SHARING THE GAINS AND SHARING THE PAINS IN FOREST MANAGEMENT

Abstract

One of the most common models in economics, to analyze individuals' decisions, is the Public Good Games (PGG). In this study we conducted a modified PGG with a sample of users of a common pool resource (CPR). Individuals have an endowment of money and have to decide the amount to be allocated into a common fund to preserve and manage the CPR. A key difference from previous studies is the inclusion of a sanction, to be shared out across the group. Our goal is to analyze the factors that motivate the sharing of the contribution to the CPR, as well as factors affecting the willingness to share the sanction. In addition, we test the compliance of the principles of collective action (PCA), proposed by Ostrom (1990), and their implications in the management of PGG. We have found that in line with previous literature, individuals are willing to share an important amount of the endowment with their neighbors. In the case of the sanction, however, users prefer that the common fund pays their amount of respective penalties. However, these PCA help to promote cooperation particularly when common owners face costly economic incentives.

Keywords: public good game, reward, punishment

JEL: Q2, H4

1. INTRODUCTION

Traditional economic theory argues that individuals are rational and selfish. In terms of environmental resource markets, the most typical result will be non-cooperation and free-riding behavior; thus, zero cooperation is the result predicted for most environmental resource extraction games (Hardin, 1968). However, several studies have shown that deviations from the output of traditional economic theory take place (Gächter and Herrmann, 2006). Specifically, Ostrom (1990) pointed out that communities can govern their natural resources without overharvesting. To test this hypothesis of rational and selfish individuals, some of the most used models in economic literature have been the Public Good Games (PGG). Ostrom et al. (1992) have argued the possibility that in common pool resources (CPR) individuals reach successful agreements to manage resources efficiently. In this sense, provision of information, communication and the possibility of sanctioning are important factors that can help management strategies. Other studies analyze relevant aspects to sustain cooperation. Fehr and Fischbacher (2003) stated that individual heterogeneity and the interaction between altruist and selfish people are crucial in cooperation, as well as the environment in which these individuals act. According to their results, more altruist individuals can influence selfish ones. More recently, Rustagi et al. (2010) indicate that structural factors, such as the characteristics of the resource, the size of the group and socioeconomic differences, and other social behaviors such as conditional cooperation or costly enforcement of the norm can explain these deviations. Cardenas (2011) emphasizes that it is necessary to take part in the conflict between self-interest and group interest to avoid overexploitation. In this respect, literature has focused significantly on the role that institutions, regulations and economic incentives

can play. Nevertheless, studies such as Cardenas (2011) conclude that policymakers should also take into account that their regulations can alter the normative behavior of users, as they combine the valuation of the regulation with their subjective thoughts regarding this mechanism. Janssen et al. (2013) also emphasize that it is important to allow for the enforcement of rules and social norms as they can act as complements or substitutes. Therefore, aspects such as communication, information, sanctioning, social behavior and others factors, including the characteristics of resources, or of the environment, matter.

In this study, we conduct a modified one shot linear Public Good Game (PGG) (via survey) in a CPR with users of the resource. With this PGG our aim is to analyze forest owners' decisions in a parallel setting to reality. Thus, throughout this game we establish an amount of money that has to be shared out and assume each individual makes a decision freely. In this sense, the PGG has been adapted as much as possible to a real situation familiar for our participants. In addition, we evaluate whether the principles of collective action (PCA) (Ostrom, 1990) are functioning in our area of study and their derived implications in the PGG decisions (See Table 3). The objectives of this paper are: first, to analyze which economic incentives promote more cooperative behavior among small communities of landowners: a reward or a punishment? Second; we test the incidence of social norms through the PCA. Third, we analyze the effect of these PCA in sharing decisions.

No other study was found which analyzes this kind of economic incentives with CPR owners in a PGG. There are studies that have analyzed the differences of giving and taking in PGG. For example, Khadjavi and Lange (2014) found that individuals are less cooperative in a taking frame that in a giving frame. Nevertheless, the existence of the two

options does not imply that individuals behave more selfish. Furthermore, we also evaluate some aspects that have received little consideration in the literature. In particular, we analyze users' decisions instead of using laboratory experiments with students. We test the effect of different amounts of endowment in a PGG. Next, we test the effects of PCA in users' decisions. Throughout this study, we hope to shed light on the kind of economic incentives which are more suitable in terms of promoting more cooperative results (rewards vs. punishments). Cooperation among users may increase sustainable management and encourage other conservation policies.

The reminder of this paper is structured as follows: The next section describes the area of study; then, the features of our PGG are described in the following section; section 4 describes the empirical approach. Section 5 shows data description, while section 6 describes the main results. The paper concludes with a section of the main conclusions and implications.

2. AREA OF STUDY

Our area of study is located in the North West of Spain, Galicia. This is one of the most important forest areas of Europe. This forest surface is about 1.4 million hectares, which represents 48% of the total territory. Furthermore, more than 120,000 hectares correspond to certified forest surface, which places Galicia at the head of Spain in terms of sustainable forest management (Xunta de Galicia, 2014). The main problems of this sector are related to the abandonment of traditional forest practices due to de-population (Gómez-Vázquez et al. 2009) and the presence of forest fires. Barreal et al. (2012) highlight that Spain is one of the five countries with the most fires in the South of Europe. Within Spain,

Galicia suffers around 45% of the total country´s wildfires, representing 23% of affected surface. A study conducted by Ponte and Bandín (2008) (members of the police department) indicates that since the 1990s, forest fires in this region have turned into a social disturbance.

Given this context, it is important to analyze the management of Galician forests: 98% of the territory is managed by private owners and 2% is owned by the public sector (Gómez-Vázquez et al. 2009). The private forests are managed both by single owners, as well as collective owners known as communal forests (Comunidade de Montes Veciñais en Man Común, CMVMC). There are around 2,800 communal forests which occupy about 700,000 ha (Xunta de Galicia, 2014). The Spanish Government (2012) defines them as "*private forests, with independence of: origin, productive capacity, current utilization and agrarian vocation, are of the neighbors´ communities. In addition, communal forests are exploited in a community regimen, without allocation of quotas among neighbors. Furthermore, these forests are indivisible, inalienable, imprescriptible and indefeasible goods."* Thus, we are studying a CPR, given that forests in our area of study are excludable.

Communal forests have existed for centuries and have played an important role in agriculture (Caballero, 2014). They were regulated under a common law until the year 1968[1], when an institutional framework for communal forests was established, without individual quotas of property. These communities are also a signal of identity, of Galician culture and are an economic and productive indicator, due to the creation of jobs and wealth (Xunta de Galicia, 2014). To be a member of the communal forest the individual has to reside in the local community and attend meetings and assemblies, where one

member of each household or family is represented and decisions about the CPR are taken collectively. One important issue that has been detected in Galicia is that in areas where communal forests are present, the incidence of forest fires is lower. In this sense, Fuentes-Santos et al. (2013) show that 61.52% of forest fires occur in forests where there exists private land management (which represents about 65% of forests); 15.88% in public land management (roughly 2% of forests) and the rest (22.59%) in collective management (about 33% of forests).

However, conflicts among communal forests also arise. Internal conflicts highlight disagreements among commoners, whereas external conflicts demonstrate conflicts involving various parties: between neighbor communities and government organizations (based on different perspectives between owners and government); with enterprises (cession rights of resources and their uses); but the most important are external socio-economic and environmental conflicts with NGOs (Gómez-Vázquez et al. (2009)).

3. PUBLIC GOOD GAMES

Field experiments have shown that the hypothesis of selfish and rational behavior is not always true. One of the most typical mechanisms to analyze individuals´ decisions with respect to public goods is the PGG or a Voluntary Contribution Mechanism (Isaac and Walker, 1988). Brekke et al. (2011) state that the understanding of how individuals make voluntary contributions is important. This game is played by n individuals. All individuals i receive an endowment e and simultaneously and independently decide whether to keep this endowment for themselves or invest a given amount $g_i \varepsilon [0, e]$ in the CPR. The total

amount contributed by all n participants together equals $g = \sum g_i$, where $0 \le g_i \le e$ is multiplied by a number m (marginal per capita return), with $0 < m < 1 < nm$. Therefore, when the PGG is played once, and considering that players are rational and selfish in maximizing utility, contributing nothing is a dominant strategy. However, the joint group outcome is maximized when everybody contributes with the endowment full. Following Ostrom et al. (1992), Fehr and Gächter (2000) and taking into account our study we can express the utility function of users as:

$$\begin{aligned} u_i(g) &= e \quad if \ g_i = 0 \\ &= e - g_i + m\sum_{j=1}^{n} g_j \quad if \ g_i > 0 \end{aligned} \tag{1}$$

A paper by Chaudhuri (2011) conducts a survey about the PGG literature. The main conclusions of this study are that the most typical issues analyzed in PGG are conditional cooperation, costly punishments and others means to sustain cooperation. In addition, this author also highlights that the main conclusions obtained with respect to the investment in public goods are that in one-shot experiments the contribution is on average 40% and 60% of the optimal level with large variations from 100% to 0%. In addition, when individuals play the game repeatedly, contributions decline over time and more participants choose to "free-ride" (Ledyard, 1995). Fehr and Gintis (2007) find two types of behavior: free-rider or conditional cooperators. The first type corresponds to those who never contribute to a public good, and the second to those who increase their contribution when they expect that others will also contribute. Specifically, Fischbacher et al. (2001) conducted a PGG, finding that around 50% of the subjects can be classified as conditional cooperators. Furthermore, the key factors that favor the cooperation among individuals are

communication, the establishment of a threshold and a higher marginal per capita return. Nevertheless, there are others factors that can also influence choices; for example: gender, the size of the group, and reciprocal motivations, among others. Ostrom et al. (1992) stated that information, communication and sanctions can help to reach agreements efficiently. Andreoni (1995) concludes that studies of preferences for cooperation should also be considered in the analysis.

The possibility of sanctions has been extensively studied in previous literature. Thus, Fehr and Gächter (2000) show through a PGG that cooperators, can be willing to punish free-riders even when this is costly for them. Croson (2007) has studied three theories to explain decisions made in PGG: those of commitment, altruism, and reciprocity; concluding that in the reciprocity model, contributions made by individuals are positively related to the contributions of others, or with their beliefs about those contributions. Janssen et al. (2013) found that distrust in regulations may influence individuals to break the rules. Van Miltenburg et al. (2014) describe that both punishments and rewards are effective means to establish cooperation in social dilemmas. These questions will be addressed in the following section.

As mentioned, we conducted a modified one shot PGG where members of communal forests have to make a decision about how to share both: a reward and a punishment. First, our PGG is modified due to the fact that we do not create explicit groups of users, but rather, single users are told to consider the rest of the members (50 members[2]) in their decisions ($n=50$). Therefore, the group under consideration will be composed of all users. A second important aspect to take into account is that the contributions to the fund will allow different management efforts in forests to be carried out, from which the community

will benefit, specified as 40% over the initial amount invested[3] (*m)*. In addition, our PGG is described as a real situation that collective owners can face as owners of the communal forest. According to the last Law of 2012[4] of Galician forests that manages communal forests, the earnings of forest communities have to be split following this rule: at least 40% has to be reinvested while 60% can be reinvested or can be assigned to buy forests; improve the value of the forest in terms of heritage, cultural and environmental issues; use for public services or share out benefits among communal owners. In addition, and as stated, we also include a sanction to be shared out. It is important to highlight that the game is conducted through an interview and no real money is being played. Bethwaite and Tompkinson (1996) also carry out an Ultimatum Game in the same fashion. In particular, we pay special attention to the question of the size of the reward and punishment (*e*). Figures 1a and 1b show the game presented to forest owners.

4. EMPIRICAL APPROACH

4.1 Empirical Model

We model individuals' allocations as a function of the size of the reward vs. the punishment, the social characteristics of individuals and the most relevant socio-economic characteristics, among other variables. Furthermore, and with the aim to incorporate the PCA in the regression models, we conducted a factor analysis to reduce the several variables obtained from the survey of owners to the most relevant variables for our analysis (Table 3). Factor analysis is a statistical technique used for data reduction purposes and it is commonly used in social sciences (Harman, 1976). Thus, we employ this technique to reduce the set of responses to the PCA questions in the survey to a small number of latent

explanatory factors that affect the forest owners' decisions. We assume that there are a number of unobservable factors or latent variables that account for the correlations among the observed variables such that, when latent variables are constants, the partial correlations among observed variables become zero (Loureiro et al. 2013). Therefore, these factors determine the observed variables, which in our particular case study are the responses to PCA.

We estimate an Ordinary Least Squares (OLS) regression. Using the Breusch-Pagan (1979) test, we assessed the presence of heteroskedasticity, finding that the test carries a value of 67.74 for a Chi-squared with 1 degree of freedom and an associated p-value of 0.00 in the case of the reward. Therefore, we reject homoscedasticity. For the case of punishment, the test carries a value of 36.90 for a Chi-squared with 1 degree of freedom and a p-value of 0.00, indicating heteroskedasticity. To deal with this problem we estimate an OLS clustered by the communal forests from which respondents are members. The dependent variables in this regression equation are the vectors of the total distributions (rewards and punishments), labeled as (Y); the vector of explanatory variables (X_i) is grouped into four categories that include: the endowment size X_s; the forest and forest management characteristics X_f, and the socio-economic characteristics, X_{se}; the social characteristics of interviewers, X_{sc}; while the vector $(L)$is the latent indicator that represents the PCA obtained through factor analysis.

The OLS model corresponds to the estimation of the following equation:

$$Y_i = \beta_0 + \beta_s X_{si} + \beta_f X_{fi} + \beta_{se} X_{sei} + \beta_{sc} X_{sci} + \beta L_i + \varepsilon_i, \quad (2)$$

where β_0 is the usual constant term, the corresponding β are the coefficients associated with the respective explanatory variables to be estimated, and ε is a vector of error term, independently and identically distributed (i.i.d). We estimate four OLS models to explain the distribution of rewards and punishments with and without the effect of the PCA.

4.2 Research Hypothesis

We analyze whether the size of the reward or punishment to share out, influences the decisions of collective owners. We expect that different sizes of the endowment will imply different allocations into the fund. In this sense, Anderson et al. (1998) found that contributions increase with the endowment and Andersen et al. (2011) concluded that stakes matter in the Ultimatum Games. Therefore our aim is to test whether this issue also occurs in our PGG.

$$H_0 : \beta_{se}10 - \beta_{se}100 - \beta_{se}1000 = 0$$
$$H_1 : \beta_{se}10 - \beta_{se}100 - \beta_{se}1000 \neq 0 \qquad (3)$$

5. DATA DESCRIPTION

A face-to-face and online survey were carried out in north-west Spain, in the region of Galicia, from 2013 until summer 2014, interviewing a sample of 96 forest owners. Two types of surveys were designed with the same questions but one version includes the PGG as a reward and the other as a punishment. The survey requested information about the characteristics of communal forests, from which they are members, with the objective to

reflect members' knowledge. In addition, we also included questions related to their opinion about public authorities, and the way in which decisions relating to forest questions are made. Moreover, the survey also included questions to test whether the PCA were functioning. The PGG was presented in another section of the questionnaire and included some questions to understand the degree of effort made by members, to maintain a forest in good condition and therefore assesses their opinion of other forest owners' efforts. It is important to highlight that the PGG was conducted individually. The same strategy was employed by Haugli (2014) with the goal of promoting comprehension amongst participants. Finally, socio-demographic characteristics were elicited in the last part of the survey.

With the data collected in both surveys (the reward and punishment versions) we find that 74.44% of the respondents are men. In addition, the average age of our sample is about 54.75 years, and the number of individuals who live in the same household is around 3.07 persons. With respect to the level of studies we found that 45.88% of the respondents have a basic level of studies or no studies (*primary education*). With respect to income-related questions, we detected that about 31.32% of participants make less than €1,500/monthly (*less €1500)* in these rural communities.

With regards to the characteristics of forests and forest management, more than 34.44% of respondents affirm to be collective owners of forests with less than 100 ha *(forest size*). With respect to the number of members, about 51.11% of the forests have more than 100 communal members (*over 100 members*). In addition, we asked respondents about the degree of forest conservation in their community, and 48.32% of respondents affirm that the forest conservation status is quite strong. Nevertheless, around 27.77% of

respondents think that the future of forestry over the coming 50 years will worsen (*poor future for forestry*). Moreover, we find that 33.33% of users mention that the last fire that they remember was in last 5 years *(last fire*).

Regarding the owners' opinion about the main problems that forests are facing in their areas, 32.58% mentioned the de-population of rural areas as the principal worrying issue. Furthermore, 28.08% stated negligence with respect to the care of forests, and with a similar % forest fires were mentioned by 28.07% of respondents. Moreover, 15.73% indicated low economic profitability as the main issue facing forestry today. In addition, other tree diseases were mentioned by 14.61% of users. Finally, the invasion of non-native species and the over-exploitation or de-forestations were also commented on by 8.97% and 3.36% of the commoners, respectively.

From an economic point of view, 6.23% of users indicate that they are moderately competitive (forests create some additional sources of income but they are not a fixed source of income). Moreover, we find that around 64.44% mention that the last time when they sold timber was at least 5 years ago (*last timber sold*). About 54.44% believe that the public administration is dealing with forest problems badly or quite badly (*poor administration*). With the goal to know more about the effort that they put in forest tasks, we asked about their level of effort compared with the rest of the owners; 32.22% state that their own effort is higher than the rest of the members (*greater effort*); while 20.45% think that the rest of the owners do the necessary tasks to keep the forest in good condition (*commoners do tasks*). We obtain more information about their own work asking about their degree of participation in activities promoted by communal forests; 66.66% of respondents said they participate all or most of the time.

With the aim of obtaining more information about their social characteristics, we included questions to know whether they were born in forest locations, with 72.22% answering in the affirmative (*place born*). About 55.55% responded that their relationships with the rest of owners are very or quite good (*very good relationship*). Furthermore, 58.88% of owners agree with the following sentence: "The majority of my community members can be trusted" (*trust in neighbors*). In addition, 46.66% of individuals indicated that their decisions are made jointly with the family and not individually *(decisions in family*). To gain insight into their time preferences, we evaluated the degree of agreement or disagreement with the following sentence: "Forest management will have to be undertaken thinking more about present than future generations" (*present before future*). We find that 17.77% agree with this statement. We also find that 13.33% confirm experiencing the following feeling: "Often, I give things without expecting anything in return" (*give free*). While 26.66% affirm feeling the following often or very often: "Sometimes, I think that it is not fair that some people work less and have the same rights as me" (*not fair*). We also asked landowners whether they think that they have a leader to deal with forest issues and 63.33% responded in an affirmative way (*leader*). Furthermore, 28.57% of respondents are members of trade unions (*trade union*). To conclude, around 37.64% of the respondents confirmed occupying or have occupied a position of responsibility in their area, and 26.66% affirmed feeling more connected to left wing parties (*left wing*). It is important to highlight that this description of our sample is based on both versions of the survey (reward and punishment). In Table 1, we show the summary statistics for the variables analyzed, differentiating between the reward and punishment versions.

6. RESULTS

6.1 Public Good Game

The distribution of rewards and punishments is presented in Figures 2 and 3. With regards the reward, the amount of money shared can be considered as a proxy of cooperation (Stoop et al. 2012). Assessing the results, we can see that when the endowment to share out is €10, around 93.75% decide to allocate the full amount to the common fund and the rest (6.25%) decide to keep €5. Thus, on average the mean contribution is about €9.65. However, when the endowment is higher the decision changes. Specifically, for an endowment of €100, 4.26% decide to allocate the money to their pockets while 6.38% decide to split the endowment at 50% and 89.36% allocate €100 to the fund. On average, the contribution to the fund is about €94.18. This situation changes slightly when the endowment is even higher. In this way, for an amount of €1000, around 2% of individuals keep the total amount in their pockets; another 2% decide to donate €100 to the fund. Furthermore, roughly 24% split the reward at 50% and around 64% decide to send the total amount of money to the fund. On average the mean contribution to the fund for this endowment is about €836.95.

Nevertheless, for a punishment of €10, only 29.27% decide to pay the total amount of the fine from their own pockets, while more than 68% prefer that the community fund pays the penalty. Thus, on average owners allocate about €7.30 to be paid by the fund. When the punishment is €100, only 14.63% face the fine directly, while 75.61% also decide that the fund should pay and the rest make different allocations (2.44% allocate €5, 4.88% allocate €50 and 2.44%, €75). Therefore, the average amount of fine allocated to the fund is

€80.25. For a punishment of €1000, 4.88% will pay the total amount while 92.68% decide that the fund should pay all (€946.10 on average).

Therefore, we observe that the higher the size of the reward, the higher the amount of money that collective owners keep in their pockets, making these differences statistically significant[5]. Nevertheless, it is important to highlight that they are quite generous because the percentages of money kept by them is quite small. In the survey of literature conducted by Chaudhuri (2011), it was found that average contributions were about 40% to 60% of the optimal level. This is an interesting result in terms of cooperation as we do not have any mechanism to further it (such as penalties, communication, among others). Stoop et al. (2012) have concluded in their study that without any kind of contact among players, cooperation is not guaranteed.

This situation changes drastically when participants have to distribute a fine. Therefore, when forest owners face a fine, the higher the penalty, the higher the amount of money that they prefer the fund to pay. Summarizing, Table 2 shows the percentage of money allocated to the fund. In the case of the reward: the higher the endowment, the lower the contribution to the fund. To the contrary: the higher the size of punishment, the higher the allocation to the fund. These differences are statistically significant[6]. Therefore, when we compare the effectiveness of rewards and punishments, we find that rewards imply better results in terms of user generosity. In the next subsection, we present the results obtained with regards to the principle of collective action. In order to understand what drives these allocations we also estimate OLS models.

6.2 The role of PCA

The survey results, relating to the PCA, are presented in Table 3. With regards to the principle of clearly defined boundaries, it was found that around 80% of respondents believe that in their communities all members know each other; 50% think that residents who are not members of the communal forest know this, while 64.21% consider that neighbors respect community members in practice.

When examining congruence between appropriation and provision rules and local conditions, it is important to note that only 56.52% of commoners think that the rules that they have to follow are appropriate for resource conservation. In addition, the same percentage believes that they are appropriate and that the community can manage forests well. More interesting results are obtained with respect to the law's effectiveness; only 51.09% believe that it is effective. Moreover, 62.37% think that the existing rules respect local traditions, while 70.21% felt these measures could be improved. Analyzing the results for the principle of collective choice arrangements, 89.25% confirm that forest decisions are taken collectively with individuals equally represented. In addition, 64.13% state that there are controls to ensure compliance by the forest community and 56.04% state that there are also controls for outside members (principle of monitoring). With regards to the principle of graduated sanctions, 63.74% of sampled commoners affirm that there are penalties for people who do not comply with the requirements and 46.25% state that these penalties vary depending on the degree of infraction. Only 32.97% express that there is a quick mechanism to resolve conflicts and 52.17% believe that their rights and decisions are respected by non-members and the administration.

Therefore, and as a conclusion, we observe that PCA are not functioning perfectly in our sample of communal forests. Maybe, the adoption of these PCA could be improved as a way to deal with the current management problems.

6.3 Factor analysis and OLS results

- *Factor analysis*

With this technique, we have obtained four factors that will be used as explanatory variables. We employ the Kaiser test (Kaiser, 1960) to determine the relevant number of factors. We also obtain the rotated factor loadings that show the relative contribution of each question in testing the PCA on the retained factors (values greater than 0.30). Thus, the four factors obtained are (Table 5 and 6):

- *Factor 1* is associated with the rules that commoners have to follow. Thus, this factor includes whether these rules are suitable for resource preservation, for correct resource exploitation and whether they are effective. Therefore, it aggregates owners' opinions about rules. We denote this factor as "rules".

- *Factor 2* is associated with penalties and whether current laws could be improved. Thus it sums up if there are punishments for those who infringe the rules and whether they vary according to the degree of offense. Thus, we denote this factor as "penalties".

- *Factor 3* is associated with boundaries. It aggregates owners' opinions about whether they know each other and about neighbors knowing who are not members of the communal forests. We denote this factor as "boundaries".

- *Factor 4* is associated with monitoring. Thus it includes questions that analyze whether there are controls both inside and outside of the forest. This factor is denoted as "monitoring".

- *OLS results*

In order to understand what drives the allocations of money we estimate OLS models with and without the effect of PCA obtained via factor analysis. . This allows also a check about the robustness of the main results. In Table 4, we summarize our results. The first three columns present the results for the "reward", whilst in next three columns, present the "reward" results taking into account the variables related to PCA. "Punishment" results are presented in following columns next to the model of punishment and PCA. Overall, the models fit the data quite well with R^2 between 88.90 and 94.70%, respectively.

First, we examine and discuss the estimates shown in Table 4 for the "reward". With regards to the endowment size, we observe that the coefficients obtained for e*100* and e*1000* are positive and statistically significant, with respect to the omitted category e*10*. Contributions to the fund are higher for greater endowment[7] sizes.

We also analyse the effect of different characteristics of owners to understand their decisions. Thus, Bechtel and Scheve (2014) conclude that socio-demographic characteristics play an important role in social dilemmas. With regards to the

characteristics of forestry management, we observe that communities with larger hectares, or with higher numbers of members, allocate greater amounts of money to the fund (*forest size, over 100 members*). This may be consequence of the fact that they are richer communities. Furthermore, areas that have sold timber in the last five years also show a positive coefficient (*last timber sold*). Therefore, recent earnings may imply more generous decisions.

With regards to socio-economic characteristics, we observe that people with *primary education* make higher contributions to the fund compared to people with more studies. In addition, we note that people earning less than €1500/monthly contribute less (*less €1500*), which is to be expected for those on lower incomes.

Examining other social characteristics, we observe that neighbors, who believe that the majority of the community can be trusted, make lower allocations to the fund (*trust in neighbors*). Therefore, we find that trust may not necessarily imply higher allocations to the common fund because this also may depend of their economic income. On the contrary, those who state that forest management should be undertaken thinking more in terms of the present generation, show positive contributions to the fund (*present before future*). In this sense, these users prefer to invest in a common fund that can improve the collective good. In the same way, people who identified themselves with the political left wing (*left wing*) make higher contributions, as do those who declare doing favours for their neighbors without expecting anything in return (*give free*). This last indicator could also be considered as a proxy for altruism. Altruism is defined by Batson and Powell (2003) as a motivation for increasing another person's welfare.

Examining the reward results, taking into account PCA, (through factor analysis), three indicators lose their significance (*forest size*, *less €1500*, *trust in neighbors*), but the remaining variables maintain it, and in addition, we achieve more insights. With regards to the endowment size, the results are similar to those obtained in the baseline model. Furthermore, individuals making decisions with family on forest-related matters make higher contributions to the fund (*decisions in family*) but also individuals who think that the rest of owners do the necessary tasks to keep the forests in good conditions (*commoners do task*). Factors creating a negative effect, include individuals who believe in the existence of a leader – these individuals make low contributions (*leader*). With regards to factors that represent the PCA, we find that factor 2 is statistically significant and has a negative coefficient; therefore it implies fewer contributions to the fund. This factor is associated with *penalties*. This can be consequence of the fact that forest owners believe that penalties are a costly characteristic for them and therefore they perceive the appropriation of the reward as more fair. Finally, the rest of the indicators, including the baseline reward model, maintain their significance.

Now, we present and discuss the results obtained for the "punishment" regression. With respect to endowment size, we observe that punishments with *e100* and *e1000* show a negative and statistically significant coefficient with regards to the omitted $e10^{8}$. Therefore, when we are explaining fine payments, the larger the endowment, the greater the amount allocated to the fund. Furthermore, in terms of the characteristics of forests and forest management, we find that owners who believe that the future of forests will worsen (*poor future for forestry*) allocate more punishment to the community fund.

Regarding other socioeconomic characteristics, we find that commoners with lower education levels decide that the fund should pay higher amounts (*primary education*). Assessing other social characteristics, we find that individuals who think more in terms of the present than the future (*present before future*) and those who identify more closely with the left wing political parties (*left wing*) make higher fund allocations for sanctions. To the contrary, those who think there is a leader in their communities make lower allocations to the fund (*leader*).

The regression model which takes into account the PCA shows more information. With regards to the endowment size, results are in line with those obtained in the previous baseline model. Nevertheless, we detect that for three indicators, their coefficients change the sign. Specifically, the introduction of the latent variables which represent the PCA, make people who think in present terms (*present before future*) and those who more closely identify with left wing political parties (*left wing*) are more willing to pay a higher amount of sanction from their own pocket, while those who believe in the existence of a *leader* make higher allocations of the punishment to the fund. The rest of the indicators maintain their statistical significance. Furthermore, participants stating that the administration is not managing forests appropriately, (*poor administration*) make higher allocations to the fund. In this sense, we believe that these users may think that the sanction is not fair, as the administration is not handling forest management well. Moreover, those who confirm making greater efforts than their neighbors (*greater effort*) make higher allocations to the fund. Perhaps these owners do not feel the same degree of responsibility. Additionally, users who make decisions with family on forest-related matters, (*decisions in family*), those having good relationships with their neighbors (*very good relationship*) and

owners who state they are trade union members (*trade union*) make higher allocations of punishment to the fund.

With regards to the PCA, we can observe that factors 1, 3 and 4, which represent "rules"; "boundaries" and "monitoring" have a negative coefficient, and share smaller sanction allocations to the fund. Therefore, it seems that the existence of clear rules, boundaries and control make individuals assume higher amounts of fines themselves. On the contrary, factor 2, associated with "penalties" shows a positive coefficient, implying higher allocations to the fund. We interpret this result in the following way: the fact penalties form part of their management strategies means, that when facing a punishment from the outside, one feels less responsible for it.

7. CONCLUSIONS

The aim of this paper is to analyze, in the context of a CPR, how common owners make decisions. Through a modified PGG we have analyzed how landowners share out a reward and a punishment. Our interest is to study the differences in behavior when forest owners receive a reward as a consequence of their good actions and whether their behavior is any better, knowing they can be punished.

Evaluating how positive economic incentives are shared (reward), our results are in line with previous studies, finding that on average people make higher contributions to a CPR than suggested by traditional economic theory. Specifically, we find that communal forest owners are quite generous with contributions over 80% of the reward received. Nevertheless, an interesting and novel result is obtained with regards to the sharing of

"punishments". In this sense, people are more egoistic and prefer that a common fund pays the majority of the penalties. Therefore, our results imply that the establishment of a reward implies more cooperative behavior than the establishment of a penalty. We also find that endowment size is an important factor to consider. In this sense, Andersen et al (2011) concludes that the size of the stake matters in ultimatum games.

With regards to the PCA, we have included several questions in the survey and through factor analysis we have obtained four main latent indicators: *rules, boundaries, penalties* and *monitoring*. Examining the role they each play in individuals' decisions, we observe that when owners face the sharing of a reward, this does not imply more cooperative results. However, in the case of the punishment, three of the factors: rules, boundaries and monitoring make individuals assume higher amounts of the imposed fine. Therefore, these PCA help to promote cooperation particularly when common owners face costly economic incentives.

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TABLES

Figure 1a: Case A: Reward

Imagine that you are a member of a communal forest that is formed by 50 neighbors. Your community has received a reward by the "Law against fires" as a consequence of the effort that this communal forest organization has made to fight against forest fires and the good condition of the forest. These funds can be used freely by collective owners. Therefore, you can collect your proportional amount or reinvest it in the community fund. The amount that you deposit in the fund will be used to finalize works in the forest from which the community will obtain some benefits equivalent to 40% of the initial amount invested. Using the following table, please indicate your preference:

Reward	*When splitting the reward among 50 members, you have the right to:*	*I take:*	*I deposit in the fund:*
If the reward is €500	*€10*		
If the reward is €5,000	*€100*		
If the reward is €50,000	*€1,000*		

Figure 1b: Case B: Punishment

Imagine that you are a member of a communal forest that is formed by 50 neighbors. Your community has been punished by the "Law against fires" as a consequence of an inadequate effort, made by this communal forest organization to fight against forest fires and due to the very poor condition of the forest. This amount of money can be paid by collective owners or a community fund. Therefore, you can pay your proportional amount or you can decide that the community fund pay your amount. In the following table, please indicate your preference:

Punishment	*As there are 50 members, splitting the punishment you should pay:*	*I pay:*	*The fund pays:*
If the punishment is €500	*€10*		
If the punishment is €5,000	*€100*		
If the punishment is €50,000	*€1,000*		

Figure 2: Allocations of the reward in a fund account for different endowment sizes (€10, €100, €1000)

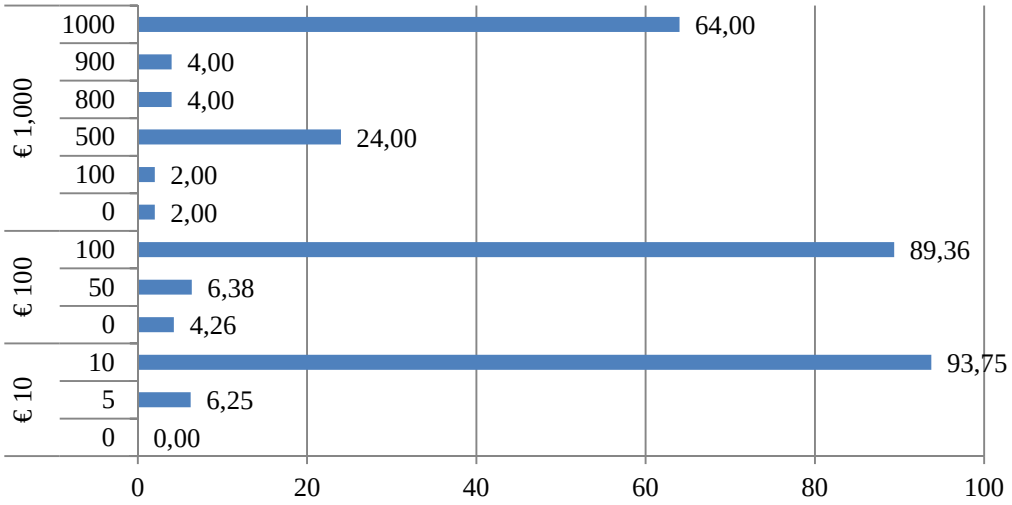

Figure 3: Allocations of punishment in a fund account for different endowment sizes (€10, €100, 1000€)

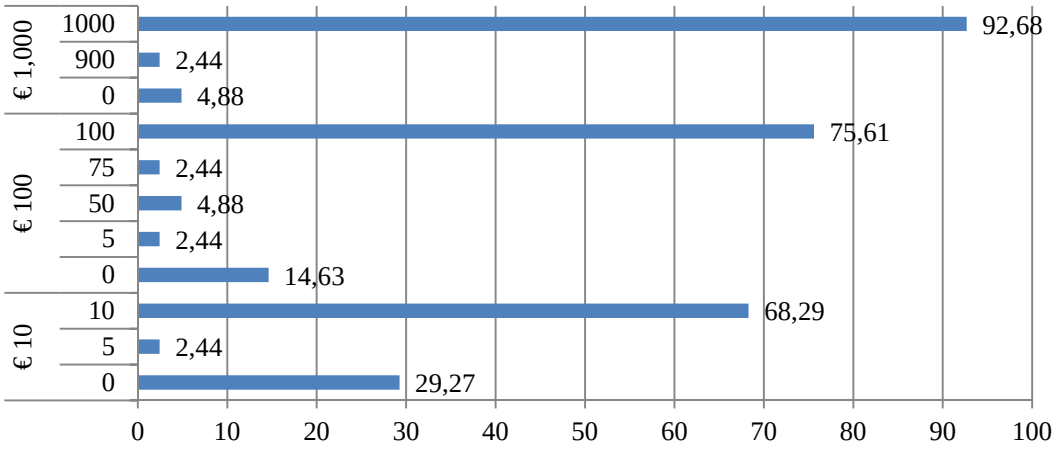

Table 1 Summary statistics

		Reward		Punishment	
Variable	**Description**	**Mean**	**Std. Dev.**	**Mean**	**Std. Dev.**
Fund	Amount of money allocated or taken from the fund	323.120	402.883	344.573	447.498
	Size of endowment				
***e*10**	1, if the size of the individual reward or punishment is €10; 0 otherwise	0.333	0.473	0.333	0.473
***e*100**	1, if the size of the individual reward or punishment is €100; 0 otherwise	0.333	0.473	0.333	0.473
***e*1000**	1, if the size of the individual reward or punishment is €1000; 0 otherwise	0.333	0.473	0.333	0.473
	Characteristics related to forestry and forest management				
Forest size	1, if the size of forest is equal or less than 100 ha; 0 otherwise	0.490	0.502	0.170	0.378
Poor future for forestry	1, if owners think that over a period of 50 years the future of forestry will be poor; 0 otherwise	0.224	0.419	0.341	0.476
Over 100 members	1, if the numbers of commoners is higher than 100; 0 otherwise	0.633	0.484	-	-
Poor administration	1, if owners think that the management of forestry carried out by the administration is very or quite poor; 0 otherwise	0.510	0.502	0.585	0.495
Last fire	1, if owners remember that the last fire was in last 5 years; 0 otherwise	0.306	0.462	-	-
Last timber sold	1, if the last time that owners sold timber was at least 5 years ago; 0 otherwise	0.735	0.443	-	-
Greater effort	1, if owners think that their own effort is greater than the rest of the owners; 0 otherwise	-	-	0.415	0.495
Commoners do task	1, if owners think than the rest of the owners do the necessary tasks to keep the forest in good condition; 0 otherwise	0.184	0.389	-	-
	Socio-economic characteristics				
Less than €1500	1; if the monthly income obtained is less than €1500; 0 otherwise	0.490	0.502	-	-
Primary education	1, if owners have no studies or have basic studies; 0 otherwise	0.429	0.497	0.439	0.498
	Social characteristics				
Place Born	1, if owners were born in forest locations; 0 otherwise	0.673	0.471	-	-
Very good relationship	1, if owners respond that their relationships with the rest of owners are very or quite good; 0 otherwise	0.490	0.502	0.634	0.483
Decisions in family	1, if owners affirm that their decisions are made with the family and not individually; 0 otherwise	0.531	0.501	0.390	0.490
Trust in neighbors	1, if owners agree with the following sentence: "The majority of my community members can be trusted"; 0 otherwise	0.429	0.497	-	-

Present before future	1, if owners agree with the following sentence: "Forest management will have to be undertaken thinking more about present than future generations"; 0 otherwise	0.204	0.404	0.146	0.354
Trade union	1, if owners are member of trade unions; 0 otherwise	0.319	0.468	0.243	0.431
Give free	1, if owners do the following action very often: "I often give things without expecting anything in return"; 0 otherwise	0.163	0.371	0.098	0.298
Left wing	1, if owners confirm identifying more with left wing parties; 0 otherwise	0.204	0.404	0.341	0.477
Not fair	1, if owners think often or very often the following: "Sometimes, I think that it is not fair that some people work less and have the same rights as me"; 0 otherwise	0.204	0.404	0.341	0.476
Leader	1, if owners think that they have a leader to deal with forest issues; 0 otherwise	0.571	0.497	0.707	0.457
Factor 1	Rules	-0.193	1.031	0.302	0.874
Factor 2	Penalties	-0.178	1.128	0.279	0.675
Factor 3	Boundaries	-0.374	0.909	0.586	0.847
Factor 4	Monitoring	0.223	1.036	-0.350	0.834

Table 2 % of money allocated to the fund

	Reward	**Punishment**
e 10	96.60	73.10
e 100	94.18	80.25
e 1000	83.70	94.62

Table 3 Questions to test whether the PCA are functioning

		No	Yes	D/K
Clearly defined boundaries	Do you think that in your community all community members know each other?	19.20	79.79	1.06
	Do you think that the residents who are not community members are clearly not part of the community?	38.30	50.00	11.70
	Do you think that in practice the neighbors respect community members?	27.40	64.21	8.42
Congruence between appropriation and provision rules and local conditions	Do you think that the rules of forestry, that have to be complied with, are appropriate to conserve the resource?	34.80	56.52	8.70
	Do you think that these rules are appropriate to manage forests?	37.00	56.52	6.52
	Do you think they are effective?	38.00	51.09	10.90
	Do you believe these rules respect the local traditions and beliefs?	26.90	62.37	10.80
	Would you say that existing standards can be improved?	4.26	70.21	25.50
Collective choice arrangements	In terms of decisions around forestry issues, are these taken collectively, together and equally represented?	8.60	89.25	2.15
Monitoring	Are there controls to ensure compliance by the community?	26.10	64.13	9.78
	Are there controls to ensure compliance by neighbors who are not members of the community?	33.00	56.04	11.00
Graduated sanctions	Are there penalties for owners who do not comply with the obligations laid down in the law?	14.30	63.74	22.00
	If there are sanctions, are they variable depending on the offense committed?	26.30	46.25	27.50
Conflict resolution mechanisms	Are there quick mechanisms to solve the conflicts that can arise?	38.50	32.97	28.60
Minimal recognition of rights	Do you think that your rights and decisions are respected by others, who are not members of the community and the administration?	23.90	52.17	23.90

Table 4 OLS models

	Reward		Reward with PCA		Punishment		Punishment with PCA	
Fund	**Coefficient.**	**Std. Err.**	**Coefficient.**	**Std. Err.**	**Coefficient.**	**Std. Err.**	**Coefficient.**	**Std. Err.**
				Size of endowment				
e100	77.700***	10.872	75.357***	13.512	74.843***	4.936	75.263***	5.836
e1000	793.493***	43.667	803.408***	46.153	927.031***	35.038	934.473***	26.931
				Characteristics related to the forest and forest management				
Forest size	68.438***	22.127	14.909	30.622	-2.876	28.962		
Poor future for forestry	19.549	23.648	-45.130	29.916	25.418*	12.433	60.849***	11.357
Over 100 members	81.185***	26.729	100.193**	41.431				
Poor administration	13.114	12.646	51.058	35.772	-33.661	25.360	61.917***	10.717
Last fire	41.447	27.882	-1.758	24.176				
Last timber sold	95.464***	31.045	133.548***	41.669				
Greater effort					-4.626	18.428	30.970**	13.059
Commoners do tasks	23.601	31.149	84.677*	48.523				
				Socio-economic characteristics				
Less than €1500	-38.375**	13.623	-14.711	25.700				
Primary education	156.956***	37.598	187.761***	27.942	57.323**	22.908	98.672***	22.306
				Social characteristics				
Place born	-40.718	34.877	-23.093	32.532				
Very good relationship	14.099	20.155	15.526	26.702	63.771	43.686	112.881***	21.674
Decisions in family	17.723	13.349	36.503*	17.960	-35.139	23.520	212.383***	9.515
Trust in neighbors	-87.129***	21.676	-51.753	34.895				
Present before future	133.704***	19.765	134.321***	45.847	101.985**	46.423	-212.308***	14.209
Trade union	19.884	15.948	0.664	40.134	45.068	28.187	141.496***	15.673
Give free	176.687***	56.246	273.557***	42.079				
Left wing	157.739***	30.965	203.148***	42.973	105.463***	32.169	-241.378***	16.503

Not fair	18.179	25.191	-8.544	18.220	5.507	17.529	1.029	14.253
Leader	-37.836	27.278	-72.253***	24.320	-60.795*	31.752	58.783***	6.135
Factor 1 "Rules"			-6.324	29.666			-192.570***	6.059
Factor 2 "Penalties"			-20.128*	11.505			202.573***	13.415
Factor 3 "Boundaries"			-7.495	16.995			-47.831***	7.267
Factor 4 "Monitoring"			-9.359	12.835			-34.053***	8.768
Constant	-250.057***	31.387	-329.526***	37.421	-63.614	37.658	-227.311***	50.512
R-squared	0.889		0.896		0.915		0.947	
Root MSE	144.170	N=111	147.400	N=99	140.570	N=96	123.570	N=57

*** Significance level at 1%, **significance level at 5%, * significance level at 10%

ANNEX

PRINCIPLES OF COLLECTIVE ACTION (PCA)

Ostrom (1990) proposed some PCA[9] that can be useful to achieve success for CPR management in terms of maintenance and cooperation. Thus, these PCA are:

1. *Clearly defined boundaries:* individuals with rights to extract resource units from the common pool resource (CPR) must be defined clearly as the boundaries of the CPR itself. This is the first step in organizing collective action. Without this principle, Ostrom (1990) argued that local users could find outsiders reaping the benefits without making any contributions. Specifically, the questions included in the survey analyze this principle: whether all communal users know each other, whether non-members also know that they are not members and if limits are respected.

2. *Congruence between appropriation and provision rules and local conditions*: the rules of appropriation should be related to the local conditions and to provision rules. Specifically, they make reference to time, place, technology and the quantity of units. Questions included are related to whether rules are appropriate to conserve the resource, whether the community has the right to appeal, whether they are effective, the degree of respect towards local traditions, and to conclude their opinion about if they could be improved.

3. *Collective-choice arrangements*: individuals can participate in the modification of operational rules. Ostrom (1990) clarifies that although good rules may exist, this fact

does not guarantee that users will follow then. The question that we include to test the existence of this principle is whether decisions related to forests are taken collectively.

4. *Monitoring:* individuals who monitor the CPR are responsible in the presence of appropriators. Thus, questions to analyze are whether there are controls to ensure compliance and if so, whether these are respected.

5. *Graduated sanctions*: those who do not comply with the rules should face graduated penalties depending on the degree of non-compliance. First, we asked whether there are penalties for individuals who do not comply and if these vary depending on the offense committed.

6. *Conflict resolution mechanisms*: the appropriators and their officials should have reasonable access to resolve conflicts. It is important, when we are dealing with rules expected to be in place for a long period of time, that mechanisms exist that allow the discussion and solution of problems. We asked whether there are quick mechanisms to solve conflicts.

7. *Minimal recognition of rights to organize*: the rights of collective owners are not questioned by external authorities. Users should feel that they are involved in rule design. Ostrom (1990) highlights that when government authorities are the only ones to set rules it is going to be difficult for users to sustain such rules long-term. To examine this issue, we asked their opinion on respecting their rights and decisions.

In our survey and with the aim of testing whether these PCA are functioning in our area of study, we have included several questions as can be seen in Table 3.

FACTOR ANALYSIS

The results from the factor analysis are presented in Tables 5 and 6[10]. As a first step, we do not impose limits on the number of factors. We employ the Kaiser test (Kaiser, 1960) to determine the relevant number of factors. The Kaiser rule indicates that each observed variable contributes one unit of variance to the total variance in the dataset. Therefore, any component displaying an eigenvalue greater than one, accounts for a greater amount of the variance than had been contributed by a single variable. Any component carrying an eigenvalue less than one, accounts for less variance than that contributed by any one single variable. Table 4.5 results suggest retaining four factors that carry an eigenvalue greater than one.

Table 5 Eigenvalues

Factor	Eigenvalue	Difference	Proportion	Cumulative
Factor 1	**4.826**	2.458	0.322	0.322
Factor 2	**2.368**	0.434	0.158	0.480
Factor 3	**1.933**	0.871	0.129	0.608
Factor 4	**1.062**	0.066	0.071	0.679
Factor 5	0.997	0.241	0.066	0.746
Factor 6	0.755	0.044	0.050	0.796
Factor 7	0.711	0.087	0.047	0.844
Factor 8	0.625	0.117	0.042	0.885

Factor 9	0.507	0.145	0.034	0.919
Factor 10	0.362	0.056	0.024	0.943
Factor 11	0.306	0.064	0.020	0.964
Factor 12	0.243	0.087	0.016	0.980
Factor 13	0.156	0.079	0.010	0.990
Factor 14	0.077	0.005	0.005	0.995
Factor 15	0.072	.	0.005	1.000

Moreover, Table 6 explains the rotated factor loadings that show the relative contribution of each question in testing the PCA on the retained factors.

Table 6 Rotated Factors

Variable	**Factor 1**	**Factor 2**	**Factor 3**	**Factor 4**
Do you think that in your community all community members know each other?	-0.073	-0.064	**0.326**	0.157
Do you think that the residents who are not community members are clearly not part of the community?	-0.112	0.066	**0.416**	-0.001
Do you think that in practice the neighbors do not respect community members to the community?	-0.044	-0.128	**0.339**	0.033
Do you think that the rules of forestry, that have to be complied with, are appropriate to conserve the resource?	**0.350**	0.058	-0.229	-0.071
Do you think that these rules are appropriate to manage forests?	**0.311**	0.080	-0.155	-0.019
Do you think they are effective?	**0.308**	0.060	-0.149	-0.056
Do you believe these rules respect the local traditions and	0.197	-0.033	0.017	-0.090

beliefs?				
Would you say that existing standards can be improved?	0.047	**0.330**	-0.033	-0.147
In terms of decisions around forestry issues, are these taken collectively, together and equally represented?	-0.024	-0.044	0.098	0.283
Are there controls to ensure compliance by the community?	-0.070	0.055	0.034	**0.472**
Are there controls to ensure compliance by neighbors who are not members of the community?	-0.019	-0.032	0.006	**0.405**
Are there penalties for owners who do not comply with the obligations laid down in the law?	0.049	**0.406**	0.007	0.033
If there are sanctions, are they variable depending on the offense committed?	0.028	**0.357**	-0.226	0.124
Are there quick mechanisms to solve the conflicts that can arise?	-0.067	0.198	0.264	-0.017
Do you think that their rights and decisions are respected by others, who are not members of the community and the administration?	0.058	-0.014	0.187	-0.048

[1] This law is available at: https://www.boe.es/diario_boe/txt.php?id=BOE-A-1968-904

[2] We have chosen 50 members as we contacted communities with a great variety in terms of the number of users. Therefore, we explained that this is a hypothetical situation. According to Balboa et al. (2006) the average number of owners by communal forest is about 54.

[3] In the case of the "punishment" the return has no sense.

[4] This law is available at: http://www.xunta.es/dog/Publicados/2012/20120723/AnuncioC3B0-050712-0001_es.html

[5] We have conducted a t-test of mean differences in STATA 10.1 S.E. Specifically; the value obtained is -6.464 with a p-value of 0.000 comparing the rewards of size 10 and 100. Comparing the reward of 10 with the reward of 1000 we obtain a statistic of -7.581 with a p-value of 0.000. Finally, the comparison between the reward of 100 and the reward of 1000 reports a statistic value of -6.578 and a p-value of 0.000.

[6] We have conducted a t-test of mean differences in STATA 10.1 S.E. Specifically; the value obtained is -5.722 with a p-value of 0.000 comparing the punishment of size 10 and 100. Comparing the punishment of 10 with the punishment of 1000 we obtain a statistic of -7.163 with a p-value of 0.000. Finally, the comparison between the punishment of 100 and the punishment of 1000 reports a statistic value of -6.373 and a p-value of 0.000.

[7] We obtained a statistical value of 353.32 with a p-value of 0.000 with a test conducted in STATA 10.1 S.E.

[8] We obtained a statistical value of 1029.65 with a p-value of 0.000 with a test conducted in STATA 10.1 S.E.

[9] Elinor Ostrom (1990) explains 8 PCA. In this study we only evaluate 7. The reason is that according to Ostrom the eight principles "Nested enterprises" only should be taken into account if we are explaining resources with a higher number of users, which is not our case.

[10] It is important to highlight that in questions to test the PCA, users could respond "Yes", "No" or "Don´t know". We decided to recode the "Don´t Know" responses as "No" so as not to drop more observations due to our limited number of responses.