



RESEARCH ARTICLE

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Sharing the gains in forest management: Insights from the application of principles of collective action

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Abstract

Aim of study: To analyze the factors that motivate the sharing of a contribution to a common pool resource (CPR).

Area of study: We obtained data from Galicia communal forests during 2013-2014.

Material and methods: A survey among forest owners in which questions about decisions, mimicking those in public good games, were included. In addition, the compliance with the principles of collective action (PCA), and their implications in the management of CPR were tested.

Main results: PCA are not functioning perfectly in our sample of communal forest owners. In line with previous literature, results suggest that individuals are willing to share an important amount of endowment in a CPR. Examining the role that PCA play in individuals' decisions, it was observable that when owners face the sharing of an endowment, the *monitoring*, *conflict resolution mechanism* and *minimal recognition of rights* imply more cooperative results. Current communal forests should promote a better application of these PCA in order to obtain a more cooperative behavior from their members.

Research highlights: Communal forest owners are quite generous according to the results obtained. In addition, it has also been found that the endowment is an important factor to consider, while social aspects represented through the PCA also matter when explaining sharing decisions. The present study may be useful in order to promote stronger cooperation in local communities.

Additional keywords: public good game; endowment; communal forest; survey.

Abbreviations used: CPR (Common Pool Resource); OLS (Ordinary Least Squares); PCA (Principles of Collective Action); PGG (Public Good Game); RE (Random Effects).

Authors' contributions: Design of the survey and game: MA and MLL. Drafting of the manuscript: MA. Critical revision and editing: MLL.

Supplementary material (Table S1) accompanies the paper on FS's website.

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Introduction

Cooperation in groups at times is challenging to achieve. Specifically, with regards to the management of natural resources, Cardenas & Ostrom (2004) emphasized the need of resolution of collective action problems. They indicated the importance of understanding how groups make decisions about the use of the resources and how self-governed policies can promote the sustainable use. When explaining human behaviour, the traditional economic theory argues that individuals are rational and selfish. In terms of environmental resource markets, the most typical result will find the existence of non-cooperative and free-riding behavior; thus, zero cooperation is the predicted

result for most environmental resource extraction games (Hardin, 1968). However, several studies have shown that deviations from the output of traditional economic theory may take place (Gächter & Herrmann, 2006). Specifically, Ostrom (1990) pointed out that communities can govern their own natural resources without overharvesting. Some of the most used models in economic literature to test the hypothesis of rational and selfish individuals are the Public Good Games (PGG).

In this paper, the aim is focused on common pool resources (CPR), specifically in communal forests. At this regard, Ostrom *et al.* (1992) argued that individuals may reach successful agreements to manage resources efficiently in CPR. 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 & Fischbacher (2003) stated that individual heterogeneity and the interaction between altruistic and selfish individuals are crucial in cooperation, as well as the environment in which these individuals act. According to their results, more altruistic individuals can influence selfish ones. More recently, Rustagi *et al.* (2010) pointed out that structural factors, such as the characteristics of the resource, the size of the group and socioeconomic differences, as well as other social behaviors, such as conditional cooperation or costly enforcement of the norm can explain these deviations. Cardenas (2011) emphasized that it is necessary to mediate in the conflict between self-interest and group interest to avoid overexploitation through incentives, controls, sanctions or community-based recommendations, among others. In this respect, literature has focused significantly on the role that institutions, regulations and economic incentives may play. Nevertheless, studies such as Cardenas (2011) concluded 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 emphasized 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 other additional factors, including the characteristics of resources, or of the environment, matter.

This empirical study is conducted 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 of the Galician territory. Furthermore, more than 120,000 ha correspond to certified forest surface, which places Galicia at the front run of Spain in terms of sustainable forest management (Xunta de Galicia, 2014). This paper focusses on communal forests¹, which 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 (BOE, 1968), when an institutional framework for communal forests was established, without individual quotas of property.

These communities are also a signal of identity, of local culture and are economic and productive resources, due to the creation of jobs and wealth (Xunta de Galicia, 2014). To be a member of the communal forests, 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.

Conflicts among communal forests may arise. Thus, internal conflicts highlight disagreements among commoners, whereas external conflicts demonstrate issues 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 also external socio-economic and environmental conflicts with non-governmental organizations (Gómez-Vázquez *et al.*, 2009). The objective of this study is to analyze the sharing rules in collective forest managements (CPR) through a modified public good game and assess the interplay of social factors. Two aspects of this paper can be considered a novelty: the first is the fact that the study is conducted with actual forest owners, instead of students or other subjects; and the second contribution is the analysis of the Principles of Collective Action (PCA) proposed by Ostrom (1990) used to understand their implications in terms of sharing.

Material and methods

Public good games

To analyze individuals' decisions, a survey was used employing questions which reflected the choices to be made in a PGG. This game is usually played in a laboratory by n individuals. This game has been simulated in the context of structured surveys with actual CPR owners. In a lab setting, all individuals i receive an endowment e and simultaneously and independently decide whether to keep this endowment for themselves or invest a given amount $g_i \in [0, e]$ in the CPR in question. The total amount contributed by all n participants together equals $g = \sum g_i$, where $0 \leq g_i \leq e$ 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 0 is a

¹With regards to 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). They represent around 33% of the total forest surface. The BOE (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."

dominant strategy. However, the joint group outcome is maximized when everybody contributes with the full endowment. The payoff function of users can be expressed as:

$$p_i(g) = e - g_i + m \sum_{j=1}^n g_j \quad \text{if } g_i > 0 \quad (1)$$

A paper by Chaudhuri (2011) conducted 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 other means to sustain cooperation. In addition, this author also highlighted that the main conclusions obtained with respect to the investment in public goods are that in one-shot experiments the contributions are about 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 & Gintis (2007) found 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. 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 other 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) concluded that studies of preferences for cooperation should also be considered in the analysis.

In this paper, a survey employing questions reflecting a one shot PGG (individuals only decide one time and in an individual basis²) where members of communal forests have to make a decision about how to share an endowment was conducted. First, this PGG is modified due to the fact single users are told to consider the rest of the members (50 members³) in their decisions ($n=50$). Previous studies usually employ groups of four people. In our specific case, the group

under consideration will be composed by all users of the community in order to represent a similar situation to the reality. A second important aspect to take into account is that the contributions to the fund will allow different management efforts in the communal forests to be carried out, from which the community will benefit, specified with a percentage over the initial amount invested (m). Thus, in order to keep a perfect similarity with the reality, m represents a future re-investment which is not specified, depending on each specific community and it is based on previous rents obtained and shared. At this respect, our PGG is described as a real situation that collective owners can face frequently as owners of the communal forest (Rodríguez *et al.*, 2017). It is important to highlight that the game is conducted through an interview and no real money is being played. Bethwaite & Tompkinson (1996) also carried out an ultimatum game under the same conditions. These practical approaches should be taken into consideration when comparing these results with those obtained by other studies. Finally, it is important to note that each participant was presented with three different sizes of endowment, in order to assess whether the size of the economic incentives matter in sharing decisions. A similar exercise employing the ultimatum game was conducted by Andersen *et al.* (2011) in poor villages of Northeast India, finding that the size of the endowment matters.

Data description

A survey was carried out in North-west Spain, in the region of Galicia, from winter 2013 until summer 2014, interviewing a sample of 75 forest owners. In order to facilitate the first contact with forest owners, information from the websites of communal forests was obtained. After an initial phone call or contact e-mail, we visited the place where they live (a total of 29 different places) conducting face to face surveys at their homes; or after attending their annual association meetings. Some participants preferred to answer via online rather than face to face, petition that was accommodated. Information from 29 communal forests belonging to 31 different councils was collected. The four provinces of Galicia are represented in this small sample; with 55.71% of the observations from the

²In this paper, it is used a one-shot game and individuals play individually. Nevertheless, respondents belong to actual forest communities. Thus, the sharing decisions (though simulated) are framed in real communal forests and although the game is not played in group, a concrete group of reference does exist in the mind of the respondents (the communal forests to which they belong), with which they have had repeated interactions. Therefore, provided some real conditions in the community (communication level, overall cooperation/free-riding level, concrete social norms, past experiences, etc.) and individual preferences, the respondent indicates a sharing decision. We thank a reviewer for suggesting this reflection.

Therefore, provided some real conditions in the community (communication level, overall cooperation/free-riding level, concrete social norms, past experiences, etc.) and individual preferences, the respondent indicates a sharing decision. We thank a reviewer for suggesting this reflection.

³An average size of 50 members was chosen, given communities contacted had a great variety in size. Therefore, that the fact that this is a hypothetical situation was explained. According to Balboa *et al.* (2006) the average number of owners by communal forest is about 54.

province of A Coruña, 22.86% from Lugo, 17.14% from Pontevedra and 4.29% from Ourense. The survey requested information about the characteristics of communal forests, from which they are members, with the objective to reflect members' knowledge. In addition, questions related to their opinion about public authorities were also included, and the way in which decisions related to forest are made. Furthermore, the survey also included questions to test whether PCA

were functioning. PCA related questions can be seen in Table 1 and a full description is added in the Table S1 [suppl.]. The PGG was presented in another section of the questionnaire.

Table 2 shows an example of the game presented to participants. Basically, forest owners had to decide about the sharing of endowment that the community receives as a consequence of the actions carried out in order to keep forests in good conditions. As it can be

Table 1. Questions to test whether the PCA are functioning and percentage obtained.

		Degree of compliance (%)
Clearly defined boundaries	Do you think that in your community all community members know each other?	72.39
	Do you think that the residents who are not community members are clearly not part of the community?	49.47
	Do you think that in practice the neighbors respect community members?	68.75
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?	53.64
	Do you think they are effective?	50.00
	Do you believe these rules respect the local traditions and beliefs?	59.37
Collective choice arrangements	In terms of decisions around forestry issues, are these taken collectively, together and equally represented?	85.41
Monitoring	Are there controls to ensure compliance by the community?	50.52
	Are there controls to ensure compliance by neighbors who are not members of the community?	44.27
Graduated sanctions	Are there penalties for owners who do not comply with the obligations laid down in the law?	51.04
	If there are sanctions, are they variable depending on the offense committed?	35.41
Conflict resolution mechanisms	Are there quick mechanisms to solve the conflicts that can arise?	22.39
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?	46.35

Table 2. Example of the PGG presented to participants.

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		

seen, each common owner has to decide the sharing of three different endowments. In this way, we can test whether the size of the endowment is important as has been found in other previous literature. In addition, the survey also 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 (these questions were asked before participating in the PGG). It is important to highlight that the PGG was conducted individually. The same strategy was employed by Braaten (2014) with the goal of promoting comprehension amongst participants. Finally, socio-demographic characteristics were elicited in the last part of the survey.

Empirical approach

Individuals' allocations made in the stated preference exercise were modelled as a function of the size of the endowment (reward), the forest characteristics of individuals and the most relevant social and socio-economic characteristics, among other variables. Furthermore, the PCAs were also incorporated into the regression model in order to test the effect of other perceptions towards the collective management.

A first Ordinary Least Squares (OLS) regression was estimated. Using the Breusch-Pagan (1979) test, it was assessed the presence of heteroskedasticity, finding that the test carries a value of 24.93 for a Chi-squared with 1 degree of freedom and an associated p -value of 0.00. Therefore, we reject homoscedasticity. To deal with this problem, an OLS model clustered by individual was estimated⁴. In addition, and in order to take into account the panel nature of our data, based on the fact that three different responses from each individual were collected, the between and within variability was also analyzed using a Random Effects (RE) model⁵. The dependent variable in this regression equation is the vector of the total distributions (the amount of the endowment shared with regards to the total amount of endowment available), labeled as (Y). This vector represents the percent of endowment that individuals decide to send to the public fund. The vector of explanatory variables (X_i) is grouped into four categories that include: the size of the endowment to be shared X_s , the forest characteristics X_f , the socio-economic characteristics X_{se} , while X_{pca} represents the PCA.

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

$$Y = \beta_0 + \beta_s X_s + \beta_f X_f + \beta_{se} X_{se} + \beta_{pca} X_{pca} + \varepsilon \quad (2)$$

where Y represents the cooperation of the individuals within their groups when they face the economic incentive; β_0 is the usual constant term, the corresponding β are the coefficients associated with the respective explanatory variables to be estimated. Thus, β_s represents the amount of endowment to be shared; the β_f contains the characteristics of the forest where individuals are; β_{se} includes the socio-economic characteristics of the participants while the vector β_{pca} represents the seventh PCA proposed by Ostrom (1990), and ε is a vector of the error term, independently and identically distributed.

Research hypotheses

One of the main aims of this paper is to analyze the impact of PCA in sharing decisions. It is important to note that with the aim of including the effect of PCA several questions were included in the survey (see Table 1); and in order to measure the impact of PCA, we constructed indicators to measure the existence of these principles. Table 1 provides information about the type of questions used to estimate each individual PCA. Questions were answered with a "yes" or "no", and recoded as 1 and 0, respectively. Thus, in order to create the indicators, the affirmative responses were added up.

It is expected that PCA may have a significant impact on explaining the sharing of the endowment. The aim was to investigate whether individuals feel that they are involved in the decision-making process; whether they are aware that their rights are respected; and whether there are controls to assure them, among others factors. Thus, the hypothesis proposed is to test whether the fulfillment of PCA enumerated by Ostrom (1990) influence sharing decisions in the community.

$$H_0 : \beta_{pca} = 0 \quad (3)$$

$$H_1 : \beta_{pca} \neq 0$$

The second question of analysis is whether the size of the endowment matters in sharing decisions. To study this hypothesis, a variable which represents the size of each individual endowment has been included. In this sense, Anderson *et al.* (1998) found that contributions increase with the endowment; while Andersen *et al.* (2011) concluded that stakes are important but in the case of ultimatum games. Therefore, this is a novelty aspect in the literature of PGG, due to the fact that no

⁴In our PGG each individual faces three decisions, this means, the sharing of three different amounts of endowment to be shared. Therefore, clustering by individual this aspect has been taken into consideration.

⁵A Hausman test was conducted in order to test whether a Fixed Effects model performed better than a RE model. The test conducted carried out a value of $\chi^2_1 = 0.080$ with a p -value of 0.771. Therefore, the RE model is selected as the model that best fits the data.

previous studies were found that analyzed the effect of the size of endowment in this type public good game. Specifically, the hypothesis to be tested is:

$$\begin{aligned} H_0 : \beta_{se} &= 0 \\ H_1 : \beta_{se} &\neq 0 \end{aligned} \quad (4)$$

Results

Data results

In terms of the dataset composition, 64% of the respondents were men, with an average *age* of 55 years and the average number of household members was around three persons. With respect to the level of studies, 52% of the respondents have a basic level of studies or no formal studies (*basic studies*), and with regards to the income-related questions, about 24% of participants earn less than €1,000/monthly (*lower income*).

With regards to the characteristics of forests, about 44% of them had more than 100 communal members (*over 100 members*). It was also detected that in terms of location, 58% of the communities in this sample were close to the sea (*near to the coast*) (as opposed of being distant rural communities). This geographical indicator is important, since it provides information about the degree of economic dynamism of the area.

Previous studies have shown that communities located near the coast are more active and dynamic, mirroring the economic local conditions (Alló & Loureiro, 2016). With the goal to know more about their engagement in forest management, participants were asked about their level of effort compared with the rest of the owners; and 21% stated that their own effort is higher than the rest of the members (*greater effort*).

With the aim of obtaining more information about their social characteristics, additional questions related to whether they were born in locations near to forests were included, with 75% answering in a positive way (*place born*). About 52% responded that their relationships with the rest of owners were very or quite good (*good relationship*).

Finally, it was also taken into account the survey mode: whether the surveys have been completed via online instead of face to face, with 33% preferring the online mode (*online*). Table 3 shows the summary statistics for the variables analyzed.

Public good game

The distribution of the endowment is presented in Figure 1. It is important to note that each individual had to make three allocation decisions due to the three different sizes of the endowment. The amount of endowment shared can be considered as a proxy of

Table 3. Summary statistics for the variables analyzed.

Variable	Description	Mean	Std. Dev
Fund	Percentage of endowment allocated to the fund	83.698	29.309
Size of endowment	10, if the size of the endowment is €10; 100 if the size is €100 and 1000 if the size is €1000	370.000	448.158
Clearly defined boundaries		0.406	0.492
Congruence between appropriation and provision rules and local conditions		0.406	0.492
Collective choice arrangements		0.854	0.354
Monitoring		0.411	0.493
Graduated sanctions		0.865	0.911
Conflict resolutions mechanisms		0.224	0.418
Minimal recognition of rights		0.464	0.500
Age	Age of respondents	54.578	15.174
Born place	1, if respondents were born in the place where forests are; 0 otherwise	0.750	0.434
Basic studies	1, if the responds have a basic level of studies; 0 otherwise	0.505	0.501
Lower income	1, if respondents earn less than €1,000 per month; 0 otherwise	0.240	0.428
Near to the coast	1, if the communal forest is located close to the coast; 0 otherwise	0.578	0.495
Over 100 members	1, if the collective forest has more than 100 members; 0 otherwise	0.443	0.498
Greater effort	1, if owners think that their own effort is greater than the rest of the owners; 0 otherwise	0.214	0.411
Good relationship	1, if owners respond that their relationships with the rest of owners are very or quite good; 0 otherwise	0.521	0.501
Online	1, if the respondent answered the survey via online; 0 otherwise	0.333	0.473

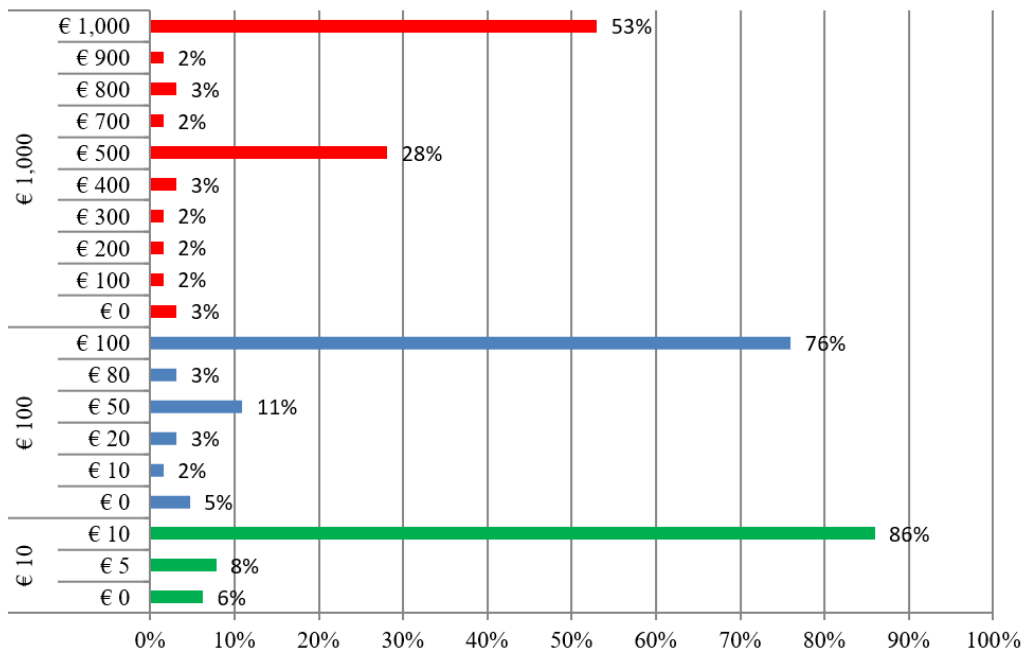


Figure 1. Allocations of the endowment (%) in a fund account for different endowment sizes (€10, €100, €1000).

cooperation (Stoop *et al.*, 2012). Assessing the results, it was observable that when the endowment to share was €10, around 86% decided to allocate the full amount to the common fund, and around 8% decided to invest half of the endowment in the public fund, while the rest (6%) decided to keep the endowment for themselves. Thus, on average the mean contribution was about €9. However, when the endowment was higher, the allocation changed. Specifically, for an endowment of €100, 5% decided not to share this endowment, also another 5% decided to send a positive value below the half to the public fund; while 11% decided to split the endowment at 50%. Moreover, around 3% sent to the public fund more than half, but less than 100% of the endowment, and 76% allocated the total €100 to the fund. On average, the contribution to the fund was about €85. This decision changed slightly when the endowment was even higher. For an endowment of €1000, 3% kept the full amount, around 9% decided to share less than half with the fund, while 28% decided to share half with the public fund. In addition, 7% of the owners share more than half with the public fund, and finally, 53% decided to send the total amount to the fund. On average, the mean contribution to the fund for this endowment was about €759. Therefore, the higher the size of the endowment, the higher the amount of endowment that collective owners keep for themselves. Nevertheless, it is important to highlight that in spite of that, they were quite generous, given that the percentages of endowment kept by themselves was quite small (around €1 on average for an endowment of €10, around €13 for an endowment of €100, and about €240 for an endowment of €1000). 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, particularly in the absence of mechanisms to encourage it (such as penalties, or communication strategies, among others). Stoop *et al.* (2012) concluded that without any kind of contact among players, cooperation is not guaranteed.

The role of PCA

The survey results related to the PCA are presented in Table 1. With regards to the principle of *clearly defined boundaries*, around 72% of respondents believed that in their communities all members knew each other; 49% thought that residents who were not members of the communal forest knew this fact, while the 69% considered that neighbors respected community members in practice.

When examining *congruence between appropriation and provision rules and local conditions*, it is important to note that only 53% of commoners thought that the rules that they had to follow were appropriate for resource conservation. With regards to the regulation’s effectiveness; only 50% believed that it was *effective*. Moreover, 59% thought that the *existing rules respect local traditions*. Analyzing the results for the principle of *collective choice arrangements*, 85% confirmed that forest decisions were taken collectively with individuals equally represented. In addition, around 50% of participants stated that there were controls to ensure

compliance by the forest community, and 44% stated that there were also controls for outside members (*principle of monitoring*). With regards to the principle of *graduated sanctions*, 51% of commoners affirmed that there were penalties for people who did not comply with the requirements, and 35% stated that these penalties varied depending on the degree of infraction in the case of the endowment. Only 22% expressed that there was a *quick mechanism to resolve conflicts* and 46% believed that their *rights and decisions are respected* by non-members and the administration for the endowment treatment.

OLS and RE results

In order to understand the factors that drive the allocations of endowment to the CPR, we estimated a robust OLS and a RE models. The main results are summarized in Table 4. First, we examined and

discussed the estimates with regards to the size of the endowment for both models. We observed that the coefficient obtained for *size of endowment* was negative and statistically significant. Therefore, when the endowment to be shared was larger, less proportion was shared with the public fund. This means that with lower endowments, individuals are willing to share proportionately a greater amount of endowment with the public fund.

We also considered the effect of different characteristics of owners to understand their decisions. Thus, Bechtel & Scheve (2014) concluded that socio-demographic characteristics play an important role in social dilemmas. Specifically, we obtained that the *lower income* indicator was negative and statistically significant. Moreover, those individuals who thought that they made a *greater effort* than the rest, were more likely to allocate the endowment to the public

Table 4. Results obtained from the OLS and RE models.

	OLS			Random effects		
	Coef.	Robust SE	P> t	Coef.	SE	P> t
Size of endowment	-0.012	0.004	0.001	-0.012	0.003	0.000
Near to the coast	-1.848	5.801	0.751	-2.565	7.724	0.740
Members over 100	8.358	6.453	0.200	7.752	7.874	0.325
Age	0.203	0.344	0.557	0.178	0.294	0.546
Born place	2.705	6.010	0.654	1.752	8.013	0.827
Basic studies	4.889	8.314	0.559	3.909	8.142	0.631
Lower income	-15.172	6.598	0.025	-13.556	7.526	0.072
Greater effort	23.481	5.218	0.000	23.332	7.996	0.004
Good relationship	3.239	7.195	0.654	3.855	6.225	0.536
Online	-2.536	8.283	0.760	-4.198	9.687	0.665
Clearly defined boundaries	0.966	6.624	0.885	0.958	8.349	0.909
Congruence between appropriation and provision rules and local conditions	-15.587	5.746	0.009	-16.000	7.390	0.030
Collective choice arrangements	-4.921	7.397	0.508	-5.875	9.006	0.514
Monitoring	19.649	6.443	0.003	20.764	9.211	0.024
Graduated sanctions	-7.208	2.385	0.004	-6.829	3.717	0.066
Conflict resolutions mechanisms	15.854	5.501	0.005	15.624	8.180	0.056
Minimal recognition of rights	16.944	5.561	0.003	17.307	9.260	0.062
Constant	64.552	20.428	0.002	67.974	20.763	0.001
Sigma_u				18.325		
Sigma_e				19.500		
Rho				0.469		
Wald χ^2 (17)				48.120		
F statistic	8.480					
p-value	0.000			0.000		
R ²	0.319					
Root mean squared error	25.347					
N	192			192		

fund. These may be more altruistic or more committed commoners.

With regards to the effect of PCA, we observed that the principles related with the *congruence between appropriation and provision rules and local conditions* and *graduated sanctions* showed negative and statistically significant coefficients. Therefore, individuals who believed that these principles were being fulfilled are less willing to share the endowment. Furthermore, we also observed that three PCA had a positive impact promoting more cooperative decisions, specifically, the *monitoring*, the *conflict resolution mechanisms* and the *minimal recognition of rights*. These results may be implying that when individuals feel that they are involved in the management process, are more willing to share the endowment towards the CPR. Therefore, results show that PCA fulfilment may encourage more generous decisions, but not always (as in the case of *congruence between appropriation and provision rules and local conditions* and *graduated sanctions*).

Discussion

The aim of this paper was to analyze, in the context of a CPR, how common owners made decisions. Through a survey using questions mimicking the decisions of a PGG, the question of how landowners shared out an endowment was analyzed. It is important to highlight that responses obtained from the survey were assessed as a proxy of the real contributions. In addition, we would like to emphasize that we were focusing on a sample of forest owners who were very active in CPR management. As an example, around 79.2% affirmed that they attended the meetings organized by the communal forest, and also 56% participated in the activities proposed. We acknowledge that this fact may bias some of the results.

Therefore, and spite of having a sample of very active members, and as a conclusion, we observed that PCA were not functioning perfectly in our sample of communal forest owners. Thus, the adoption of these PCA could be improved as a way to deal with the current management problems faced by these CPR. Regression models were estimated in order to assess PCA effects in sharing decisions. In addition, the size of the endowment was also considered in order to understand whether the sharing of an endowment is dependent on the size of this.

Evaluating how endowments were shared, obtained results were in line with previous studies, finding that on average common owners made higher

contributions to a CPR than suggested by traditional economic theory. Specifically, it was found that communal forest owners were quite generous. It was also found that the endowment size was an important factor to consider. In this sense, Andersen *et al.* (2011) concluded that the size of the stake matters in ultimatum games.

With regards to the PCA, we have included a number of questions in the survey that were used through the construction of indicators. Examining the role each play in individuals' decisions, it was observable that when owners face the sharing of an endowment, the *monitoring*, *conflict resolution mechanism* and *minimal recognition of rights* imply more cooperative results. Therefore, current communal forests should promote a better application of these PCA in order to obtain a more cooperative behavior from their members. The present results may be useful in order to promote stronger cooperation in local communities.

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