Gender heterogeneity in user groups and fishing extraction: experimental evidence for a Caribbean Colombian marsh

Jorge Maldonado[1].

Yady M. Barrero[2].

ABSTRACT

User's social dynamics and their interaction influence decisions on the extraction of common pool resources (CPR's). This paper analyses the relationship between the composition of gender mixed groups and CPR use from an experimental perspective. An extension of the conventional theoretical model is presented to include gender-related types of users and group composition. The empirical exercise is based on data from an experimental economic game in a Colombian fishing community in the Caribbean; the CPR game includes groups of five people, and there can be only-male groups, only-female groups or mixed group (with female majority or with male majority). Results show that the players of mixed groups with female majority extract in average less of the CPR than the other groups. Indeed, inside this mixed group is the man who extracts the lower level. Those ideas might suggest that women participation in mixed groups is convenient for the sustainable use of natural resource because they motivate extract fewer resources.

Key words: gender effect, Common pool resources, field experiments

JEL Codes: D03, D64, Q01, Q22, C23, C93

[1] Profesor asociado. Facultad de Economía. Universidad de Los Andes. Colombia. jmaldona@uniandes.edu.co
[2] Estudiante del Doctorado en Economía. Facultad de Economía. Universidad de Los Andes. ym.barrero10@uniandes.edu.co

Gender heterogeneity in user groups and fishing extraction: experimental evidence for a Caribbean Colombian marsh

Introduction

Common pool resources (CPR) are characterized by being non-excludable and rival; i.e., it is not possible to prevent users from accessing the resource, but the removal of each one affects the level available to all. In this context a social dilemma arises to align individual interests and collective incentives (Cárdenas 2009). The individual extraction can lead to overfishing when everyone acts without considering the common good and the effects on others.

Communities that depend on natural resources for subsistence and income generation face this type of decisions and the dilemma between individual and collective levels of extraction. These communities involve men and women that have to make joint decisions over time about extraction of natural resources (fish, wood, water) that are CPRs, and have to solve the social dilemma associated to them. In that sense, it is important to understand the users' dynamics of resource extraction, both at individual and group level.

Behaviour of users in groups may depend on the type of people who integrate the team. At the same time, this observed behaviour of the group depends on the individual decisions. For instance, Maldonado & Moreno (2009), through a set of extraction games in fishing communities in the Colombian Caribbean, found that players who behave cooperatively mostly belong to groups in which all are extracting below the Nash equilibrium, while players who extracted and generated more inefficient outcomes are associated with groups that consistently extracted above the Nash equilibrium. The interrelationship between the personal condition and the group conformation, on the individual and collective extraction decisions is an important element of this research.

Another important element is given by the heterogeneous nature of the groups, and its effect on levels of extraction. Heterogeneity is referred to when user groups, or teams during an economic experiment, are made up of people of different conditions. Currently, there is also an ongoing debate on the effects of heterogeneity on cooperation and collective action, raised from the seminal article by Olson (1965) in the context of different levels of wealth and public goods experiments. "Heterogeneity introduced in the utility function of the group members could adopt many forms, and therefore the range of results leaves open the question of whether heterogeneity affects cooperation positively or vice versa" (Cardenas 2009).

The effect of the diversity of users on the management of natural resources has been associated with the provision of facilities for their use or access to available stock; recently the gender of users has become a variable considered in the analysis, highlighting the various implications of including women in decision-making processes. Some ideas about these implications are that women are more cooperative than men in the use of natural resources; they influence positively men's decisions and their presence can improve the behaviour on mixed groups.

In that sense, some papers have identified that among forest users in India and Nepal, women's groups are more cooperative than men´s because a woman has stronger family and social networks to confront her material restrictions and because, due to her activities, she pays a greater cost if she decides not to cooperate (Agarwal 2000, 2001). Even though women do not act directly on the activity of resource use, they exercise significant influence as they can motivate the decisions of men; this is evidenced in the case of illegal hunting in Tanzania and Ethiopia (Lowassa, Tadie & Fischer 2012).

Other studies show the usefulness of joint work between men and women: Westermann, Ashby & Pretty (2005) analysed some rural programs in developing countries and find that higher percentage of mixed group participants expressed altruistic motives as reasons to settle. Meanwhile, Mwangi, Meinzen-Dick and Sun (2011), using data from forest groups, found that the presence of mixed groups explains positively and significantly the probability of having more capacity in monitoring forest resources.

These analyses are performed with various interdisciplinary approaches such as comparative research and case studies, including surveys and interviews with CPR user groups. As a methodological contribution to the understanding of the effect of gender heterogeneity within groups of users of natural resources, this research uses data from field experimental economic games. The economic games allow achieving greater control over the conditions of decisions of the players and keep the realism of the data collected naturally (Levitt & List 2009).

The reason for considering the heterogeneity gender as a determinant of CPR extraction is to recognize that men and women act differently. These differences are expressed in their decisions and the way people interact in different economic contexts. Gender differential features have been widely discussed in the behavioural literature and verified through laboratory and field experiments. Eckel & Grossman (2002, 2008) and Crosson & Gneezy (2009) show that women are more risk-averse than men in terms of consumption decisions, investment or labour markets. There is also a distinction when men and women face competition environments, as men prefer competitive scenarios (Nierdele & Vesterlund 2007; Crosson & Gneezy 2009). It has also been found that the perception of gender differences is not the same for men and women: for example, women are considered more altruistic than men, but men believe that women are as generous as they are (Aguiar et al. 2009). On the other hand, in mixed environments, stereotypes of "male vs. female selfishness generosity" expressed as context in a dictator game affect more to men than to women (Boschini, Muren, & Persson 2012).

Even social structures with noticeable differences in cultural gender roles make men and women adopt radically different behaviours. In India, for public-good games, Andersen, Bulte & Gneezy (2008) find that in matrilineal communities there are few agents acting strongly as free-riders, achieving greater provision of public goods; however, this increased provision is due to the actions of men more than the actions of women.

Other studies using field CPR games, including the structure of the group of players and gender of users as determinants of their decisions, don't have conclusive results. Cardenas et al. (2011) use a voluntary contribution mechanism (VCM) and a "game of the watershed" to find the determinants of decisions of collective action in the context of provision and appropriation of water. They propose to analyse group composition by gender of users and gender itself as explanatory variables. Their results are ambiguous in the sense that being a woman is significant only in two of the three stages of the game in the watershed but it is not on the stages of VCM; while the effect of the composition of the group is negative for the game of the watershed (indicating that heterogeneous groups contribute less), but positive in the game of VCM (because heterogeneous groups contribute more).

The objective of this paper is to analyse how the gender of users and gender-group composition determine CPR extraction using experimental economic games and investigate the behaviour of the players into mixed groups. This work aims to contribute to the literature on the effect of heterogeneity of the groups in the use of natural resources. Extraction in mixed groups of either male or female majority is studied in order to approximate how different gender heterogeneity affects individual and group behaviour. I used some data from experimental economic games with fishing communities from the Colombian Caribbean, specifically at Santa Marta marsh. These games have designs that did not include gender as a treatment variable. However, they exhibited heterogeneity in the composition of teams to include mixed groups with either female or male majority, and groups of only men or women; this composition allows validate whether extraction decisions change with the formation of the teams.

Results so far show that the players of mixed groups extract, on average, different amounts of the CPR than other groups. Indeed, inside mixed groups, behaviour is not the same for women and men.

Those ideas might suggest that decisions in mixed groups are key points for the sustainable use of natural resource because they could motivate different extraction levels.

The paper is organized as follows: in addition to this first section where it is presented a review of the background of the research topic, in the second section with the methodology we explain the extended theoretical model from the conventional model of RUC; we described the game and its participants, as well as those conducted statistical procedures. Thirdly we realize the results of the econometric exercises and finally we propose the discussion regarding the findings.

Methodology.

This section starts from the basic model for common pool resources and it presents a theoretical model that explains the level of individual extraction depending on the characteristics of resource users and the formation of groups. It derives some hypotheses that contextualize the empirical work involved; and it describes the game played and the participants. At the end, it explains the statistical procedures to obtain the results.

I. The Model.

The experimental economic game that is analysed in this study corresponds to the schema associated with a common pool resource (CPR). Fishing is a non-excludable but rival good: it is difficult to prevent fishermen make use of the resource in an open access model; however, decisions affecting every fisherman extracting resource availability, and therefore it changes the decisions of the other users in the area. There is a divergence between the private solution (characterized in theory and the Nash equilibrium) and the social optimum; it is the problem of common pool resources and it is reflected the lack of exclusion, since individuals have incentives to appropriate more resource units when they decide individually, if they cooperate with others considering the needs of all.

The theoretical model for a renewable resource defines the costs and benefits of the activity for each individual user at a given point in time, their depend on their own mining ($x_{i,t}$) and the stock of available resources (S_t), but the cost and benefits also depend on decisions aggregate extraction ($\sum_i x_{i,t}$). This structure allows to capture the payoff function the externality caused by the non-exclusion and rivalry that characterize this type of resources. However, this model is not able to explain why individuals deviate from the individual optimal and often decide to remove a smaller amount than expected theoretically. One explanation for this behaviour is related with different preferences for each user; these are given by his characteristics and by the way that he interacts with others inside his group.

In an attempt to model this behaviour repeatedly observed in both economic games as in real life, the base model is adjusted to include the component of heterogeneity, and it try to explain the decision of individuals. In this case is not possible to define the profit function only in monetary terms, but now the model is defining an individual utility (U) where part of the utility is formed through monetary function (π) and another part or the utility depends of differentiation between individuals due to their own characteristics or for the environment in which the individuals are immersed (θ) (Equation 1).

$$U(x_{i,g}) = U_i(\pi_i, \theta_{i,g}) \qquad (1)$$

In this utility function, the first element is an expression of direct valuation for extraction monetary and for the effect of rivalry in the use of the resource ($\pi_{i,t}$). It corresponds to the individual cash payments, which depends on the levels of individual extraction in each period $x_{i,t}$ and the total stock of the resource S_t. So, $\pi_{i,t}$ has two components, i.e., the general payoff function is given by:

$$\pi_i(x_i, S) = f(x_i, S) + g(\textstyle\sum_i x_i) \quad (2)$$

Where $f(x_i, S)$ is private monetary benefit and $g(\sum_i x_i)$ represents aggregate impact on the function of individual monetary benefits for extraction. It is assumed that $f_x \geq 0, f_{xx} \leq 0$, $f_S \geq 0$, $f_{SS} \leq 0$, $g_x \leq 0$, $g_{xx} \geq 0$.

The second element of the individual utility function captures the effects of differential behavior for each one. This element is the contribution to the classic model proposed by this paper. It is called θ, and depends on two components, one related to the own individual characteristics (h) in this case the user gender, and another related to the effect of the group in which this individual is taking their decisions (k), that is the proportion of each gender inside each group :

$$\theta(x_i) = h_i(x_i, \delta^j) + k_{i,g}(x_i, n^j) \quad (2)$$

The θ function is modelled as separable in order of easier the identification of both mechanisms for heterogeneity: the individual typology expressed by user gender and the interaction between user types through male majority groups, female majority groups or only male or female groups.

Thus h_i is the function that affects the individual behaviour when they decide the level of extraction and it depends on the gender. Besides it defines the type of player as δ^j with j = *F or M* (Females or Males).

In the context of the CPR, when the users reduce their individual extraction, they are helps to conserve more resources available to other users, which can be seen as an expression of altruism and this behaviour can generates profit in all resource users. It is assumed that both men and women increase their levels of individual utility when they extract less resource because they behave altruistically:

$$\frac{\partial U_i(x_i;S)}{\partial \theta(x_i)} * \frac{\partial \theta(x_i)}{\partial h_i(x_i;\delta^j)} * \frac{\partial h_i(x_i;\delta^j)}{\partial x_i} < 0$$

Although there is not conclusive evidence of greater altruism in one gender, according to studies of the psychology of behaviour such as Andreoni & Vesterlund (2001), women may be more altruistic than men when altruism is highly valued. In the context of this model it is assumed that women (identified by the parameter δ^F) lose more profit per unit when they extract one unit more, compared with individual men´s extraction level, i.e.

$$\frac{\partial h_i^F(x_i, \delta_i^F)}{\partial x_i} < \frac{\partial h_i^M(x_i, \delta_i^M)}{\partial x_i}$$

The functional form or h_i may be linear or not. The linear approximation implies that the individual utility function is reduced at a constant rate with increasing levels of extraction. The nonlinear approach implies that the rate at which the individual's utility decreases to extract the resource depends on the number of units previously uses: this rate may be lower as the number of units extracted (convex to the origin) or rate can grow when the user marginally to extract more resource units (concave to the origin).

Although it may be more realistic a concave nonlinear functional form (indicating higher levels of marginal disutility as resource extraction increases), for simplicity of the modelling, we define h_i function as a linear function from the extraction levels.

$$h_i = \delta_i^j x_i \text{ with } j = F \text{ or } M \qquad (4)$$

On the other hand, $k_{i,g}$ is the function associated with the group composition according to the gender of their members; therefore depends on n^j, it is the number of individuals of type j in each group, again j = F or M. In the overall population there are both men and women, such that $n = n^F + n^M$

If we define η as the proportion of women in each group, then $\eta = \frac{n^F}{n}$, and $\eta' = \frac{n^M}{n}$, so η + η´=1.

Given the different conformations of the groups, η is between 0 and 1. It is assumed that the individual decisions change depending on the composition of the group. Be $\kappa_i = \kappa(\eta)$ the function is $k_{i,g} =$ additively separableAnd again, for simplicity it can be assumed that function as linear: $k_{i,g} = \kappa_i * x_i$ (5)

This suppose that the value function for the monetary profits and the function for heterogeneity are additively separable. Both elements are expressed in Equation 6

$$U(x_i) = U_i(\pi_i) + U_i(\theta_{i,g})$$

$$U(x_i) = U\left[f(x_i, S) + g\left(\sum_i x_i\right) + h_i\left(x_i; \delta^j\right) + k_{i,g}\left(x_i; n^j\right)\right] \quad (6)$$

Now, the problem for the individual agent is: $\max_{x_i} U(x_i) \;\; s.a \; \sum_{i=1}^{n} x_i \leq S$ (7)

The stock of the fishery resource is assumed given, the game is static (it does not depend on the actions of the participants extraction). Therefore the only active constraint for fishery users is that the total extracted does not exceed the level of the resource stock.

The Individual optimum is calculated solving the optimization problem by each type of user. They define their extraction level and it is different for women and men:

Women: $(x_i^{*P})^F = [f(\pi_i)] - \delta_i^F - \kappa_i$ (8)

Men: $(x_i^{*P})^M = [f(\pi_i)] - \delta_i^M - \kappa_i$ (9)

According to the behaviour of each type of user, must be extract both men and women below the Nash equilibrium, and besides in the case of open access, women would extract fewer units than men: $\left(x_{i,t}^{*P}\right)^F < \left(x_{i,t}^{*P}\right)^M$

The socially optimal level of extraction is calculated considering the preferences of all users, both women and men, for this, is necessary add their individual utility functions in the W function. So, the problem of social optimality is:

$\max_{x_i} W = \sum_{i=1}^{n} U(x_i) = n^F * U^F(x_i^F) + n^M * U^M(x_i^M)$ (10)

The restriction is extract less than the resource availability. This is $n^F x_i^F + n^M x_i^M \leq S$

The level of extraction by gender, under the conditions of social optimum is:

Women: $(x_i^{*S})^F = [f(\pi_i), n^F] - \delta_i^F - \kappa_i$ (11)

Men: $(x_i^{*S})^M = [f(\pi_i), n^M] \quad - \delta_i^M - \kappa_i$ (12)

With $f(\pi_i, n^F) < f(\pi_i)$.

In the theoretical model presented in this section it is clear that for both men and women, the level of extraction is less than the level defined in the conventional model. Moreover, the level of individual extraction depends not only on being male or female, but the type of composition of the group to which each belongs (mixed, men only or women only).

Thus, as a first hypothesis of this paper, we seek to ensure that there is an effect of differentiation in the levels of extraction of men and women: it is expected that there are differences in the average level of resource extraction in the experimental game for male players compared to the average level of women players.

It also aims to examine whether there are effects of gender composition inside the group and if this organization affect individual extraction levels. The hypothesis is that in mixed groups different levels of resources are extracted, compared with homogeneous groups of both men and women. Therefore, if the behaviour of mixed groups is different from the homogeneous groups, it is expected within mixed groups, there are differences in decisions of men and women according to their gender composition. That is, levels of extraction when there are different levels of η function, should be showing a different behaviour.

II. The game and the players

The experimental economic games (EEG) used in this research were conducted in April 2009 in rural communities near to Salamanca Island Road Park and Wildlife Sanctuary of Cienaga Grande de Santa Marta (La Cienega). The field experiment simulated a real problem with fishing resource users. The purpose of the game was to analyse the fishery decisions, and determine the individual and collective incentives for the users, as well as explore the effect of the state of the resource on extraction decisions.

The effect of gender of the players on their decisions extraction or the establishment of user groups as mixed or homogeneous design was not part of this game, although both variables are dimensions of individual and group characterization for the experiment.

Four communities in the area of La Cienega were visited between 13 and 20 April 2009. According to the Protocol to the EEG conducted by the GEMAR[3] researcher team, these communities were chosen for host community organizations and because they have cultural, historical and usage relationship with the bog. The local leaders spread the call for participants and they enabled people attended the sessions.

In each community, the researches held two sessions on the same day: in the morning session they participated in a group exercise of participative valuation of the ecosystems of the area[4], and in the afternoon they played the EEG and finally they answer a characterization survey. Each player earned on average between $ 15,000 COP of 2009 and $ 20,000 COP of 2009 for participating in the EEG, no one lost money by playing the game, the researchers pay the winnings in individual and confidential form. These values paid correspond to one or at most two fishing daily wages, so that players have enough incentive to participate in games attentively, but the payment are not so high as to induce unrealistic behaviour to use of resources.

The game motive the participation of people directly related to the fishing activity in the area. However assistance of other community members indirectly involved in resource use, both men and women were not excluded. The researches prevented that two or more of player belonged to the same household play in the same group. To participate in the experiment was not necessary to read or write because the research team was able to advice these cases and they recorded their extraction decisions in each round.

[3] GEMAR is the Grupo de Economía del Medio Ambiente y Recursos Naturales

[4] The article "Alternative approaches to the assessment of ecosystems: exploring the involvement of local users" Moreno & Maldonado (2011) describes and develop the exercise of participatory appraisal in these communities

In total we had the participation of 100 players, organized into 20 groups of five. Of all players the majority were men (72 men and 28 women). The formation of the groups was defined intentionally in the morning activity and it kept for afternoon experimental games. By this, participants will not only recognized for their daily living in the community, but they had as regards behaviour what happened in the morning session in the exercise of participatory valuation. As the fishing activity in the area is carried out by residents of small communities that are known for years, and fishing operations are carried out among family and close friends, forming teams for the games randomly or anonymously not bring greater benefits.

The 65% of the groups were integrated by only men. Table 1 summarizes the distribution of the groups and their type in the study area. This diversity in gender organization allows use extraction decisions in each case and relate with the group configuration. We can to compare the behaviour of groups of only men with extraction levels of women-only groups, and assess if the presence of women in mixed groups changes extraction levels, following the purpose for this research.

Table 1 Distribution and configuration of groups of EEG in La Cienaga.

Groups	Members	Number of groups	%	Total
Male	5 men	13	65	65
Female	5 women	3	15	80
Mixed	1 woman and 4 men	1	5	85
	4 women and 1 man	3	15	100
	Total	**20**		

Source: Based on data from researchers GEMAR - Uniandes

In the game, the resource states were randomly and secretly assigned. So, 50% of the groups was given a pay table indicating scarcity (red table), and the other 50% had a table of payments representing resource abundance (green table). The pay tables are presented in Annex 1, which shows that those playing with green boards received greater benefits at each level of abstraction that the players with red tables. Resource stock was unchanged during the ten rounds of the game and it did not depend on prior extraction. 27 women and 23 men played with the high stock, and 49 men and only one woman played with the low stock.

In each round, the participants had to choose individually and secretly extractions level on a scale of 1-8 units, with 1 as the social optimum and 8 the private optimal level. This choice was consigned in a card game. The researcher collected game cards for each group and he calculated the total extracted by the group. Finally, he announced the result to the players, who consulted on a pay table and write down in his chart the level extraction, the total extracted by the group and their points on the respective round.

The survey data permit a demographic and socioeconomic characterization of participants. It identifies some variables of interest: the average age for the total population that participated in the games was 42 years, and the players reported on average 5.2 years of schooling (it is little more than complete primary education). The 71% were born in the community and the remaining 29% had an average of 21 years living in the community (reporting an average age of 41 years). That is, the people who were not native had on average half of their lives in the localities where they were seated. Fishing was their main economic activity for 53% of those surveyed players and on average they reported a monthly income per household of $ 623,000 COP of 2009. Table 2 reports these variables separately for men and women; it shows that the group of women is younger, better educated and engaged in fishing in lower percentage than the group of men.

Table 2 Sociodemographic characterization. Participants in the EEG in La Cienaga.

	Participants	Average age	Average Schooling	% born in the community	% with fishing as the main activity
Men	72	46	4.8	71%	68%
Women	28	32	6.1	72%	39%
Total	100	42	5.2	71%	53%

Source: Based on data from researchers GEMAR - Uniandes

III. Empirical Model.

We present a brief review of the data, and later we define several econometric specifications. The decision variable is the level of extraction of each player (from 1 to 8 units) in each period of the game (and on average for time), control variable for the entire analysis is resource stock (high or low), and the dimensions of analysis are the individual and the group.

Individual dimension is analysed to identify differences between men and women within groups, on average for all periods or time to time. The **group dimension** (separating only men groups, women-only groups and mixed groups) allows checking for group rate effect on individual extraction. This identification of the control variables, decisions and dimensions are taken into account in the specification of econometric models. Table 3 shows the characteristics of the data.

Table 3 Data analysis for EEG La Cienaga.

Dimension	Category	Resource Stock	
Individual (i)	Men	High	Low
	Women		
Time (t)	1,2,3,4,5,6,7,8,9,10		
	Average		
Group (g)	Only male		
	Only female		
	Mixed (Male): 1 woman y 4 men		
	Mixed (Female): 1 man y 4 women		

Source: Based on data from researchers GEMAR - Uniandes

The data is characterized by individual extraction level in every round for each particular player (for 10 time), and they have discrete nature within the range of 1 to 8. Since we want to identify the influence of the formation of groups on individual extraction levels, we also considered the teams of players like aggregate units of analysis. This lets us define a data panel and choose a model that is appropriate to these characteristics. According to Moreno, et al, (2010) we use a generalized least squares (GLS) with random effects. That model permits differentiates the error for the same player during the 10 periods of play of the error in the observations between players because it assumes that there are no observable heterogeneity. The fixed effects model is not appropriate because each player has invariant effects throughout the game, which can affect their behaviour.

According to the theoretical model, the individual extraction level depends on the stock of the resource, the type of the individual and the group conformation, following that we estimate some models. The dependent variable is the level extracted by each player in each period and explanatory variables associated are resource stock, player gender like feature or type and number of women in mixed groups because the gender heterogeneity present here.

Estimation had three forms starting with a basic model, later an extended model and finally a model considering interactions. The variables included in each case are listed in Table 4.

Table 4 Specifications of econometric exercises.

	Basic Model	Extended Model	Model with interactions
Exercise 1	Gender dummy Stock dummy		
Exercise 2	Gender dummy Stock dummy	Group conformation (mixed groups) Extraction first lag	
Exercise 3	Gender dummy Stock dummy	Group conformation (mixed groups) Extraction first lag	Gender dummy in mixed groups, in high stock and first lag

Source: Authors

A first estimation exercise as basic model is:

$$X_{i,g,t} = \alpha_0 + \alpha_1 F_i + \alpha_2 S_g + \mu_{i,g,t} \qquad (14)$$

Where:

$X_{i,g,t}$ is the extraction of each player i belonging to group g in period (or time) t

F_i is a dummy that takes value 1 if player i is female or 0 if player i is male

S_g is a dummy that takes value 1 if group g is facing high resource stock and 0 if the group g is facing low resource stock.

A second exercise is to relate the above variables with the gender composition groups and the first lag of individual extraction (extended model):

$$X_{i,g,t} = \beta_0 + \beta_1 F_i + \beta_2 S_g + \beta_3 W1_g + \beta_4 W4_g + \beta_5 X_{i,g,t-1} + \mu_{i,g,t} \qquad (15)$$

Now

$W1_g$ is a dummy equal to 1 if the group g consists of four men and a woman, and takes value 0 otherwise.

$W4_g$ is a dummy equal to 1 if the group g consists of four women and a man, and takes value 0 otherwise.

$X_{i,g,t-1}$ is the first lag extraction of each player i belonging to group g

Include the first lag extraction permits recognize the players ability to learn from past elections, and to identify a kind of temporary inertia in the path of extraction.

Significance is expected on the parameters associated with the explanatory variable vector, especially β_1 , β_3 and β_4 that are associated with the sex of the players and their membership in mixed groups.

If β_1 is significant this indicate that the individual extraction level changes when the player is female. This coefficient can be positive or negative, although it could be expected to be positive as found in Andreoni & Vesterlund (2001) and Andersen, Gneezy & List (2008).

If β_3 y β_5 are significant, these indicate that the extraction changes when the group is gender mixed allowing to check an effect of heterogeneity, which has been verified in other games. As presented by Croson & Gneezy (2009) and Boschini, Muren & Persson (2012) this effect should also be negative.

As a final exercise, to identify the behaviour of women into mixed groups and in front of the other explanatory variables, we include in the previous model, some interactions in addition to the variables already defined for Equation (14).

So

$$X_{i,g,t} = \gamma_0 + \gamma_1 \ + \gamma_2 S_g \begin{array}{c} +\gamma_3 W1_g + \gamma_4 W4_g + \gamma_5 X_{i,g,t-1} + \gamma_6 (F_i * W1_g) + \gamma_7 (F_i * W4_g) \\ +\gamma_8 (F_i * S_g) + \gamma_9 (F_i * X_{i,g,t-1}) + \mu_{i,g,t} \end{array} \qquad (16)$$

$F_i * W1_g$ it is the interaction of being a woman and belong to the group of four men

$F_i * W4_g$ it is the interaction between a woman and belong to the group of four women.

$F_i * S_g$ it is the interaction between being female and address the high stock of the resource

$F_i * X_{i,g,t-1}$ it is the interaction between a woman and consider lag extraction in the previous period

In the latter specification, we can calculate the effect of being male or female over each variable, the state of the resource, the gender effect over the formation of the mixed group and the influence to be woman or man of the first lag of the extraction. We will verify their statistical significance using a t test. Table 5 shows how to calculate the differential effects in each case.

Table 5 Calculation of gender interactions.

Variable	Definition	Men	Women
Stock	Effect of being female and address the high stock of the resource	γ_2	$\gamma_2 + \gamma_8$
Mixed group (majority men)	Effect of being a woman and belong to the group of four men	γ_3	$\gamma_3 + \gamma_6$
Mixed group (majority women)	Effect of being a woman and belong to the group of four women	γ_4	$\gamma_4 + \gamma_7$
Extractions' first lag	Effect of lag extraction in the previous period	γ_5	$\gamma_5 + \gamma_9$

For example, the effect of the resource state on men extraction level would be measured by the coefficient γ_2, while for the same effect on women is necessary measure the value of the sum of the coefficients $\gamma_2 + \gamma_8$.

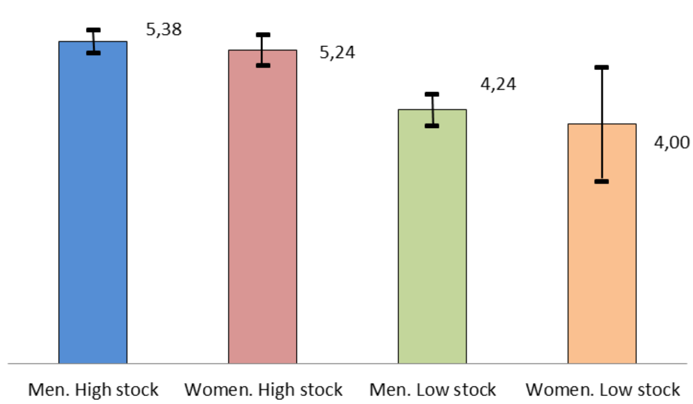
Results

We present some considerations of the data, to identify regularities and trends before econometric estimates:

1. **Descriptive statistics for analysis variables.**

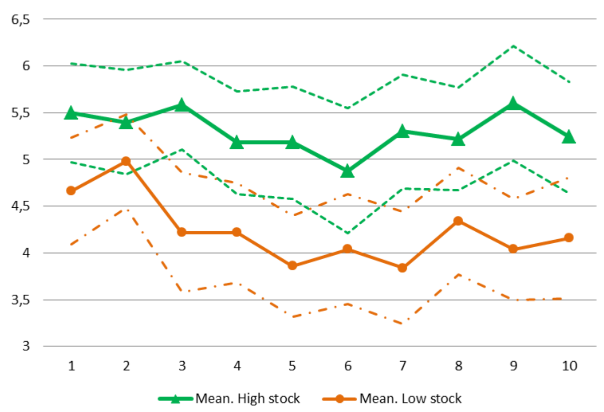
Average of extraction (Figure 1): In both resource level, women extracted on average less than men. The average extraction in general was lower in the low state in the state high. But apparently don't have a significant difference between being a man and a woman in every state of the resource.

Figure 1 Average extraction (Men and women by resource stock).



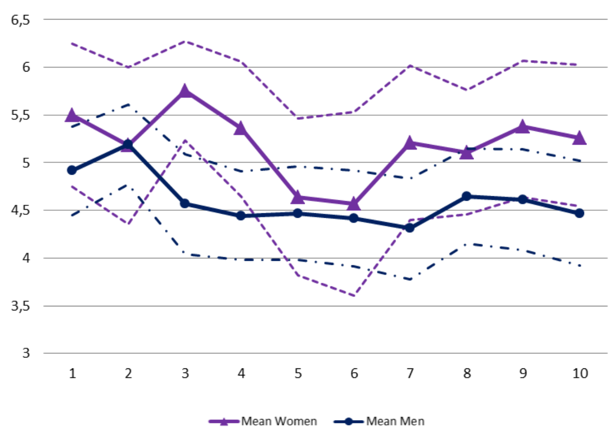
Average extraction per period (Figure 2): In all rounds the average level of extraction was minor in the low stock that in the high stock. This indicates that the level of the resource would be conditioning the extraction throughout the game. There is a change of level in the game between rounds 1 and 2 against 3-10 rounds. This might be due to an initial error in the game comprehension or an adjustment of player's expectations during early periods. For this reason, the econometric estimates used only data for rounds 3 at 10, thus counting on 800 observations.

Figure 2 Extraction average (Ten rounds for resource).



Average extraction by gender and period (Figure 3): Men and women have similar extraction levels, especially at the beginning and at end of the game (period 1, 2 and 7, 8, 9 and 10).

Figure 3 Average extraction men and women. Both states.



Analysis for the high state of the resource. Participants faced to high stock at gender homogenous groups were on average lower extraction in only women groups that only men groups. For gender mixed teams, groups of four women and a man extracted on average fewer units than mixed groups of four men and a woman. In the latter, men extract more than women, and even more than men in mixed groups of female majority. Finally it was found that on average women who played in teams with four men extracted more units than other women in the game.

Tables 6 and 7 have detailed information for each variable. Initially all the variables have 1,000 observations, later they were restricted to 800 observations in order to the econometric exercises. It is evident that the average individual level is far from the social optimum (1 unit) as much as the individual optimal (8 units).

Table 6 Descriptive statistics of numerical variables EEG La Cienaga

Variable	Mean	Standard deviation	Minimum	Maximum
Individual extraction	4.772	2.143	1	8
Grupal extraction	23.76	6.36	9	37
Number of women in group	1.25	1.97	0	5

Table7. Details for categorical variables EEG La Cienaga

Variable	Category	Percentage
Resource Stock	High	50%
	Low	50%
Gender	Female	28%
	Male	72%
Group type	Mixed	20%
	Only men	65%
	Only women	15%
Number of women in group	0 women	65%
	1 woman	10%
	4 women	10%
	5 women	15%

Parametric analysis

Table 8 shows the results of the determinants of individual extraction under the specifications defined in the methodology. It is observed that in all cases the coefficient associated with the gender dummy is not significant. That is, after controlling for the other regressors, no statistical difference between the level of extraction of men and women. This is relates with the evidence in Figure 1 where average extraction for women was very close to those of men.

The coefficient of the dummy resource status is always positive and highly significant; so, have a rich fishery resource level (high stock) increases the extraction by one unit or more. This dynamic is illustrated in Figure 2.

Table 8 Estimation results by gender, group and with lags (Dependent variable: Individual extraction, rounds 3-10).

Independent variables	(1)	(2)	(3)
Gender (Women = 1, Men = 0)	-0.14 (0.278)	-0.73 (0.218)	0.43 (0.457)
Resource stock (High =1, Low = 0)	1.25 (0 .286)***	1.01 (0.239)***	0.94 (0.249)***
Groups with one woman and four men		0.38 (0.202)*	0.22 (0.264)
Groups with one man and four women		-0.38 (0.196)**	-0.65 (0.225)**
First lag of individual extraction		0.26 (0.051)***	0.32 (0.061)***
Interaction: gender and male majority groups			0.53 (0.466)
Interaction: gender and female majority groups			0.39 (0.385)
Interaction: gender and resource stock			0.63 (0.407)
Interaction: gender and lag of extraction			-0.24 (0.103)*
Constant	4.09 (0.183)***	2.97 (0.246)***	2.72 (0.279)***
Number of data	800	800	800
Wald chi2(k)	25.34 ***	82.33***	164.01 ***

There is a relationship between the conformation of groups and individual extraction. The second column of Table 5 reports a significant relationship between the type of extraction and mixed groups: the level of individual extraction increases 0.38 units if the player is part of mixed groups with male majority, regardless of gender; but is reduced by 0.38 units if the player belongs to mixed groups where four women (and is the only man in the group). This effect is more statistical significance for groups of four women and one man, possibly due to the greater number of people organized in this teams.

However, the first lag of individual extraction are significant and positive in explaining contemporary path of extraction, which reveals the existence of inertial behaviour of the players and learning dynamics between rounds.

Table 9 shows the different results for men and women to include interactions of the variables for the entire sample, corresponding to column 3 of Table 8:

Table 9 Differential effects in mixed groups Model with interactions

	Man	Woman
Interaction: gender and resource stock	$\gamma_2 = 0.94$ (***)	$\gamma_2 + \gamma_8 = 1.56$ (***)
Interaction: gender and male majority groups	$\gamma_3 = 0.22$	$\gamma_3 + \gamma_6 = 0.75$(**)
Interaction: gender and female majority groups	$\gamma_4 =$ - 0.65 (**)	$\gamma_4 + \gamma_7 =$ -0.257
Interaction: gender and lag of extraction	$\gamma_5 = 0.32$ (***)	$\gamma_5 + \gamma_9 = 0.09$

Women were more sensitive than men when they respond a state of high stock and therefore significantly increased their extraction. Furthermore, related with the gender conformation groups, woman in the male majority group extracted 0.75 units more. In contrast, man in the group of female-majority extracted on average 0.65 units less for being part of that team. Finally, facing the extraction lag, men were more sensitive than women to increase their level of extraction according to the extraction of the previous period.

Discussion

In this article we analyse the effect of gender user´s and the gender heterogeneity in the users groups in the levels of individual extraction in the common pool resources (CPR). For this we propose an original theoretical model that is an extension to conventional CPR model, and we use experimental data from economic games in fishing communities along the Colombian coast for the hypothesis verification. This approach allowed us to study the decisions into mixed groups and identify the differential behaviour for men and women inside this teams.

Theoretically, we model an individual utility function including conventional components such as the monetary benefits of extraction and the effect of competition in resource use, and in addition an element of heterogeneity of users from two-dimensional shapes: one of them associated with being male or female and other related with group gender composition in which the user is located. In the proposed model the logic of individual decisions that cause overexploitation of the resource is maintained, but the inclusion of gender heterogeneity leads to differential extraction levels between men and women, and if it compared with the results of conventional model without heterogeneity, it produces a lower total extraction. The model set out in this article is a versatile theoretical tool because permitted analyse any observable heterogeneity in the CPR users and not just gender; in other contexts the model may include differences associated with educational level, age, or income level of users and determining their level of extraction from the discussion in this document.

On the other hand, the empirical exercise in this study shows no statistical evidence about the effect of gender differentiation associated with being male or female in the overall levels of extraction. A similar finding is reported by Andreoni & Vesterlund (2001) and in games of provision and collective appropriation of water presented by Cardenas, et al., (2011) where for most of the communities studied is not significant the fact of being a woman.

What we found in this article are differences in behaviour by gender in response to different variables associated with extraction: on average women were more sensitive when they met high fishing stock and they decided to extract some more as a result of this abundance of the resource. In contrast, men had higher inertia in resource use, being positive relationship between contemporary and historical level of extraction. These distinctive gender features are recognized by Croson & Gneezy (2009) who state that the preferences of women are situationally influenced by the conditions of the game, while men manage behavioural patterns that are consistent over time.

Also we test the effect of belonging to mixed groups on decisions extraction of the players, as expected from the hypotheses: Mixed group of four women and a man extracted less resource units, while mixed groups of four men and women use more units than other teams. The lower level of extraction by members of mixed groups of female majority may be expressing concern about the availability of the resource for other users in your community, and in this sense it can be an approximation to a more altruistic behaviour related to exclusion of common pool resources. This result is consistent with evidence from other games by Croson & Gneezy (2009) and Boschini, Muren & Persson (2012)

Another important and novel contribution of this article is the analysis of the behaviour of men and women within mixed groups: In the case of mixed group of male majority, it is the woman who's removed more units. Apparently most dynamic resource extraction by men affect the decisions of the only woman in the team. This can be understood from a kind of effect of group identification where identity is constructed within the group on the basis of majority behaviour, and may again be due to an influence of context on decisions of women enunciated by Croson & Gneezy (2009).

In groups of four women and one man, it is man who extract less units, which could be due to a "strategic cooperation" to assimilate its performance of other women around. In fact, in a context of public goods games Gneezy, Andersen, & List (2008) they showed that men who are part of strong female social structures are more generous than men and women in situations of male structures. Even as mentioned Lowassa, Tadie & Fischer (2012) although women don’t made directly extractive activities, their presence may encourage or discourage behaviour of men in their group or community.

Therefore, it is considered important to promote the participation of women in decision-making scenarios related to common pool resources (such as grassroots organizations and community councils) even at management level; so, men and women can take part in the spaces provided for institution building, enabling them to define and manage conservation strategies around the use of resources.

Differential behaviour between men and women within mixed groups may be due to factors such as the *prosociality*, different perceptions of their peers and the environment, or the quality and quantity of information available. About this, Cardenas, et al. (2011) state that "the relevance of the group context is based on the notion that the decisions of the players are also affected by the recognition that other players are within the transaction. This knowledge can influence the construction of reputation, reciprocity and trust in the game, when players recognize their prior knowledge (the experiment) or preconceptions of the other players to influence their decisions "(p.19, 20)

For the game to La Cienega, fishing is a mostly masculine activity, this would suggest that men have more knowledge about ecosystem, and for the risks of exploitation. Such that the men should care more about the sustainability of the resource extracted less than women. This gender bias in the activity is a limitation of the study. While analysis of the causes of differential behaviour is not the interest of this investigation, this arises as a future question to verify the effect of gender heterogeneity in groups with data from other CPR experiments using different types of natural resources, which the women play a main role as users (mollusc, water or firewood).

Analysis of experimental data from other games with natural resources in addition to fishing and conducting experiments designed to compare the effect of mixed groups in decisions extraction, will allow to overcome the limitations identified so far and have more information to propose policy recommendations on the contribution of men and women in rural communities in the management of common pool resources.

References

Aguiar, F., Brañas-Garza, P., Cobo-Reyes, R., Jimenez, N., Miller, L., 2009. Are women expected to be more generous? *Experimental Economics* 12 (1), 93-98

Andreoni, J., & Vesterlund, L., 2001. Which is the Fair Sex? Gender Differences in Altruism. The Quarterly *Journal of Economics* 116 (1): 293-312

Agarwal, B., 2000. Conceptualizing environmental collective action: Why gender matters. *Cambridge Journal of Economics* 24(3): 283-310

Agarwal, B., 2001. Participatory exclusions, community forestry, and gender: An analysis for South Asia and a conceptual framework. *World Development* 29:1623-1648

Boschini, A., Muren, A., & Persson, M., 2012. Constructing gender differences in the economics lab. *Journal of Economic Behaviour and Organization* 84(3): 741-752.

Cárdenas, J.C., 2009. *Dilemas de lo colectivo. Instituciones, pobreza y cooperación en el manejo de los recursos de uso común*. Bogotá: Universidad de los Andes, Facultad de Economía, CEDE, Ediciones Uniandes. 312 p.

Cárdenas, J.C., Rodríguez, L., Jhonson, N., 2011. Collective action for watershed management: field experiments in Colombia and Kenya. *Environment and Development Economics*. Volumen 16. Special Issue 03: 275-303.

Croson, R. & Gneezy, U., 2009. Gender differences in preferences. *Journal of Economic Literature* 47(2): 448-474.

Eckel, C., & Grossman, P., 2002. Sex differences and statistical stereotyping in attitudes toward financial risk. *Evolution and Human Behavior* 23: 281 – 295

Eckel, C. & Grossman, P., 2008. Men, Women and Risk Aversion: Experimental Evidence. *Handbook of Experimental Economics Results*, Elsevier.

Gneezy, U., Andersen, S., Bulte, E., & List, J. A., 2008. Do women supply more public goods than men? Preliminary experimental evidence from matrilineal and patriarchal societies. *American Economic Review* 98(2): 376-381.

Levitt, S & List, J., 2009. Field experiments in economics: The past, the present and the future. *European Economic Review* 53:1- 18

Lowassa, A., Tadie, D., & Fischer, A., 2012. On the role of women in bush meat hunting - insights from Tanzania and Ethiopia. *Journal of Rural Studies* 28(4): 622-630.

Maldonado, J.H., & Moreno, R., 2009. Does scarcity exacerbate the tragedy of the commons? Evidence from fishers´ experimental responses. *Documentos CEDE* No. 22. Octubre de 2009. Universidad de Los Andes.

Moreno, R. P & Maldonado J.H., 2010. Evaluating the role of co-management in improving governance of marine protected areas: An experimental approach in the Colombian Caribbean. *Ecological Economics* 69: 2557-2567

Moreno, R. P & Maldonado, J.H., 2011. Enfoques alternativos en la valoración de ecosistemas: explorando la participación de los usuarios locales. *Revista Ambiente y Desarrollo*, Volumen XV No. 29, julio – diciembre de 2011:11-42

Mwangi, E., Meinzen-Dick, R., & Sun, Y.,2011. Gender and sustainable forest management in East Africa and Latin America. *Ecology and Society* 16(1):17

Nierdele, M. & Vesterlund, L., 2007. Do Women Shy Away From Competition? Do Men Compete Too Much? *The Quarterly Journal of Economics* vol. 122(3): 1067-1101

Olson, M., 1965. *The logic of collective action: Public goods and the theory of groups*. Cambridge, Mass: Harvard University Press.

Westermann, O., Ashby, J., & Pretty, J., 2005. Gender and social capital: The importance of gender differences for the maturity and effectiveness of natural resource management groups. *World Development* 33(11): 1783-1799