cooperation behavior.

To analyze this type of concern, previous cooperation experiences (of the private forest owners) would have been an interesting point to study but, because of the lack of data we were enable to examine the hypotesis. This type of variable is difficult to obtain and to measure. Besides, Kittredge (2005) highlights the fact that cooperation efficiency is criticized by many private forest owners because of free-riding behavior and inequitable shared benefit. Thus, it is necessary to also know the level of satisfaction about previous coop-

eration to analyze its effect. In this study we are not able to measure this kind of perceptions.

6 Conclusion

In this paper we analyze the drivers of preferences for cooperation in the forest sector considering two objectives: private and public goods provision. The cooperation decision depends on the level of costs borne by the owner, in particular transaction costs play an important role. We found that membership of a professional organisation and management delegation are important drivers of the willingness to cooperate for both objectives. According to our model, the results emphasize the importance of information and negotiation costs in the willingness to cooperate. These two types of costs appear as more important break than delegation cost for example.

As a natural resource, forests are geographically-related and as a consequence is dependent on the region characteristics. For example, the economic context of a region concerning the forest-based sector is also assumed to play a potential role in behavior dynamics. All variables describing the region characteristics, number of forest firms, forest size area *versus* agriculture size area, number of adjacent forest properties, would need to be introduced in the model. Having information on the number of properties which border the owner's property makes it possible to analyze if there were possible threshold or congestion effects in terms of social network, but this variable appears as non relevant in many estimations tests.

A last important point to consider is the difference between a (not yet realized) stated-preference and an effective choice. The model requires that being willing to cooperate with neighbors landowners implies that the actual or future cooperation benefits to individuals. Nevertheless, it exists a gap between the willingness to cooperate and the observed choice to cooperate. Further research direction would be to analyze the link between the willingness to cooperate for production and for environment. In this paper, the methodological choice was to analyze separately the decisions of cooperation. Giving the composite characteristic of the forest as a private and public good, it will be interesting to determine the relationship

between both cooperation.

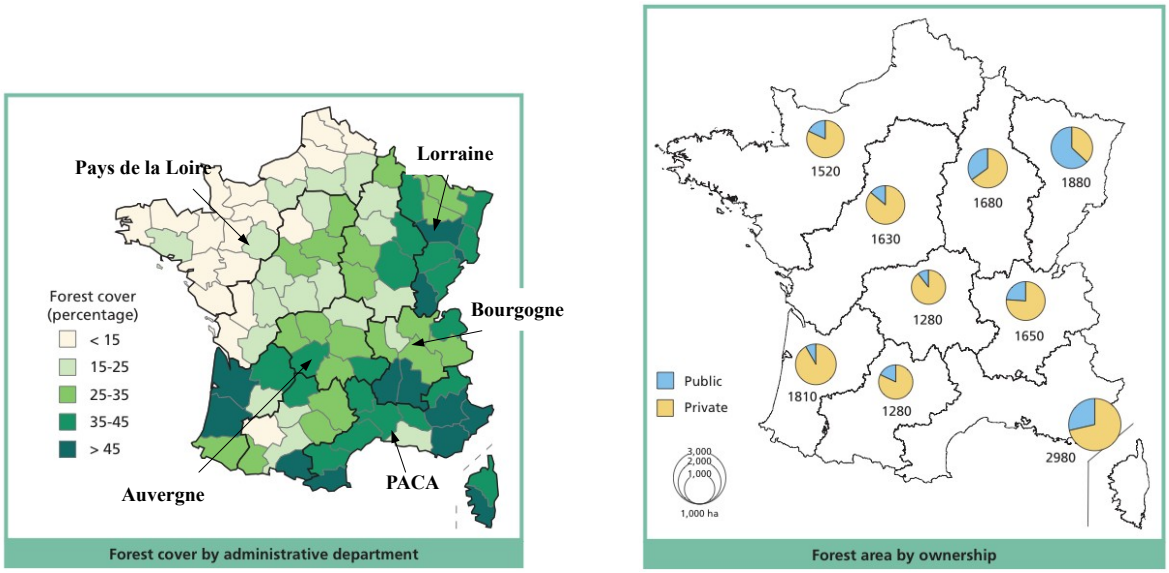
An important conclusion of this study is that potential cooperation for both private and public motivations exists among private forest owners. We show that individual intention to market timber production reduce the willingness to cooperate for both production and environment purposes. Institutional environment and membership may enhance cooperation, allowing costs reduction supported by private forest owners. We also found that management delegation is likely to promote cooperation. These results are important to consider in the design of forest public policies. In particular for public good provision, the classical scheme of incentives policies is very costly to implement with an important number of agents. These costs are increasing when agents are very heterogeneous. Forest policies could be addressed via skilled agents such as the expert.

A second important point about incentives is the complexity of interactions between non-pecuniary motives and monetary incentives (Fehr et Falk 2002). Our results show that a potential cooperation is existing among individuals without incentives. The trade-off using financial payoff could induce more coperation as well as less cooperation ("crowding-out" effect, Frey and Oberholzer-Gee, 1997). Another pitfall in designing policies addressed to "activate" agents behavior was highlighted by Sustein (1993). If the preferences are dependent from the institutional context, designing policies based on aggregate preferences leads to enter in a vicious circle. A new way to approach the question is to clarify the relation between institutional context on agent behaviors, in order to study how modifications of existing policies could induce changes in behavior.

7 Appendix

Sample characteristics

Given the extent of the French forest area and the large number of private forest owners (more than 3.5 millions), the study was lead among five chosen administrative regions: Auvergne, Bourgogne, Lorraine, Provence-Alpes-Côte d'Azur and Pays de la Loire. These regions were chosen with the agreement of experts and because of some specific characteristics. They present different level of forest covering and different ratio of private and public forest area. For example, Lorraine is characterized with more than 50 % of public forest contrary to the other regions where private forest is predominant.



(a) Forest cover level

(b) Forest area by ownership

Figure 1: Characteristics of the five administrative region. *Reference: French forest, Figures and maps - IFN - Edition 2008.*

For each region, 3 000 private forest owners were randomly chosen from a cadastral database. Private forest ownership is characterized by an important number of small properties : more than 2 millions of properties less than 1 ha and less than 10 000 properties of more than 100 ha. Hence, the following sample was constituted:

The questionnaire was sent by mail but private forest owners could choose between two possible ways of answer: by mail or by internet. The answer was anonymous, each questionnaire was identified with a specific code indicating the region of affiliation. The private forest

Table 4: Number of questionnaires sent per region

Size area Class	< 1 ha	≥ 1 and < 4 ha	≥ 4 and < 10 ha	≥ 10 and < 25 ha	≥ 25 and < 50 ha	≥ 50 and < 100 ha	≥ 100 ha
Sample	600	600	600	500	300	200	200

owner had the possibility to leave his name and address at the end of the questionnaire. The questionnaire is available upon request to the author.

A total of 590 fullfilled questionnaire were returned, that is to say a 5 % response rate. The response rate for each class of forest area is presented in the following table.

Table 5: Response rate per forest area class (%)

Classe de superficie	Auvergne	Bourgogne	Lorraine – Alsace	PACA	Pays de la Loire
S < 1 ha	11 (1,8)	12 (2,0)	4 (0,7)	11 (1,8)	11 (1,8)
1 ha $\leq$ S < 4 ha	13 (2,2)	15 (2,5)	13 (2,2)	20 (3,3)	21 (3,5)
4 ha $\leq$ S < 10 ha	15 (2,5)	22 (3,7)	24 (4,0)	17 (2,8)	20 (3,3)
10 ha $\leq$ S < 25 ha	15 (3,0)	21 (4,2)	24 (4,8)	15 (3,0)	35 (7,0)
25 ha $\leq$ S < 50 ha	14 (4,7)	18 (6,0)	23 (7,7)	14 (4,6)	19 (6,3)
50 ha $\leq$ S < 100 ha	13 (6,5)	13 (6,5)	13 (6,5)	9 (4,5)	24 (12,1)
100 ha $\leq$ S	15 (7,5)	21 (10,5)	11 (5,5)	7 (3,5)	32 (16,0)
Total	96 (3,2)	122 (4,1)	112 (3,7)	93 (3,1)	162 (5,4)

Descriptive statistics

Table 6: Descriptive statistics (part 1)

Variable	Acronym		Mean	Std. Dev.	N
Property characteristics					
Property size	superf	in hectares	73.24	171.74	554
Number of year of property ownership	year	Number	27.01	15.78	503
The forest property was purchased	PURCH	Dummy	0.49	0.5	571
The forest property was inherited	INHER	Dummy	0.65	0.48	571
The forest property comes from parcels exchange for a part	EXCH	Dummy	0.02	0.15	571
The forest comes from plantation	PLANT	Dummy	0.22	0.41	571
The forest property comes from natural regeneration	NAT	Dummy	0.08	0.27	571
1if the property is parceled out, 0: otherwise	frac	Dummy	0.43	0.5	579
Number of adjacent private forest properties	voisval	Number	5.23	12.24	299
Leisure activities provision on the property	actleis	Dummy	0.45	0.49	572
Private forest owner characteristics					
Age of the forest owner	age	Number	65.54	12.48	559
Level of education (A-Level)	educ1	Dummy	0.22	0.42	542
Level of education (master degree)	educ5	Dummy	0.32	0.47	542
Time spent on the property: 1 to 9 days	pres1	Dummy	0.34	0.48	573
Time spent on the property: 10 to 24 days	pres2	Dummy	0.18	0.39	573
Time spent on the property: 25 to 49 days	pres3	Dummy	0.1	0.3	573
Time spent on the property: more than 50 to days	pres4	Dummy	0.25	0.44	573
Knowledge about the neighboring forest	vois	Dummy	0.55	0.5	544
Reason of your presence in your property : forest works	objW	Dummy	0.34	0.47	525
Reason of your presence in your property : planning and verification	objV	Dummy	0.19	0.39	525
Reason of your presence in your property: leisure activities	objleis	Dummy	0.54	0.49	525
Bequest intention	bequest	Dummy	0.51	0.50	547
No bequest intention	nobequest	Dummy	0.20	0.40	547
Level of taxable household income (from 1 to 8)	income		5.08	2.06	456

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Variable	Acronym		Mean	Std. Dev.	N
Management decisions					
Forest plan management (1: if yes,0: otherwise)	PSG	Dummy	0.38	0.49	580
Harvest occurred during the past five years	harvest	Dummy	0.56	0.5	583
Intention to sell timber in the next five years	intmarket	Dummy	0.44	0.5	589
The manager of the forest is the owner himself	Mdirect	Dummy	0.77	0.42	529
The manager of the forest is an forest expert	Mexp	Dummy	0.14	0.35	529
The private forest owner calls upon third part advice for management	Mext	Dummy	0.18	0.39	529
Number of heirs associated to forest management	nheir		1.12	2.01	443
Membership to institution or organization which provide advice and formation for forest management (union and information centers)	ADV	Dummy	0.34	0.48	567
Membership to organizations which provide services for forest activities (formation, furniture, forest works outsourcing)	SERV	Dummy	0.20	0.40	567
Willingness to cooperate for production purpose	coopPROD	Dummy	0.15	0.36	524
Willingness to cooperate for public aims	coopENVRE	Dummy	0.08	0.28	524

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