Conditional rewards for sustainable behavior: targeting lessons from an open access fishery

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Abstract

We design and conduct a lab-in-the-field experiment to test the effect of a conditional contract on the sustainability of an open access fishery. The contract provides collective incentives to decrease extraction by conditioning the price on the aggregate catch, but maintains the individual incentives of extraction maximization. We conduct the experiment with two communities of artisanal fishermen differing in their market and technological restrictions. We find that the conditional contract, compared to a fixed price scheme, increases efficiency, the duration of the resource and the total yield. The contract has a greater effect upon groups from the less restricted community.

Keywords: artifactual field experiment, dynamic resource, artisanal fishery, stochastic production function

JEL: C92, Q22, Q57

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1. Introduction

Fish markets are usually described as paradoxical for two reasons. First, there is a high price dispersion for a relatively homogeneous good (Vignes and Etienne, 2011). Second, each additional link in the fish supply chain decreases the quality of the product (Wiefels, 2005). Although both paradoxes are related to the perishability of the good, the latter one is being overcome in developed countries by shortening the supply chain. The best example is the model of Community Supported Fishery (CSF).[2] In a CSF buyers pay, in advance, an annual fee for a share of the producers' periodical yield. This agreement transfers part of the risk from the producers to the consumers and, in exchange, commitments regarding more sustainable production are often pursued (Brown and Miller, 2008; Brinson et al., 2011). Such mechanisms, designed to add value and shorten the fish supply chain, are encouraged as a way to improve the fisheries' conditions in Africa, Asia and Latin America (FAO, 2008).[3]

The broader question we ask in this paper, which we address using a lab-in-the-field experiment, is whether such a mechanism conditionally rewarding sustainable behavior can be implemented in a developing country. The main difference with respect to developed countries is that its implementation needs to consider the large proportion of small-scale fisheries, which are more labor-intensive and have lower entry costs than large-scale fisheries. This mechanism may have three advantages for small-scale fishermen. First, conditional rewards help screening the community's commitment capacity, which is determinant in building long-term relationships.[4] Second, the conditional nature of the mecha-

[2]The CSF is inspired in the successful model of Community Supported Agriculture (CSA). By 2010, there were over 2,500 CSAs in the United States and 13 CSFs in Northeast United States and Canada (Brinson et al., 2011).

[3]Wiefels (2005) points out for the Latin American case: "The challenge is thus not to produce more but to produce better. On a commercial point of view, it is not so much the case of selling more but of selling better. Selling better means here to sell the same quantities of catches for better prices."

[4]Evidence for developing countries show that long-term relationships have economic advan-

nism may transfer the monitoring costs from an outsider (*e.g.*, an environmental authority) to the insiders, for whom monitoring should be less costly. Third, whereas alternative strategies to reward sustainability such as eco-labeling involve high fixed-costs, the conditional reward mechanisms transfer part of the producers' risk to the consumers.

Nonetheless, the implementation of conditional rewards on small-scale fisheries encompasses some difficulties. This paper focuses on the early issue of how to select communities to maximize the cost-efficiency of the conditional incentives. A selection criterion that needs to be understood is the history of successful management of the common resource. The reason is that this criterion is politically salient (*e.g.*, fishermen communities may demand a meritocratic allocation of rewarding schemes), but its expected effect is not clear. The novel conditional rewards may crowd-out the fishermen's ability to solve the collective action problem when material rewards were smaller.

Consider an adaptation of Bénabou and Tirole's framework (2006) where the extraction decision in the social dilemma is the sum of the intrinsic and extrinsic motivations.[5] The intrinsic motivation to preserve the resource is greater in communities keeping a healthier fish stock, and it arises from the interplay between social norms and market and technological constraints. The extrinsic motivation, on the other hand, is connected to the material rewards from resource management. The crowding-out may occur if a situation that originally signaled intrinsic motivation, such as not over-exploiting the resource, becomes a situation signaling individual's desire for money if rewards increase.[6]

tages in bilateral agreements, such as prioritized demand after negative shocks on the supply side (Macchiavello and Morjaria, 2015; Ghani and Reed, 2014).

[5] Bénabou and Tirole's model (2006) includes reputational motivations. We simplify the setting by arguing that in small fishermen communities the intrinsic and reputational motivations are tightly related and hence they can be combined in a single term.

[6] See Frey and Oberholzer-Gee (1997) for an example of environmental crowding-out triggered by a monetary compensation for a nuclear waste repository. See Bowles and Polania-Reyes (2012) for a survey on crowding effects caused by the introduction of economic incentives.

The effect of an increase in the material rewards for sustainability could be very difficult to evaluate with naturally occurring data. There might be self-selection on the type of contractual schemes adopted by a fishermen community. Even if incentives are randomly allocated, the open access nature of the resource makes very hard to have control on environmental variables and to prevent hidden actions from fishermen such as side-selling. Therefore, we consider a lab-in-the-field experiment to be an appropriate initial step to shed light on whether conditional incentives may work or not.

We conduct an experiment with monetary incentives aiming to test a mechanism conditionally rewarding sustainable behavior. More precisely, we offer a contract that conditions the price per unit to the aggregate catch. Half of the participants are randomly assigned to a treatment with this payment scheme, which we call the *conditional contract*. It is inspired in a Cournot game with a downward-sloping demand function that provides collective incentives to decrease extraction. However, as in the standard commons dilemma, individual incentives are aligned with a higher and suboptimal extraction level. The other half of the participants are assigned to a payment scheme with a flat-rate, which we call the *fixed price* treatment.

We hypothesize that fishermen with higher intrinsic motivation will reach similar outcomes with either the *conditional contract* or the *fixed price*. Contrarily, fishermen with higher extrinsic motivation would greatly benefit from the *conditional contract* compared to the *fixed price*.

We test this hypothesis by conducting the experiment with fishermen from two neighboring communities that, despite their proximity, display different levels of intrinsic motivation. Both communities are located in Barú, an island in the Colombian Caribbean. Fishermen in the southern side of the island, which we label the *intrinsically* motivated, are inside a marine protected area (MPA) that imposes tighter technological restrictions for fishing. They also face tighter market constraints because getting to the city takes longer and is more expensive. We label the fishermen in the northern side of the island as the *extrinsically* motivated. This label does not mean that they lack an intrinsic motivation, but rather that the relative weight they put to the extrinsic motivation is larger than for their southern neighbors.

We find that the *conditional contract* outperforms the *fixed price*. The duration of the resource before its collapse increases by 23 percent. Efficiency, defined as the ratio between the actual surplus and the surplus obtained through the social planner's solution, increases by 100 percent with the *conditional contract*. More importantly, the effect of the contract is drastically different between populations. The *conditional contract* increases efficiency by 221 percent in the *extrinsically* motivated community, and only by (a non-significant) 25 percent in the *intrinsically* motivated community.

Although fishermen characteristics differ between locations, the *conditional contract* and the *fixed price* treatments are randomly allocated within each community. Apart from the pricing scheme, every other feature of the game, including the initial stock level, the logistic growth function describing the resource dynamics, and the stochastic production function, are the same for every participant. The latter two characteristics are methodological novelties from our experimental design providing a more familiar context to the fishermen taking part in this "framed field experiment" (Harrison and List, 2004). This novel CPR dynamic game is also tested on a sample of undergraduate students. The results are discussed on a separate paper.

The execution of the experiment is as follows. Groups of four subjects are assigned to a board endowed with 100 homogeneous resource units (fish). The current stock is public information. Every period, the subjects select their level of extraction effort (fishing trips), ranging from 1 to 3. Every extraction effort unit is costless and grants a dice roll with three potential equiprobable outcomes (caught units): 1, 3 and 5. The aggregate catch and the corresponding price are publicly announced. Subjects accumulate earnings in each period according to either the *conditional contract* or the *fixed price*. This procedure is repeated until depletion, closure of the resource (*i.e.*, if the stock level is below 12 units), or if they reach the terminal tenth period of the game.

The Nash equilibrium prediction, assuming self-regarding preferences, will be effort maximization for both pricing schemes. Compared to the social planner's solution, resource duration will be shorter (30% of the maximum), total yield will be lower (66% of the maximum) and efficiency, by construction, will be zero.

By setting the Nash equilibrium as a zero efficiency benchmark we can compare the two communities across pricing schemes. With the *fixed price*, which serves as baseline for this analysis, the efficiency in the *intrinsically* and the *extrinsically* motivated communities is 40 and 17 percent, respectively. This result supports the argument that intrinsic motives provide an advantage in resource management in absence of highly salient material rewards. With the *conditional contract* the efficiency increases to 50 and 53 percent in the *intrinsically* and the *extrinsically* motivated communities, respectively. The larger effect of the conditional reward for the *extrinsically* motivated fishermen closes the efficiency gap between locations.

We further analyze the individual responses to past group behavior to shed light on why the conditional rewards work differently between communities. We find evidence of reciprocal responses in the *extrinsically* motivated community, but only with the *conditional contract*. That is, a decrease in aggregate extraction increases the price paid per unit, triggering a decrease in individual effort in the next period. In the *intrinsically* motivated community we observe the opposite reaction. That is, an increase in aggregate extraction triggers a decrease in individual effort in the next period, regardless of the payment scheme.

The paper proceeds as follows. A description of the relevant experimental literature is presented in Section 2. The fishermen's optimization problem under the two pricing schemes is presented in Section 3. We then describe the study site in Section 4, emphasizing on the observed characteristics that have led us to label the communities as *intrinsically* and *extrinsically* motivated. The full experimental design is explained in Section 5. Results are presented and discussed in Sections 6 and 7, respectively. Our concluding remarks are presented in Section 8.

2. Related literature

Open-access fishing is a classical example of the common-pool resource (CPR hereafter) problem. The non-excludability and rivalry from the resource lead to the pessimistic prediction of the *tragedy of the commons* (Hardin, 1968). Several market and non-market institutions have been studied to better understand how the tragedy can be avoided. Non-market institutions are related to appropriators' attributes that favor local governance (Ostrom, 2002). Market institutions are based on the allocation of property rights and certifications for sustainable production.

The different market institutions offer some advantages and disadvantages in the management of common property resources. Individual property rights are assigned through individual transferable quotas (Copes et al., 1986). Although they decrease competition among fishermen, they do not create the appropriate incentives to minimize unintended catch and to reduce the damage on the ecosystem (Beddington et al., 2007). Collective property rights, on the othe hand, are allocated through the definition of Marine Protected Areas (MPAs) and Territorial Use Rights (TURFS). They are focused on the regulation of fishing gear and catch seasons on specific ecosystems. However, they are considered to displace the problem elsewhere rather than providing a definitive solution (Beddington et al., 2007). Certifications given to "sustainable fisheries," also known as eco-labelling strategies, aim to target consumers willing to pay for an invironmentally friendly product (Potts and Haward, 2007). In this case, the criticism is that eco-labelling requires consumer education programs and extensive market research to be adequately targeted (Wessells et al., 1999).

Conditional schemes, such as the Community Supported Fisheries (CSF), recently emerged as an alternative to reward sustainable production. The platform is attractive to fishermen because it allows them to transfer part of the risk to the consumer in exchange for better fishing practices. Buyers pay in advance for the product that will be delivered in the future, and in case of a negative production shock they will be compensated in future deliveries (Brown and Miller, 2008; Brinson et al., 2011).

The experimental literature on CPR games has focused on the exploration of collective action, the allocation of property rights and permits, and pecuniary and non-pecuniary penalties (Ostrom et al., 1992, 1994; Cárdenas et al., 2000; Walker et al., 2000; Ostrom, 2006; López et al., 2010; Velez et al., 2012). Conditional rewarding schemes remain mostly unexplored in CPR games despite their potential in promoting efficiency-enhancing outcomes.

Some implicit forms of conditional contracts have been experimentally tested for labor market exchanges, both in the lab and the field (Fehr et al., 1998; Shearer, 2004; Gneezy and List, 2006). Besides, one may interpret threshold public good games as implicitly offering a conditional contract. The return of the investment in the common fund is conditioned to specific contribution levels above or below this threshold, which provides a focal point facilitating coordination in the social dilemma (Cadsby and Maynes, 1999; Croson and Marks, 2000).

Recent experimental designs connect the institutional analysis with specific features of the resource. For instance, Cárdenas et al. (2013) propose three games specifically designed to analyze the collective action problem in fisheries, forests and irrigation channels. In the fishery game subjects allocate effort in one of two available locations, knowing that resource's availability depends on the local aggregate effort in the previous period. This deterministic separation between effort and yield also appears in Moreno-Sánchez and Maldonado's (2010) experimental design.

Another strand of artefactual field experiments has focused on the connection between behavior in the game and field data from actual users of natural resources. Existing research studies the relationship between productivity and conditional cooperation (Carpenter and Seki, 2011); fishermen's extractive capacity, cooperativeness and impatience (Fehr and Leibbrandt, 2011); and coxswains' sharing norms in the field and in the lab (Jang and Lynham, 2015). A recent study, involving real fishing in a recreational pond, shows that recreational fishermen are less cooperative in the field that in the lab (Stoop et al., 2012).

The methodological contribution of our design is twofold. First, we introduce a stochastic production function to capture the artisanal fishermen's variance in their yield per effort unit. Previous CPR experiments have found that uncertainty in environmental variables, such as stock size, growth rate and carrying capacity, increase over-harvesting behavior (Budescu et al., 1995; Jager et al., 2002; Kopelman et al., 2002). Introducing a stochastic component in the payoffs function on a public goods game has the same efficiency-decreasing effect (Berger and Hershey, 1994; Bereby-Meyer and Roth, 2006). Ours is, to the best of our knowledge, the first CPR experimental game with uncertainty in the production function.

Second, we use a logistic growth function to emulate the resource dynamics in the open access fishery. Previous experiments have introduced the dynamics of the CPR in several ways. Herr et al. (1997) add time-dependent externalities by increasing extraction costs over time. Chermak and Krause (2002) introduce a CPR game with overlapping generations harvesting the resource at different moments in time. In Fischer et al.'s CPR game (2004), generations do not overlap and subjects made their decision without knowing their actual generation. Janssen et al. (2010) combine spatial and temporal resource dynamics by allowing subjects to move over time within a grid in which renewal rate of the resource is density dependent. In Cárdenas et al.'s forestry game (2013) the resource reproduces at a linear growth rate between decision periods. Our logistic growth function is closer to the traditional bioeconomic models (Gordon, 1954), and it is also very intuitive for the participants.

3. The model

The backbone of our model captures the rivalry and non-excludability of a CPR. It has three key elements: the stochastic production function, the resource's logistic growth function, and the pricing scheme from which CPR users benefit from.

3.1. The decision problem

A set of $n = 4$ symmetric players jointly extracts from an open access fishery. Each player i chooses his level of extraction effort $e_t^i \in \{1, 2, 3\}$ to be allocated in the common resource in the period t. The player's yield, or catch Y_t^i, depends on the realized state of nature $\boldsymbol{\omega} \in \{\omega_1, \omega_2, \omega_3\}$ for each one of the j effort units. It can be written as:

$$Y_t^i = \sum_{j=1}^{e_t^i} \mu_j(\boldsymbol{\omega}),$$

with $\mu_j(\boldsymbol{\omega})$ being a random shock independently and identically distributed such that $\mu_j(\omega_1) = 1$, $\mu_j(\omega_2) = 3$ and $\mu_j(\omega_3) = 5$ and $p(\omega_1) = p(\omega_2) = p(\omega_3) = 1/3$. At the end of each period of time t all the fish is sold at price $P_t(Y_t)$. The price depends on the period's aggregate extraction $Y_t = \sum_{i=1}^{n} Y_t^i$. We define player i's payoff in period t as $\pi_t^i = P_t Y_t^i$, and the accumulate payoff over time as $\Pi^i = \sum_{t=1}^{10} \pi_t^i$.

We assume that extraction effort is costless to minimize the confounding effects between other-regarding preferences and risk preferences.[7] This costless effort, apart from simplifying the decision setting, leads to a "two-layer" social dilemma. The first layer arises from the dynamic nature of the resource. Subjects maximize their current yield given the difficulty to secure future property rights. But by doing so they decrease the value of the future stock. The second layer appears with the introduction of the conditional contract. By construction, it creates a tension between individual and collective incentives due to the downward sloping demand function. It will be explained in detail in Section 3.3.

The resource's dynamics are given by $X_{t+1} - X_t = F(X_t) - Y_t$. To define the growth function $F(X_t)$ we adopt the logistic functional form proposed in Gordon-Schaeffer's bioeconomic model (Gordon, 1954):

$$F(X_t) = rX_t - \frac{rX_t^2}{K},$$

[7] With costly extraction effort a risk averse subject could have chosen a lower extraction to minimize the variance of its income across states of nature. Yet, it could have been confounded with prosocial behavior.

where the intrinsic growth rate is set at $r = 1/3$ and the carrying capacity is fixed at $K = 100$. Besides, the initial stock level X_0 is set equal to the carrying capacity.

Each group is subject to three termination rules which are common knowledge: *(a)* players reach the terminal period of the game $T = 10$; *(b)* the stock level X_t goes below a threshold point $\tilde{C} \equiv 12$, leading to the resource's closure; and *(c)* the total catch is at least as high as the current stock level ($Y_t \geq X_t$), leading to the resource's depletion. Subjects do not receive any additional payoff for the remaining stock when rules *(a)* or *(b)* apply. If rule *(c)* applies, and $Y_t > X_t$, the available units are divided proportionally to the intended individual catch.

3.2. Predictions with the fixed price

In this scenario the price is not conditioned to the aggregate catch. That is, $P_t(Y_t) = P_t \, \forall \, t$. We can write the optimization problem as:

$$\begin{aligned} \underset{e_t^i \in \{1,2,3\}}{\text{Max}} \quad & \sum_{t=1}^{10} I_{X_t > \tilde{C}} \left(P_t \times \sum_{j=1}^{e} \mu_j(\boldsymbol{\omega}) \right) \\ \text{subject to} \quad & X_{t+1} = \left(rX_t - \frac{rX_t^2}{K} \right) + X_t - \sum_{i=1}^{4} \sum_{j=1}^{e} \mu_j(\boldsymbol{\omega}) \end{aligned}$$

where $I_{X_t > \tilde{C}}$ is an indicator function whose value switches from 1 to 0 after the threshold $\tilde{C}$ is surpassed.

It is straightforward to check that the solution to the optimization problem with risk-neutral individualistic preferences is $e_t^i = 3 \, \forall t$. The reason is that effort is costless and $\mu_j(\boldsymbol{\omega})$ is strictly positive irrespective of the state of nature $\boldsymbol{\omega}$. This is the subgame perfect Nash equilibrium of the game. If all the group members follow this strategy the expected aggregate yield per period will be $E(Y_t) = 36$, the resource will last three periods before crossing the threshold $\tilde{C}$, and the total extraction $\boldsymbol{Y} = \sum_t Y_t$ will be 108 units.

The social planner's solution is different because it incorporates the trade-off between the immediate benefits of extraction and the future value of the stock. Whereas a single subject only internalizes as a cost its contribution to the resource's depletion $-Y_t^i$, the social planner internalizes as a cost the total aggregate catch $-\sum Y_t^i$. In the socially efficient solution total extraction is maximized by extending the resource's duration to the 10th and last period of the game, reaching a total expected extraction of $E(\boldsymbol{Y}) = 162$ units. This is 150% the total predicted extraction under the Nash equilibrium.

The social planner's solution can be reached through several paths. This is due to the discreteness of the strategy set: the feasible aggregate effort level ranges from 4 units (when $e_t^i = 1 \, \forall \, i$), to 12 units (when $e_t^i = 3 \, \forall \, i$). Nonetheless, the pattern of every efficiency-maximizing path is similar: a medium-to-high extraction effort early in the game (periods 1-2), a low extraction effort in intermediate periods, and a medium-to-high extraction at the end of the game (periods 9-10).

The intuition for this extraction path is the following: the social planner will move towards the stock level maximizing the growth rate ($K/2$). Once the targeted stock is reached, the social planner will minimize the exerted effort to make the difference between harvest and growth rate as small as possible. This would have been the steady state solution in an infinite horizon game. With a finite horizon, as in our case, the incentives to deplete the resource before the end of the game shift upwards the effort levels in the final periods.

3.3. Predictions with the conditional contract

Let us consider the scenario in which the price is a non-increasing function of the group's aggregate catch, or $P_t(Y_t)$ with $dP_t/dY_t \leq 0$. This *conditional contract* rewards a decrease in extraction effort in two ways. Like in the *fixed price* treatment, the future stock value increases when aggregate extraction decreases. But unlike the *fixed price* treatment, it also grants an immediate reward through an additional compensation in the price per unit. This immediate reward is what we defined earlier as the second layer of the social dilemma. There is a tension between the collective incentive to marginally contribute to an increase in the price paid per unit, and the individual incentive to maximize the catch and free-ride on the others' contribution to raise the price.

The downward sloping demand from our setting is shown in Table 1. The function $P_t(Y_t)$ was calibrated to warrant that (risk neutral) subjects cannot benefit from decreasing the extraction effort e_t^i to raise P_t by themselves. It can be easily checked that an increase in the price requires at least two subjects willing to decrease their effort. Hence, the Nash equilibrium $e_t^i = 3\,\forall t$ remains unaltered with the conditional contract.

Table 1: Price offered as a function of the aggregate catch in the *CONTRACT* treatment

Quantity	4-12	13-20	21-28	29-40	41-60
Price/unit	5	4	3	2	1

The social planner's solution with the *conditional contract* also reaches the 10th terminal period. The income maximization gives \$672 and an expected aggregate yield of 159 units. If, on the other hand, total yield is maximized then total income is \$666 and the expected aggregate yield is 162 units. In both cases the social planner's extraction path follows the same pattern than in the *fixed price* treatment: medium-to-high extraction in early periods, low extraction in intermediate periods, and medium-to-high extraction at the end of the game.

We take yield maximization as the reference point for the efficiency analysis. The reason is that the maximum aggregate yield is the same across treatments. We also set $P_t = \$2\,\forall\, t$ under the *fixed price* treatment. In this way, the total income under the Nash equilibrium is \$216 in both treatments. This is very useful for interpretation purposes: any additional earnings from the conditional reward are the result (in expectation) of deviations from selfish behavior. The social planner's income will be of \$324 and \$666 with the *fixed price* and the *conditional contract*, respectively.

4. Study setting

4.1. The community's degree of resource dependence

We conduct the experiments in three municipality subdivisions or *corregimientos* located in the Barú Island:[8] Barú, Ararca and Santana. All three *corregimientos* are administratively dependent on the city of Cartagena. Barú is located in the southern side of the island, farther from the city than Ararca and Santana (see Figure 1). The latter two *corregimientos*, located in the northern side of the island, are halfway by land between Barú and Cartagena.

We label the fishermen in the southern and the northern side of the island as *intrinsically* and *extrinsically* motivated, respectively. For abreviation purposes we refer to the respective subsamples as the *INTRINSIC* and *EXTRINSIC*. Fishermen in the *INTRINSIC* subsample are inside a Marine Protected Area (MPA). As a consequence, they face a tighter technological constraint in the employed fishing gear. They also have poorer access to labor and credit markets compared to fishermen in the *EXTRINSIC* subsample. The greater distance to the city translates into transportation costs that are three times larger for the fishermen in the south compared to those in the north side of the island.[9] Besides, fishermen in the northern side have access to another *corregimiento* that serves for them as an additional market.

The differences in market access and fishing gear are shown on panel (a) in Table 2. The fraction of fishermen selling their catch to the monopsonistic buyers is 72% in the *INTRINSIC* subsample and 56% in the *EXTRINSIC* subsample. Fishermen report in the post-experimental survey that these buyers also act as their source of informal insurance.[10]

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[8] The Barú island has an extension of 60 km^2. It was originally known as the Barú Peninsula until the XVII century, when it was separated it from the continental mass to build a canal connecting Cartagena with the country's most important river.

[9] Land transportation is highly constrained from the south side of the island in vehicles different from motorbikes. Therefore, the best option available for fishermen in this community is speed-boat transportation.

[10] Ice and gas are borrowed by fishermen at the beginning of the journey and they repay

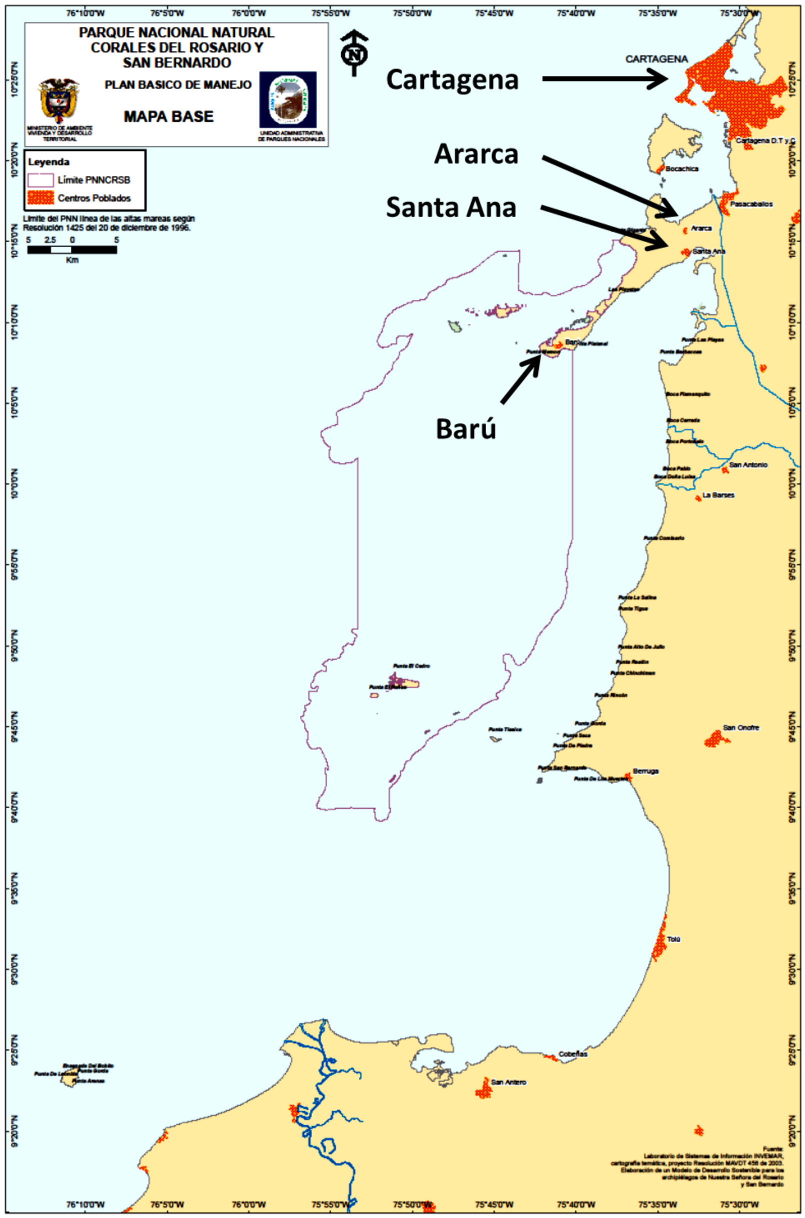

Figure 1: Map of the National Natural Park "Corales del Rosario y San Bernardo," the Marine Protected Area defining our site location. Source: "Plan Básico de Manejo Ambiental (Parques Nacionales)". The purple line defines the limits of the park. Red areas highlight densely populated areas.

Table 2: Mean tests by subsample's location. The number of subjects from inside and outside the MPA is 32 and 48, respectively. For categorical variables we report the p-value for the Chi-squared test (instead of the *t*-test). The abbreviation [COP] refers to Colombian pesos.

	EXTRINSIC	INTRINSIC		
	Mean	Mean	Difference	*p*-value
(a) Fishing inputs and market access				
Sells to fish gatherer	0.563	0.719	-0.156	0.161
Boat ownership	0.646	0.563	0.083	0.460
Handlining	0.729	0.594	0.135	0.210
Harpoon	0.021	0.438	-0.417***	0.000
Cast net	0.146	0.250	-0.104	0.248
Fish traps	0.000	0.125	-0.125*	0.012
Gill net / Trammel	0.458	0.125	0.333***	0.001
Drag net / *Boliche*	0.229	0.000	0.229***	0.003
(b) Socioeconomic characteristics				
Age	48.4	37.7	10.7***	0.001
Education [years]	2.31	5.13	-2.81***	0.000
Other economic activities	0.479	0.656	-0.177	0.122
Weekly earnings [1,000 $\times$ COP]	164.362	139.375	24.987	0.397
Perceived relative wealth [1-10]	2.83	4.125	-1.292***	0.008
No. adults in household	3.69	3.28	0.41	0.275
No. children in household	1.65	1.88	-0.23	0.472
Perceived luck when fishing [1-10]	6.67	6.26	0.403	0.442
Gambling in dominoes$^+$	0.500	0.514	-0.014	0.883

$^+$60% of the subjects play dominoes. 80% of them bet on the outcome of the game.

*** p<0.01, ** p<0.05, * p<0.1

Panel (a) also reports differences between subsamples in the employed fishing gear. For the *INTRINSIC* subsample the use of harpoon and fish traps is widely extended (44 and 13 percent, respectively) compared to the *EXTRINSIC* subsample (2 and 0 percent, respectively). Handlining, another technique with low extractive capacity, is widely used in the *INTRINSIC* and *EXTRINSIC*

with a share of their catch. Part of the debt is accumulated if the catch is not sufficient to repay.

subsamples, 59 and 73 percent, with no significant differences between locations. Technologies with high extractive capacity are widespread in the *EXTRINSIC* subsample. Gill nest, or trammels, are employed by 46 percent of fishermen compared to 13 percent in the *INTRINSIC* subsample. The drag net known as *boliche*, a more harmful and forbidden technology, is reported by 23 percent of fishermen in the *EXTRINSIC* subsample, and by none of the fishermen in the *INTRINSIC* subsample.

We do not observe statistical differences between subsamples in the reported boat ownership. Nonetheless, the tenancy structure depends on the employed technology. For technologies with low extractive capacity, frequent in the *INTRINSIC* subsample, most fishermen work alone or at most with two other fellows. Their incentives for group formation is to pool risk by dividing the earnings among the crew. Boats not owned by any of the crew members are usually property of the local monopsonistic buyer, to whom the fishermen need to commit their catch. For technologies with high extractive capacity, frequent in the *EXTRINSIC* subsample, the fishermen make larger groups due to the physical requirements for dragging the nets. These fishermen usually report co-ownership of the boats and the fishing gear.

4.2. Participants' socioeconomic characteristics

The comparison of socioeconomic characteristics between the *INTRINSIC* and the *EXTRINSIC* subsample shows that the former are younger and about two years more educated (see panel (b) on Table 2). Moreno-Sánchez and Maldonado (2010) report similar differences between communities located inside and outside the same MPA.[11] In addition, they report that fishermen inside the MPA are more aware of the environmental regulations and meet more often with local environmental authorities.

Self-reported weekly earnings, on the other hand, do not differ across com-

[11] From the eight *corregimientos* that participated in Moreno-Sánchez and Maldonado's study, only Santana overlaps with our sample.

munities. However, when the fishermen are asked about their relative wealth with respect to their community, those in the *INTRINSIC* subsample consider themselves wealthier. We also report two indirect measures of the fishermen's risk preferences: a self-assessment of their luck in the fishing activity and their gambling behavior. We do not find statistical differences between subsamples for any of these variables.

5. Experimental design

We propose a 2×2 factorial design with between-subjects variation. We randomly assign groups to a payment scheme {*FIXED*, *CONTRACT*}. We implement the experiment on two communities differing in their most salient source of motivation, captured in the subsamples' labels {*INTRINSIC*, *EXTRINSIC*}. In the *CONTRACT* treatment the price is a function of aggregate extraction, $P_t(Y_t)$, as described in Table 1. In the FIXED treatment we set $P_t = \$2 \, \forall \, Y_t, t$. This is the predicted price in the *CONTRACT* treatment if subjects play the Nash equilibrium.

The fishermen communities are labeled as the *INTRINSIC* and *EXTRINSIC* subsamples. The labels are based on the relative weight that fishermen in each location give to non-monetary motivation to preserve the resource. We argue that the fishermen located inside the MPA are more *intrinsically* motivated. This is the result of tighter technological and economic constraints, but also of a closer relationship with authorities raising environmental awareness.

Eighty artisanal fishermen participated in the treatments reported in this work. Another forty fishermen participated in a treatment variation in which the relationship between extraction effort and yield is deterministic. Results from this experimental variation, conducted only in the *INTRINSIC* subsample, are reported in Mantilla and Miquel-Florensa (2016).

In the *INTRINSIC* subsample the participants were recruited by a local member of the research team. He is a part time fisherman and the head of a fishermen association,[12] with previous experience in an unrelated academic project involving the collection of socio-economic data. We agreed on a target of 60 to 75 subjects to be recruited, about half of the fishermen in the community. A total of 72 fishermen from this community attended our call. The fishermen were invited to the activity two weeks in advance. For each specific session we invited a roughly equal number of participants from each fishermen association. The associations are geographically distant to each other within the community, but in general fishermen know each other.

In the *EXTRINSIC* subsample we contacted the head of each fishermen association three weeks in advance. They extended the invitation to the members of their respective association. We had a meeting a week before the experiments to concert some details of the sampling procedure (*e.g.*, avoid members of the same household). In one of the *corregimientos* the show up rate to the activity was 35% higher than our maximum capacity, so we were able to randomly select the participants *in situ*. The local member of our research team directly invited about twenty five percent of the participants in this location, who were independent fishermen from this community.

The activity was carried out in the communal meeting hall of each *corregimiento*. To minimize selection issues, the experiments were conducted in afternoon hours because the fishermen's journey goes from 5:00 to 13:00. Table 3 reports the number of participant per treatment cell.

We ran a total of 8 sessions with 4, 8 and 12 subjects. We knew beforehand the session size for the 3 sessions with less than 12 participants. We read aloud the game instructions to the whole group after the subjects' arrival. Instructions were not provided in written form due to moderate literacy rates. Participants signed the consent form once the procedure was clear. Groups of four subjects

[12] Fishermen associations serve as another source of informal insurance and also facilitate the collective ownership of assets such as boats and storage equipment (Villamil et al., 2015). There are four associations in the Barú *corregimiento* and three associations in Ararca and Santana.

Table 3: Experimental Design. Each cell contains in italics the treatment name, a combination of the two factors, and the total number of participants in that specific cell.

	FIXED	**CONTRACT**
INTRINSIC	*FIX-INT* (N=16)	*CNTR-EXT* (N=16)
EXTRINSIC	*FIX-EXT* (N=24)	*CNTR-EXT* (N=24)

were formed using a quasi-random procedure. Quasi-randomness allowed us to balance participants from different fishermen associations and to allocate family members (*e.g.*, siblings from different households) to different groups.

All the groups on a given session were assigned to the same treatment. Groups were spatially isolated from each other to avoid contamination during the disclosure of group-specific information. Subjects could identify their fellow group members, but any form of communication was forbidden throughout the whole activity. Identification of group members also implies that different session size is not a concern. Regarding any potential reputational effect associated to group members' identities, we argue that it should be the same across treatments.

The timing in every period of the game is as follows: *(i)* Subjects decide the extraction effort units [fishing trips]. *(ii)* Subjects receive a numbered dice per each effort unit. They also receive the number of null dices required to have a total of three cubes per roll.[13] The sides of each numbered dice were 1, 1, 3, 3, 5 and 5. The sum of the dice outcomes indicates the participant's yield. *(iii)* The monitor privately records each participant's yield. Afterwards, he publicly announces the aggregate effort, the aggregate yield, and computes the stock level for the next period. Due to the dynamic nature of the game, a board indicating the current stock level and its corresponding growth rate was publicly available for each group of four participants. *(iv)* The price is computed

[13]By forcing participants to roll the same number of dices we guarantee that the privacy of the decision is not altered by the noise during the rolling procedure.

according to the pricing scheme. In the *CONTRACT* treatment there was also a smaller board with the conditional prices listed in Table 1.

This process was repeated until one of the three termination rules applies. All of them were common knowledge since the beginning of the game. The termination rules were the following: *(a)* subjects reached the 10th period of play, *(b)* the stock level, after the reproduction, was below 12 units, or *(c)* the total catch was at least as high as the available stock level. When rule *(c)* applied and the total catch was larger than the available stock, the remaining units were divided proportionally to the intended individual catch. In the *CONTRACT* treatment the available units were paid at the price dictated by the intended aggregate catch.

A post-experimental survey was applied with the experiment. All the participants were paid at the end of the activity. On average they earned $29,500 Colombian pesos [COP]. This amount was about $15.7 US dollars at the time of the experiment and corresponds to 1.4 times the daily minimum wage.[14] The whole activity lasted between 80 and 100 minutes per session.

As part of the post-experimental survey we elicit participants' risk preferences using an incentivized choice experiment inspired in Binswanger (1980) and previously implemented by Eckel and Grossman (2008), Barr and Genicot (2008) and Cárdenas and Carpenter (2013). The experimental task consists on choosing to play one of five lotteries that simultaneously increase in expected value and payoffs' variance (see Table C.1).

Subjects are strongly balanced across pricing schemes (see Table C.2). Despite the randomization process, the adoption of handlining as fishing technology is higher for subjects assigned to the CONTRACT treatment. This is a minor concern since there are no systematic differences in the adoption of other fishing technologies, and 52% of subjects using handlining reported the use of at least one additional technology. We also observe a difference across treatments in the

[14]By August 2104, 1 USD = 1,880 COP. Colombia's daily minimum wage in 2014 was 20,533 COP.

number of adults per household, but not in the total household members.

6. Results

6.1. Analysis of group level outcomes

Table 4 reports the differences in efficiency, resource's duration and aggregate catch between the *CONTRACT* and the *FIXED* treatments. The unit of observation is the group of four fishermen. The results of a Wilcoxon test are reported in the last column of the table. Each comparison is reported for the pooled sample, as well as for the *INTRINSIC* and *EXTRINSIC* subsamples separately. We find that, for all three outcomes, the significant effect of the *CONTRACT* in the pooled sample is driven by the *EXTRINSIC* subsample.

We define efficiency as the ratio between the realized and the maximum group earnings, as shown in equation (1). Efficiency is equal to zero for the Nash equilibrium prediction, and it is equal to one for the social planner's solution.

In the *EXTRINSIC* subsample, the average efficiency increases from 0.166 in the *FIXED* to 0.533 in the *CONTRACT* treatment (p-value 0.0103). In the *INTRINSIC* subsample, the average efficiency is 0.398 in the *FIXED*, and it increases to 0.496 in the *CONTRACT* treatment. The latter difference is not statistically significant (p-value 1.000).[15]

$$\textit{Efficiency} = \frac{Group\, Earnings - Nash\, Eq.\, Earnings}{Max.\, Group\, Earnings - Nash\, Eq.\, Earnings} \tag{1}$$

[15]This result is robust to an alternative measure of efficiency: the ratio between the realized and the maximum group earnings, *as if* everyone would have been paid with the *conditional contract*. We compute these hypothetical earnings for subjects in the FIXED treatment, and compare them with the actual earnings of the subjects in the CONTRACT treatment. The intuition is that if the efficiency gap between payment schemes is small, then the conditional rewards are not very salient and subjects are motivated to decrease their extraction effort by "something else". Under this alternative definition, the *CONTRACT* increases efficiency by 35.8 percent in the *EXTRINSIC* subsample (p-value 0.0319), whereas in the *INTRINSIC* subsample the *CONTRACT* increases the efficiency by 0.6 percent. However, this increase is not significant (see Table C.3 in the Appendix).

Table 4: Comparisons between payment schemes: efficiency, resource's duration and total catch. Unit of observation is group. The p-value for the non-parametric Wilcoxon test is reported in brackets.

	CONTRACT	FIXED PRICE	Difference
Efficiency			
Pooled (N=20)	0.518	0.259	0.259**
	(0.172)	(0.213)	[0.0155]
Extrinsic (N=12)	0.533	0.166	0.366**
	(0.229)	(0.106)	[0.0103]
Intrinsic (N=8)	0.496	0.398	0.098
	(0.018)	(0.274)	[1.000]
Duration [rounds]			
Pooled	6.80	5.50	1.30*
	(1.87)	(1.51)	[0.0969]
Extrinsic	6.83	4.83	2.00*
	(2.48)	(0.75)	[0.0855]
Intrinsic	6.75	6.50	0.25
	(0.50)	(1.91)	[0.8809]
Total Yield			
Pooled	135.2	122.0	13.2**
	(8.76)	(11.50)	[0.0125]
Extrinsic	138.2	117.0	21.2***
	(10.23)	(5.73)	[0.0064]
Intrinsic	130.75	129.5	1.25
	(3.50)	(14.79)	[1.000]

Standard deviation in parenthesis. p-values in brackets.

*** p<0.01, ** p<0.05, * p<0.1

We find similar differences in terms of the resource duration. In the FIXED treatment the mean duration of the resource is 5.50 periods compared to 6.80 periods in the CONTRACT treatment (p-value 0.097). This effect is driven by the *EXTRINSIC* subsample, where the introduction of the *conditional contract* increases the resource's average duration from 4.8 to 6.8 rounds (p-value 0.086). In the *INTRINSIC* subsample, on the other hand, resource duration increases from 6.50 to 6.75 with the *conditional contract* (p-value 0.881).

The structure imposed on the resource dynamics allows us to explore in depth the differences of resource duration. We employ survival analysis to exploit the time variation of the final round for each group. The effect of the *conditional contract*, as well as the differences between the two fishermen communities, are robust to the use of non-parametric and parametric survival analysis models (see Appendix A).[16]

For the aggregate catch we also find an effect of the pricing scheme. In the *EXTRINSIC* subsample the group's total yield increases 18.1% in the *CONTRACT* treatment (p-value 0.006). In the *INTRINSIC* subsample, on the other hand, the 0.9% increase in the group's total yield associated to the *CONTRACT* treatment is non-significant (p-value 1.000).

6.2. Analysis of individual extraction effort

Participants in our experiment choose, every round, whether to exert 1, 2 or 3 units of extraction effort. The mean and median effort per period are 1.72 and 2 units, respectively. We limit our analysis to the first four periods to not overweight groups whose resource lasted longer. Within this range, where all groups are observed, the mean effort increases to 1.82. We find that the *CONTRACT* decreases the effort per round 0.21 units compared to the *FIXED* treatment. Besides, in the *INTRINSIC* subsample the effort per round is 0.20 units lower than in the *EXTRINSIC* subsample.

We further analyze the differences in the dynamics of the chosen effort levels. After the first round of play, in the *FIXED* treatment we observe a substitution from the intermediate ($e = 2$) to the high ($e = 3$) extraction effort level. Contrarily, in the *CONTRACT* treatment the substitution goes from the intermediate ($e = 2$) to the low ($e = 1$) extraction effort level. A full description of the chosen effort levels over time is presented in the Appendix B, where we use a simplex to illustrate the different trajectories between payment schemes and

[16] In the parametric model the logistic growth function is explicitly considered by assuming a non-monotonic hazard rate.

between subsamples.

Being aware of these divergent trajectories, we ask whether social norms linked to the history of the resource's extraction can explain part of the heterogeneity in the *conditional contract*'s effectiveness. Think, for instance, that people care about their extraction level with respect to others, and respond reciprocally to any deviation. On a positive reciprocity path, when people chooses a low extraction effort because the others also do so, the conditional rewards may increase the salience of the material benefits by providing an immediate reward (*i.e.*, a higher price). It may lead to a positive relationship between the *conditional contract* and the *extrinsic* motivation.

A different social norm could be that people care about their extraction level with respect to the state of the resource. In other words, a subject may be willing to decrease their extraction, even if others' extraction effort is high, to prevent the resource's depletion. This scenario is more likely to occur in presence of a strong *intrinsic* motivation.

We aim to detect behaviors that fit any of these norms by analyzing how the subjects' extraction effort in period t responds to the group behavior in period $t-1$. We will find support to the reciprocity norm if the individual effort moves in the same direction than the lagged aggregate effort. A reaction in the opposite direction will be indicative of preferences to avoid the resource's collapse.

We use a random-effects ordered logistic model with the exerted effort as dependent variable. The multiple observations per subject are very likely to be correlated due to the dynamic nature of the stock and the repeated interactions within the group. We therefore limit our analysis to the first four periods of the game, we control for the current stock level using a quadratic polynomial, and we cluster the standard errors at the group level.

We compute separate regressions for the *EXTRINSIC* and *INTRINSIC* subsamples. The reason is that we expect to detect different norms according to the relative intensity of intrinsic and extrinsic motivations. We consider four different specifications of past aggregate behavior: the lagged aggregate yield from the group ($\sum Y_{t-1}$) and from the other group members ($\sum_{-i} Y_{t-1}$), as well as the lagged aggregate effort from the group ($\sum e_{t-1}$) and the other group members ($\sum_{-i} e_{t-1}$). We also include an interaction term between the past aggregate behavior and the *CONTRACT* treatment. This interaction aims to capture any potential association between a given social norm and a pricing scheme.

Table 5 reports the regression coefficients. As the purpose of this exercise is to detect differential responses to the lagged aggregate behavior we will not interpret the estimated magnitudes.[17] We find evidence for the willingness to avoid the resource collapse in the *INTRINSIC* subsample. The coefficient for the lagged aggregate behavior is negative and statistically significant in all the four specifications (see columns 1-4). On the other hand, we find evidence of the reciprocity norm in the *EXTRINSIC* subsample, but only for the *CONTRACT* treatment. The corresponding interaction term is positive in all four specifications, and statistically significant in three of them (see columns 5-8).

6.3. *The correlation of extraction effort and individual characteristics*

We take the econometric model from subsection 6.2 and add a set of individual characteristics as covariates. The purpose of this exercise is to check whether risk preferences influence the extraction decision; and also to look for correlations between extraction effort and characteristics associated to the labels of *intrinsic* and *extrinsic* motivation.

The econometric specification includes the subject's choice in the incentivized risk elicitation task, an ordinal measure of the degree of risk aversion. We do not find a statistically significant correlation between extraction effort and risk preferences in any of the fishermen communities (see Table C.4 in the Appendix). We argue that is not likely to be an issue of measurement error given

[17] The exponentiated regression coefficient $exp(\beta_k)$ can be interpreted as the multiplicative effect that an additional unit in x_k has on the probability of increasing the extraction effort from $e = \{1\}$ to $e = \{2, 3\}$ or from $e = \{1, 2\}$ to $e = \{3\}$.

Table 5: Random-effects ordered logistic model explaining exerted effort. Standard errors are clustered at the group level. The estimations are based on the first four periods, the latest point in time in which subjects from all the groups are still allowed to make an effort decision. Columns (1)-(4) correspond to the *INTRINSIC* subsample and columns (5)-(8) to the *EXTRINSIC* subsample.

Dependent variable:	INTRINSIC				EXTRINSIC			
Exerted effort e_t^i	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
CONTRACT	-0.933**	-0.669	-1.245*	-1.912*	-5.842***	-7.651***	-3.077	-5.443**
	(0.448)	(1.281)	(0.743)	(1.080)	(2.121)	(2.613)	(2.173)	(2.146)
$\sum Y_{t-1}$	-0.142**				-0.0165			
	(0.0719)				(0.0713)			
CONTRACT $\times \sum Y_{t-1}$	0.0371				0.197**			
	(0.0427)				(0.0904)			
$\sum e_{t-1}$		-0.502***				-0.218		
		(0.193)				(0.217)		
CONTRACT $\times \sum e_{t-1}$		0.0825				0.843***		
		(0.192)				(0.298)		
$\sum_{-i} Y_{t-1}$			-0.130***				0.0492	
			(0.0487)				(0.0865)	
CONTRACT $\times \sum_{-i} Y_{t-1}$			0.0723				0.0948	
			(0.0587)				(0.116)	
$\sum_{-i} e_{t-1}$				-0.439***				-0.125
				(0.152)				(0.250)
CONTRACT $\times \sum_{-i} e_{t-1}$				0.352*				0.720**
				(0.186)				(0.330)
α_1	-7.712	-11.49**	-8.676*	-10.44*	-2.598	-4.681*	-0.771	-3.140
	(5.483)	(5.608)	(4.563)	(5.662)	(2.773)	(2.713)	(3.081)	(2.851)
α_2	-5.379	-9.267*	-6.528	-8.362	-0.156	-2.179	1.787	-0.579
	(5.510)	(5.534)	(4.570)	(5.704)	(2.680)	(2.517)	(3.043)	(2.689)
σ_u^2	1.798*	1.472**	0.967**	0.854**	1.707	1.727	2.600	2.462
	(0.983)	(0.572)	(0.473)	(0.378)	(1.591)	(1.460)	(1.938)	(1.823)
Observations	96	96	96	96	144	144	144	144
Number of ID	32	32	32	32	48	48	48	48

Additional controls: current stock level S_t in linear and quadratic form. Clustered standard errors in parenthesis.

Clustered standard errors in parenthesis. *** p<0.01, ** p<0.05, * p<0.1

the simplicity of the risk elicitation protocol (Eckel and Grossman, 2008). And also because the correlation between the measure of risk aversion and the subjects' reported gambling behavior is highly significant (Spearman's $\rho = 0.194$, p-value 0.034).

The econometric specification also includes three variables associated to the fishermen's market and technological constraints: whether or not they sell their catch to a local buyer, the boat ownership status and the reported fishing gear.

In the *INTRINSIC* subsample, selling to a local buyer is negatively correlated with extraction effort. We speculate that the effect of the local buyers' provision of informal insurance dominates the effect of the buyers' greater bargaining power, fostering a more efficient outcome. We also find that boat ownership is positively correlated with extraction effort. We speculate that this is a reflection of the appropriation norms associated to ownership (*i.e.*, boat owners get a larger proportion of the shared earnings), and that ownership of physical assets reveals a tendency to secure a larger share of the common resources.

For the *EXTRINSIC* subsample we find that the use of the highly extractive gill nets is positively correlated with extraction effort. We do not find any effect for the use of the less extractive cast nets. The excluded category gathers the low extractive techniques handlining and harpoon fishing, plus the harmful but seldom reported drag nets.[18]

7. Discussion

7.1. Heterogeneous effects of the conditional contract between populations

As an attentive reader may anticipate, the explanation to the heterogeneity between subsamples involves the *INTRINSIC* and *EXTRINSIC* labels adopted in this paper. Below, we present an argument connecting the intensity of intrinsic and extrinsic motivations with the management of an open access resource.

[18] We ran an alternative specification with a categorical variable for drag nets, but its coefficient is not statistically significant. The regression results are available upon request.

We consider the relationship between present and future rewards for each community, separately; and how the conditional rewards come at play in each case.

Consider the *INTRINSIC* subsample. The healthier state of the resource and the subjects' compliance with the socially accepted extraction levels reveal a positive valuation of the future stock. Hence, there is a tradeoff between present and future rewards from resource consumption because long-term rewards are sufficiently salient. We argue that the introduction of the conditional contract does not distort the optimal choice in this tradeoff. The reason is that the contract simultaneously increases the immediate and the future rewards. Moreover, the material nature of the immediate reward creates a signal extraction problem (Bénabou and Tirole, 2006), where fishermen initially influenced by their intrinsic motivation would not like to appear as "too greedy" by shifting their extraction effort downwards.

For the *EXTRINSIC* subsample the valuation of the future stock is negligible given the poorer state of the resource. The absence of norms or institutions granting a future share of the common resource eliminates the intertemporal tradeoff for its consumption. We argue that, lacking any future reward for sustainability, the conditional contract becomes highly salient. Besides, the signal extraction problem is less concerning when the extrinsic motivations dominate the intrinsic ones.

One potential concern with our results is that they might be explained by differences between the communities that were not contemplated under the labels *INTRINSIC* and *EXTRINSIC*. Table 2 shows that fishermen in the *INTRINSIC* subsample are younger and have a higher educational attainment than those in the *EXTRINSIC* subsample. One may expect that such characteristics will make fishermen in the *INTRINSIC* subsample more attentive to the additional rewards embedded in the conditional contract. However, this is the community where the *CONTRACT* treatment has the lower effect. If anything, the unobserved ability to profit from these rewards is downward-biasing the reported effect.

Another concern raised by the differences in age and education is that the sampling procedure was systematically different between communities. For instance, younger fishermen that should have been part of the *EXTRINSIC* subsample did not participate because they have a higher reservation wage. We argue that this is not very likely to be an issue in our data because the experiments were conducted after working hours or in days when weather conditions were not suitable for fishing.

However, a different way to interpret the demographic differences between subsamples is that they may indicate a selection effect in terms of who becomes fisherman in each community. The *EXTRINSIC* subsample has a lower stock level and better access to markets. Hence, the outside options for the young and more educated subjects may be better than in the *INTRINSIC* subsample. The fact that this explanation fits our data imposes a more careful interpretation of our findings. The results apply *within* the population of existing fishermen, but we cannot guarantee that the effect holds if the implementation of the conditional contract attracts a new and different set of subjects to the fishing activity.

An additional consideration is that fishermen in the *INTRINSIC* subsample took part in a prior investigation studying the relationship between resilience and the appropriation of ancestral knowledge. This intervention could have strengthen the social norms regulating their economic activities. However, it does not represent an issue with the validity of our results because, if anything, this prior intervention increase the relative importance of the intrinsic motivation within the *INTRINSIC* subsample.

7.2. Conditional rewards and reciprocity in CPR games

We find evidence of reciprocity with the *conditional contract* but not with the *fixed price*. Besides, this reciprocity is only found in the *EXTRINSIC* subsample. Two mechanisms may explain the differences between payment schemes: a coordination-enhancing effect and the affordability to reciprocate. First, Falk et al. (2002) show that the presence of conditional cooperators transforms the commons dilemma into a coordination game. We argue that the *conditional* *contract* amplifies this effect by providing multiple focal points, with better prices acting as higher attainable rewards. Second, given that engaging in reciprocal behavior is costly (Dreber et al., 2008), the immediate rewards from the *conditional contract* make these responses "cheaper" compared to the *fixed price*.

Although conditional cooperation is identified in more than half of the participants in public good experiments (Fischbacher et al., 2001; Fischbacher and Gächter, 2010) this behavior is less common in repeated CPR games. Ostrom (1999) defines as "an unpredicted and strong pulsing pattern" the following heuristic observed in laboratory experiments: "They increase their investments in the common pool resource until there is a strong reduction in yield, at which time they tend to reduce their investments. As the yield again goes up, they repeat the cycle." Cárdenas (2011) describes, at an aggregate level, a similar result for a large sample including 865 CPR uses and 230 students. Vélez et al. (2009) connect the conditional cooperation model with the pattern observed in CPR games by arguing that this conditional behavior can also be explained by social conformity. They find that a best response function based on conformity has better explanatory power than a response function based on reciprocity.

Our findings for the *INTRINSIC* subsample are similar to the existing evidence for repeated CPR games (Cárdenas, 2011). Subjects reduce their extraction effort as a response to a large aggregate extraction level. What is particular from our experimental results is the reciprocal response to the *CONTRACT* in the *EXTRINSIC* subsample. We are not aware of previous evidence involving an interplay of positive reciprocity and "rewarding" institutions that increase cooperativeness in a CPR. On the other hand, a study by Rodriguez-Sickert et al. (2008) describes the interplay between negative reciprocity and a "sanctioning" institution. CPR users that voted against the imposition of fines initially had higher cooperation levels (98%) than those who vote in favor (80%). However, a spiral of negative reciprocity unraveled cooperation in the groups that rejected the imposition of fines.

8. Concluding remarks

We conduct a lab-in-the-field experiment to test whether or not conditional rewards for sustainability are efficiency-enhancing in an open access fishery. The proposed payment scheme conditions the price paid per unit to the group's total catch. It increases the collective incentives to reduce the extraction effort, but maintains the individual incentives to maximize the extraction effort. The experiment is conducted with groups of fishermen from two neighboring communities. The communities are labeled as *INTRINSIC* and *EXTRINSIC*, according to how their market and technology constraints shape the relative importance of the intrinsic motivation to preserve the fishery.

The conditional contract has a positive effect on resource management: it increases the efficiency, the duration of the resource and the total yield. Nonetheless, the contract has a differential effect between locations. Fishermen in the *EXTRINSIC* subsample profit more from the conditional contract, increasing efficiency by 200% with respect to a fixed price. On the other hand, fishermen in the *INTRINSIC* subsample reach similar efficiency levels with and without this contract.

We offer two arguments why the conditional contract is more effective when the extrinsic motivation has more weight than the intrinsic motivation in the extraction decision. First, and particular to the commons problem, the conditional contract provides immediate rewards that are more salient for the extrinsically motivated subjects. Second, the material rewards from the contract can generate a disutility of appearing "too greedy" among subjects with a high intrinsic motivation.

An underlying mechanism behind the effectiveness of the conditional contract is positive reciprocity. The decrease in extraction effort marginally contributes to an increase in the price per catch. We speculate that the step-wise price function is of particular importance, as it provides multiple focal points that help perceiving the social dilemma as a coordination game.

This work sheds light on the usefulness of the history of resource management as a targeting criterion for the allocation of conditional rewards. Providing these incentive schemes to fishermen communities with a worst history of resource management could be politically unpopular, but it seems to be the more efficiency-enhancing option.

One challenge, in terms of implementation, is how to promote transparency in the disclosure of the aggregate yields. Reliable information on the aggregate yield is fundamental to prevent the creation of a parallel market for the excess supply given a target price. Disclosure incentives should take into account the fishermen's willingness to reciprocate reported in this work.

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Appendix A. Resource duration: survival analysis

The survival analysis exploits the time variation of the binding termination rule of each group. We use it to compare the average time the resource remained open to extraction across the two payment schemes. Our unit of observation is group k at time t. We define as failure event (*i.e.* the moment when the group will be no longer observed) the period in which the current stock level surpasses the threshold $\tilde{C} = 12$. The group's data is censored in period $t = 10$ in case the threshold has not been crossed yet.

For this maximum likelihood estimation it is necessary to specify the distribution from the survival function $S(t) = exp(-H(t))$, where $H(t)$ corresponds to the cumulative hazard function. $H(t)$ can be written in terms of the hazard function $h(t)$ as $H(t) = \int_0^t h(u)du$. We use a non-parametric and a parametric survival-time model. In the non-parametric estimation we look at the multiplicative effect that a covariate has on the hazard rate. As the effect is time-invariant we do not need to estimate a baseline hazard function associated to the time dimension. In the parametric estimation we look at the multiplicative effect of the covariates on the survival time. The effect of a covariate is to "shrink" or "expand" the lifespan of the observed unit. Hence, the baseline hazard function is parametrized in order to be estimated.

For the non-parametric estimation we use the Cox proportional hazard model. As the covariates $\boldsymbol{x_j}$ have a multiplicative effect on the hazard function we can write the latter as:

$$h(t_j) = exp(\boldsymbol{x_j}\beta)$$

The model's underlying assumption is that the effect of the covariates $\boldsymbol{x_j}$ is time-invariant. The exponentiated coefficient β_k is thus interpreted as the hazard ratio of the variable x_k. That is, the relative probability of failure given two different levels of x_k. Hazard ratios have a multiplicative interpretation. Hence, the effect of x_k is smaller as the hazard ratio $exp(\beta_k)$ is closer to one. When $exp(\beta_k) > 1$ the probability of failure increases with x_k in $100 \times (exp(\beta_k) - 1)$ percent. When $0 \leq exp(\beta_k) < 1$, on the other hand, an increase in x_k is associated with a decrease of $100 \times (1 - exp(\beta_k))$ percent in the probability of the failure event.

Table A.1 reports the hazard ratios from the non-parametric estimations (see column 1). We find that the *conditional contract* reduces the probability of resource depletion by $100 \times (1 - 0.472) = 52.8$ percent with respect to the *fixed price*. We also find that fishermen in the *INTRINSIC* subsample have a probability of depletion 44.6 percent lower than fishermen in the *EXTRINSIC* subsample. The validity of the proportional hazard assumption is tested using the scaled Schoenfeld residuals (see Table A.2).

We evaluate the differential effect of the conditional contract between communities by introducing an interaction term (see column 2). We find that the CONTRACT treatment (compared to the FIXED treatment) reduces by $100 \times (1 - 0.232) = 76.8$ percent the probability of depletion in the *EXTRINSIC* subsample. To compute the effect of the conditional rewards in the *INTRINSIC* subsample we need to multiply the hazard rates from the *INTRINSIC* variable and its interaction with the CONTRACT variable. We find that, within this group, the *CONTRACT* treatment increases by $100 \times ((0.267 \times 4.715) - 1) = 9.6$ percent the probability of depletion. This effect is statistically significant (p-value 0.029).

Table A.1: Non-parametric and parametric survival time models. Failure event is the resource's closure or collapse. In the parametric model the survival function is assumed to follow a log-logistic distribution. In the maximum likelihood procedure is estimated $\ln(\gamma)$ instead of p. The shape parameter can be retrieved using the formula $p = 1/\gamma$. In models (3)-(4) the variance of the frailty parameter is assumed to follow a Gamma distribution.

	Cox model (no BL hazard function) *Hazard ratios*		Loglogistic BL hazard function *Time ratios*	
	(1)	(2)	(3)	(4)
CONTRACT	0.472**	0.232**	1.117*	1.104
	(0.164)	(0.159)	(0.0697)	(0.0822)
STRONG	0.554*	0.267**	1.245***	1.215*
	(0.192)	(0.143)	(0.0688)	(0.1231)
CONTRACT × STRONG		4.715*		1.035
		(4.175)		(0.1265)
Constant			1.722***	1.728***
			(0.0617)	(0.0641)
$\ln(\gamma)$			-3.012***	-3.037***
			(0.315)	(0.316)
$\ln(\theta)$			0.0167	0.0456
			(0.570)	(0.558)
Observations	142	142	142	142
Number of groups	20	20	20	20

Standard errors in parenthesis. *** p<0.01, ** p<0.05, * p<0.1.

For the time ratios coefficients the p-value corresponds to the test $exp(\beta_k) = 1$.

In the parametric estimation we use a log-logistic distribution to model the

Table A.2: Test of proportional hazard assumption for the Cox regression model. The test verifies that the scaled Schoenfeld residuals do not exhibit particular time trends. Schoenfeld residuals from columns (1)-(2) correspond to the Cox models reported in columns (1)-(2) in Table A.1, respectively.

	(1)	(2)
CONTRACT	-0.197	-0.311
	(0.5239)	(0.1255)
INTRINSIC	0.49	0.089
	(0.1397)	(0.7849)
CONTRACT × INTRINSIC		0.274
		(0.2280)
Global test (χ^2)	2.19	3.94
	(0.3349)	(0.2678)

p-values reported in parentheses. *** p<0.01, ** p<0.05, * p<0.1

baseline hazard function. This distribution provides a non-monotonic hazard rate that mimics our resource's logistic growth function. The stock threshold in the non-monotonic resource dynamics is given by half of the carrying capacity ($K/2$). Once this stock level is surpassed the growth rate start decreasing, and thus chances of failure start increasing monotonically. The hazard function is given by:

$$h(t_j) = \lambda_j p t^{p-1}/(1 + \lambda_j t^p)$$

with $\lambda_j = exp(-\boldsymbol{x_j}\beta)$.

Given the log-logistic distribution the survival function has the form $S(t_j) = 1/(1 + \lambda_j t^p)$. The parameter p captures the shape of the hazard function $h(t_j)$: it is non-monotonic if and only if $p > 1$. Otherwise, $h(t_j)$ decreases monotonically.

For interpretation purposes we rewrite the survival function as $S(t) = S_0\left(exp(-x\beta + \gamma\epsilon)t\right)$, where $\gamma = 1/p$ and ϵ is a random component. Please note that the covariates have a multiplicative effect on the baseline survival function $S_0(t)$. As we said earlier, using this parametrization the covariates "shrink" or "expand" the time elapsed before the failure occurs. This is why the log-logistic parametrization belongs to a family of models known as Accelerated Failure Time (AFT).

In the AFT models the exponentiated coefficients are interpreted as time ratios (instead of hazard ratios). In other words, the time ratio $exp(\beta_k)$ measures the increase (or decrease) in the expected timespan for two different levels of the variable x_k. When $exp(\beta_k) > 1$ the failure event is expected to take $100 \times (exp(\beta_k) - 1)$ percent more time to occur. Contrarily, when $0 \leq exp(\beta_k) < 1$ the failure event is expected to take $100 \times (1 - exp(\beta_k))$ percent less time to occur.

We specify in the parametric model that all the observations from the same group (at different points in time) share the same likelihood to experience the failure event. This is known as "shared frailty" and it allows us to control for common group effects when we have repeated observations within a group. In addition, we also control for the between-group variation by introducing a parameter α in the hazard function to capture the overdispersion. We assume that α follows a Gamma distribution $g(\alpha)$ with mean one and variance θ.[19]

We report the time ratios $exp(\beta_k)$ from the parametric model in Table A.1 (see column 3). We find that the CONTRACT treatment increases the expected elapsed time before resource depletion in $100 \times (1.117 - 1) = 11.7$ percent (with respect to the FIXED treatment). The differential effect between locations is also observed in the parametric model. The expected elapsed time before depletion is 24.5 percent larger in the *INTRINSIC* subsample compared to the *EXTRINSIC* subsample.

The estimation of the parameter $\ln(\gamma)$ in the log-logistic indicates that $p =$

[19]Two different functional forms are often used for $g(\alpha)$, a Gamma distribution and an inverse Gaussian distribution. The difference between these functional forms is what happens to the initial ratio c between the hazard rates from two groups sharing the same frailty as t approaches infinity. With the Gamma distribution the gap disappears. With the inverse Gaussian distribution the ratio tends to $c^{1/2}$ as $t \to \infty$ (Gutierrez, 2002).

20.5. This is an indication that the assumed distribution successfully captures the non-monotonic hazard rate from the exploited resource.

The estimation results with the interaction term between the *CONTRACT* and the *INTRINSIC* variables are reported in column 4. The interaction coefficient is not statistically different from one. The *CONTRACT* and *INTRINSIC* coefficients are less precisely estimated. Although their magnitude is almost the same, their statistical significance decreases.

Appendix B. Dynamics of the individual extraction effort

We use a simplex to explore the dynamics of effort choices. The path within this simplex provides information regarding the substitution of strategies over time. Figure B.1 shows the comparison between pricing schemes (see panel a) and between communities (see panel b). Each point in the simplex represents a triad (e_1, e_2, e_3) indicating the proportion of subjects in treatment k and period t that were following the strategies $e = 1$, $e = 2$ and $e = 3$, respectively. The values of e_1, e_2 and e_3 can be read on the left, right and bottom scales of the triangle, in that specific order. For instance, the triad $(0, 0, 1)$, corresponding to the Nash equilibrium of the game, will be located in the bottom left vertex of the triangle.

Points within a simplex are chronologically connected by lines. The angle (measured from the horizontal axis) of the connecting lines reveals which strategies were substituted between consecutive periods. A $0°$ angle implies a substitution from $e = 3$ to $e = 2$, a $60°$ angle implies a substitution from $e = 3$ to $e = 1$, and a $120°$ angle implies a substitution from $e = 2$ to $e = 1$. Adding $180°$ to each one of these angles means that the substitution between strategies goes on the opposite direction. For the analysis we focus on the first four periods, before any group experienced the resource's collapse. Periods 1 to 4 were marked in the simplex with full circles, and subsequent periods with hollow circles.

We find that the low extraction effort ($e = 1$) is chosen more often in the

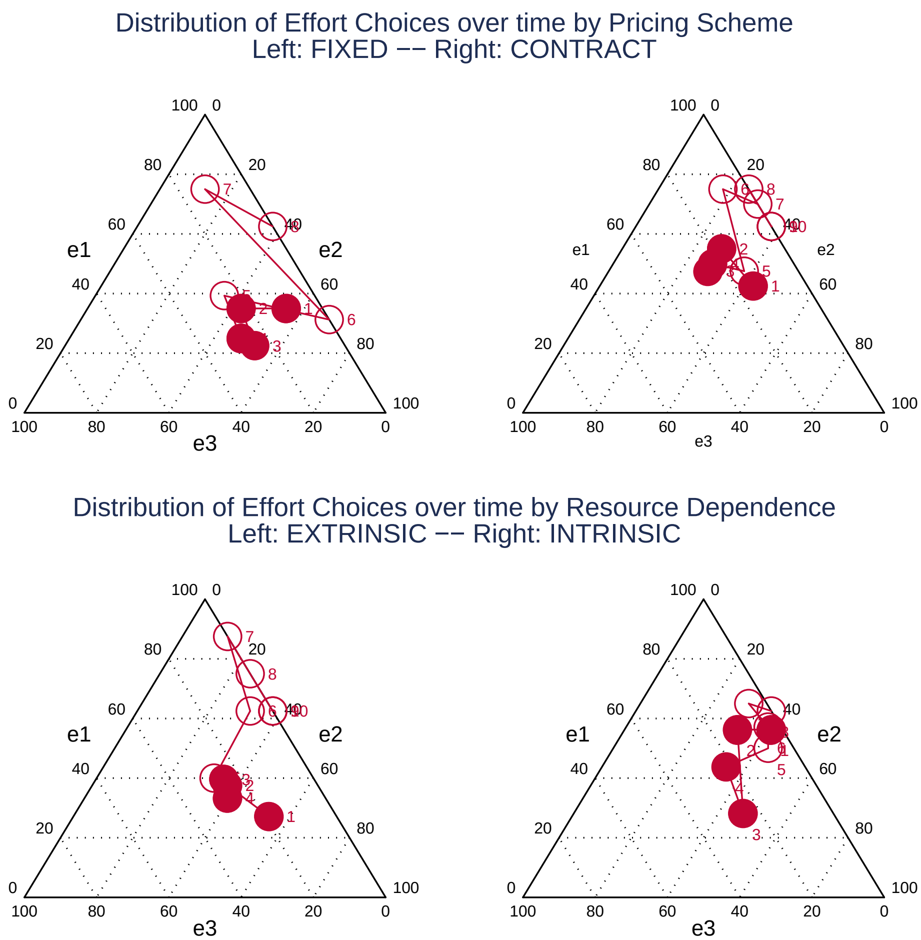

Figure B.1: Ternary plot with the distribution of effort units per period. Each circle represents one point in time. Circles are chronologically connected. The comparison between pricing schemes is shown in panel (a). The comparison between intrinsically and extrinsically motivated communities is shown in panel (b). Colored circles correspond to the first four periods. Hollow circles correspond to the last six periods.

CONTRACT (49%) than in the FIXED treatment (29%). This is compensated by a smaller proportion of intermediate effort ($e = 2$) choices: 31% in the *CONTRACT* treatment and 49% in the *FIXED* treatment.

In the *CONTRACT* treatment we observe an initial movement towards northwest, indicating a substitution of $e = 2$ for $e = 1$. Subsequent movements are negligible: they are characterized by small shifts between $e = 1$ and $e = 3$ back and forth. In the *FIXED* treatment we observe an initial movement in the simplex in the west direction, *i.e.*, a substitution of $e = 2$ for $e = 3$. This is followed by a decrease in the proportion of $e = 1$, as is indicated by a movement to the bottom.

Fishermen in the *INTRINSIC* subsample are more likely to choose the low extraction effort (46%) than their neighbors in the *EXTRINSIC* subsample (34%). Most of this offset is compensated by the proportion of high effort ($e = 3$) choices: 16% and 24%, respectively.

The observed dynamics fit a reciprocity-based explanation in the *EXTRINSIC* but not in the *INTRINSIC* subsample. In the *EXTRINSIC* subsample the actions $e = 1$, $e = 2$ and $e = 3$ are initially followed by 27.1, 54.2 and 18.7 percent of the participants, respectively. This is followed by a shift towards northwest, indicating a substitution of $e = 2$ for $e = 1$. In the *INTRINSIC* subsample we observe that $e = 1$, $e = 2$ and $e = 3$ are played in the first period by 56.3, 40.6 and 3.1 percent of the subjects, respectively. Despite the high cooperation rates at the beginning, the proportion of subjects that chose $e = 1$ decreases by half by the third period. The movement towards south is partially reversed in the fourth period.

A comparison between the colored and the hollow circles shows an evident pattern: points in the simplex tend to move upwards over time because lower effort levels guarantee that the resource is sustained longer. However, the separation between the "clusters" of colored and hollow points is particularly striking in the *EXTRINSIC* subsample. It may be an indication of the largest effect of the contract. Indeed, within this community, period 6 was reached by 50% of the groups in the CONTRACT treatment and only by 16% of the groups in the FIXED treatment.

Appendix C. Additional Tables

Table C.1: Lotteries proposed to elicit risk aversion preferences. The r parameter corresponds to the coefficient of relative risk aversion in the utility function $U(x) = (x^{1-r})/(1-r)$. The reported payoffs were offered in Colombian pesos.

Lottery	Outcomes	Expected Value	Variance in Payoffs	Risk Aversion Range (CRAA)
A	5,000 — 5,000	5,000	0×10^6	$r > 3.26$
B	4,000 — 8,000	6,000	4×10^6	$3.26 \geq r > 1.11$
C	3,000 — 11,000	7,000	16×10^6	$1.11 \geq r > 0.68$
D	2,000 — 14,000	8,000	36×10^6	$0.68 \geq r > 0.47$
E	1,000 — 17,000	9,000	64×10^6	$0.47 \geq r > 0$

Table C.2: Mean tests by pricing scheme. For categorical variables we report the p-value for the Chi-squared test instead of the t-test. The abbreviation [COP] refers to Colombian pesos.

	FIXED PRICE	CONTRACT		
	Mean	Mean	Difference	p-value
(a) Fishing inputs and market access				
Sells to fish gatherer	0.675	0.575	0.100	0.362
Boat ownership	0.625	0.600	0.025	0.821
Handlining	0.550	0.800	-0.25**	0.017
Harpoon	0.225	0.150	0.075	0.397
Cast net	0.175	0.200	-0.025	0.778
Fish traps	0.025	0.075	-0.050	0.311
Gill net / Trammel	0.375	0.275	0.100	0.346
"Boliche"	0.175	0.100	0.075	0.336
(b) Socioeconomic characteristics				
Age	44.7	43.5	1.2	0.709
Education [years]	3.70	3.18	0.53	0.460
Other economic activities	0.500	0.600	-0.100	0.375
Weekly earnings [1,000 × COP]	152.949	155.500	-2.551	0.930
Perceived relative wealth [1-10]	3.23	3.48	-0.25	0.611
No. adults in household	3.03	4.03	-1.00***	0.005
No. children in household	1.98	1.50	0.48	0.126
Perceived luck when fishing [1-10]	7.05	6.23	0.83	0.206
Gambling in dominoes	0.525	0.475	0.050	0.660

*** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table C.3: Between-treatments comparison of efficiency levels. Efficiency is defined as the groups' earnings as if the conditional contract was applied in both treatments. Maximum efficiency level is $666 according to the social planner's solution.

	CONTRACT	FIXED PRICE (applying CONTRACT prices)	Difference
Efficiency			
Pooled (N=20)	0.6683	0.5595	0.1088*
	(0.0365)	(0.0455)	[0.0786]
Extrinsic (N=12)	0.6780	0.4995	0.1785**
	(0.0627)	(0.0340)	[0.0319]
Intrinsic	0.6536	0.6495	0.0041
	(0.0061)	(0.0896)	[0.9651]

Standard deviation in parenthesis. p-values in brackets. *** $p<0.01$, ** $p<0.05$, * $p<0.1$

Table C.4: Random-effects ordered logistic model with individual characteristics explaining exerted effort. Standard errors are clustered at the group level. In the estimation are considered the observations from periods 1 to 4 only. Columns (1)-(3) correspond to the *INTRINSIC* subsample. Columns (4)-(6) correspond to the *EXTRINSIC* subsample.

Dependent Variable	**INTRINSIC**			**EXTRINSIC**		
Exerted effort e_t^i	(1)	(2)	(3)	(4)	(5)	(6)
CONTRACT	-1.898*	-2.114**	-2.044**	-5.614**	-5.322**	-4.867**
	(1.102)	(0.969)	(1.024)	(2.303)	(2.269)	(2.327)
$\sum_{-i} e_{t-1}$	-0.505***	-0.545***	-0.543***	-0.118	-0.105	-0.0475
	(0.193)	(0.200)	(0.189)	(0.264)	(0.269)	(0.273)
CONTRACT $\times \sum_{-i} e_{t-1}$	0.346	0.419**	0.412**	0.752**	0.708**	0.625*
	(0.215)	(0.190)	(0.203)	(0.348)	(0.348)	(0.332)
Lottery	-0.0799	-0.0323	-0.0256	0.0383	0.0985	0.104
	(0.197)	(0.185)	(0.228)	(0.172)	(0.198)	(0.193)
Sells to Fish Gatherer	-1.081***	-0.970***	-0.934***	-0.417	-0.166	-0.290
	(0.342)	(0.346)	(0.334)	(0.616)	(0.538)	(0.537)
Boat Ownership	0.830**	0.892***	0.852***	0.525	0.567	0.549
	(0.397)	(0.343)	(0.289)	(0.409)	(0.406)	(0.386)
Cast Net	0.267	-0.00149	-0.0484	-0.685	-0.686	-0.463
	(0.393)	(0.444)	(0.464)	(0.633)	(0.677)	(0.727)
Gill Net	-0.272	-0.343	-0.272	0.761**	0.750**	0.648*
	(0.582)	(0.384)	(0.313)	(0.347)	(0.372)	(0.386)
α_1	-10.92*	-9.219*	-8.993	-2.583	-2.076	-2.433
	(5.635)	(5.471)	(5.704)	(3.257)	(3.282)	(3.358)
α_2	-8.858	-7.137	-6.916	-0.0359	0.477	0.0916
	(5.596)	(5.507)	(5.772)	(3.082)	(3.132)	(3.181)
σ_u^2	0.251	0.196	0.169	2.071	2.002	1.833
	(0.290)	(0.314)	(0.309)	(1.700)	(1.479)	(1.507)
Luck perception and gambling controls	No	Yes	Yes	No	Yes	Yes
Wealth perception and income controls	No	No	Yes	No	No	Yes
Observations	96	96	96	144	144	141
Number of ID	32	32	32	48	48	47

Additional controls: current stock level S_t in linear and quadratic form. Clustered standard errors in parenthesis.
*** p<0.01, ** p<0.05, * p<0.1.

Appendix D. Experimental Protocol

The following instructions will be given in Spanish to the participants. The participants could interrupt and ask questions at any time. Whenever the following type of text and font e.g. [MONITOR: Complete the example removing 20 magnets and inserting again 5 magnets.] is found below, it refers to specific instructions to the monitor at that specific point that will not be read out loud.

Instructions

Greetings. We want to thank everyone here for attending the call, and specially thank to (the local organization that helped in the logistics) who made this possible. We will spend about two hours and a half between explaining the exercise, playing it and finishing with a short survey at the exit. So, let us get started.

The following exercise is a different and entertaining way of participating actively in a project about the economic decisions of individuals. Besides participating in the exercise, and being able to earn some cash, you will participate in a community workshop next (date and time of the meeting) to discuss the exercise and other matters about natural resources.

Once the game finishes, we will ask you some information about you and your community, and then we will give you what you earn during the game. All the collected information will be treated anonymously, the other participants will not know during or after the experiment, about your individual decisions and earnings. The funds to cover these expenditures have been donated by the Latin American and Caribbean Environmental Economics Program.

1. Introduction

It is very important that while we explain the rules of the game you do not engage in conversations with other people in your group. This exercise attempts to recreate a situation where a group of families must make decisions about how to use the resources of a fishery. In the case of this community, an example would be the extraction of (name of a fish usually caught in the community) in the (name of an actual local commons area in that village) zone.

You have been invited to participate in a group of four people. The game in which you will participate now is different from the ones others have already played in this community, thus, the comments that you may have heard from others do not apply necessarily to this game. This experience is also different from other games in which you could have been invited to participate years before.

In this game you will play for several periods that are equivalent, for instance, to weeks of work in which you can complete between one and three fishing trips.

At the end of the game you will receive your earnings in cash according to the amount of money you accumulate during the exercise. Your earnings will be approximated to the closest multiple of $1,000 [MONITOR: Give a couple of examples of how to approximate the game earnings.].

2. The RESOURCE BOARD

Let us begin by presenting the RESOURCE BOARD (See Figure D.1). We will suppose that there are initially 100 units of fish, corresponding to each one of the magnets in the board. Suppose now that in a given period, or a week in our game, the total amount of resource caught among the four players was 20 units. This means that we will remove the last 20 magnets of the board.

Before moving to the next week or period, the remaining fish in the RESOURCE BOARD will reproduce. The number of newborn fish will depend on the actual number of fish. At the end of each period, we will count the remaining fish and read the blue number on the right side of the board indicating the resource's GROWTH for that specific stock level. We will add this number of magnets into the RESOURCE BOARD [MONITOR: Complete the example removing 20 magnets and inserting again 5 magnets.].

As you may have noticed, when there is a lot of fish the resource does not grow rapidly. This is because there is not enough food for all the fish to reproduce. Similarly, when there is few fish the resource neither grows rapidly. This is because there are not enough fish that can reproduce themselves. Now that we know how the resource is reproduced let's move to understand how we can extract it.

3. The FISHING TRIPS

Every week, or period, you can make up to three FISHING TRIPS. Each period you will receive three FISHING FORMS (See Figure D.2). You will use them to indicate how many fishing trips you are planning to make in that specific round. You must fold each FISHING FORM to indicate if you want to fish or not. If you fold it in one direction the boat will stay in ground (as in the NOT FISHING drawing), and if you fold it in the opposite direction the boat will go to the sea (as in the FISHING drawing).

It is very important to keep in mind that the number of FISHING TRIPS you decide in each period are absolutely individual. You don't have to show your decision to the rest of group members if you don't want to. The monitor will pass collecting your private decisions to guarantee its privacy.

4. CATCHING FISH (STOCHASCTIC TREATMENT)

To determine your catch the monitor will give you one numbered dice for each FISHING TRIP you decided to make (see Figure D.3). You will have equal probabilities of having a GOOD, REGULAR or BAD day as you have two faces of the dice marked with the numbers 5, 3 and 1. A GOOD day gives you 5 FISH UNITS, a REGULAR day gives you 3 FISH UNITS and a BAD day gives you 1 FISH UNIT [MONITOR: Show the poster with the unfolded dice.]. The monitor will give you a total of three dices, the quantity of numbered dices will match your number of FISHING TRIPS and the remaining dices will be blank on all their sides. In this way we can guarantee the privacy of your decisions.

Once we know the result of all the FISHING TRIPS in the week, the MONITOR will calculate and announce publicly the total amount of fish FISH UNITS caught by the group, will remove the same amount of magnets from the RESOURCE BOARD and will annotate the weekly earnings (round earnings) for each one of the participants.

5.A. PAYING THE FISH (FIXED PRICE TREATMENT)

The monitor will annotate the FISH UNITS you caught each week. Each FISH UNIT will be paid at 2 tokens. The monitor will pay, at the end of the game the amount earned by the fish sold.

5.B. PAYING THE FISH (CONDITIONAL CONTRACT TREATMENT)

The monitor will give annotate the FISH UNITS you caught each week. Each unit caught will be paid according to the total number of units extracted in the week. After

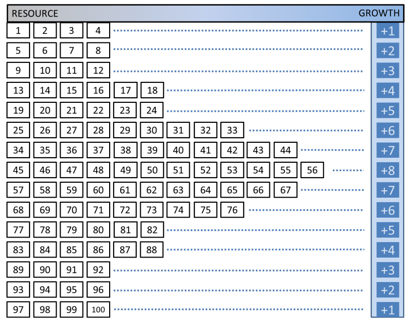

Figure D.1: Resource Board. The cells on the left represent the current stock level. The cerulean cells on the right represent the resource's growth.

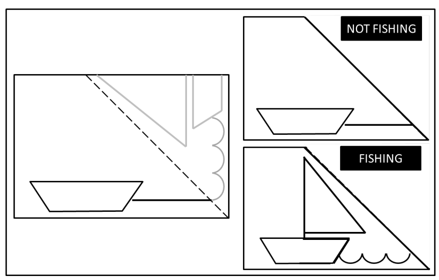

Figure D.2: Fishing form. According to the side in which it is folded it represents one additional effort unit [FISHING] or not [NOT FISHING].

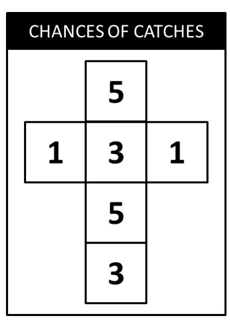

Figure D.3: Representation of the unfolded dice. The three possible yield levels, 1, 3 and 5, were equally likely to be draw.

the monitor announces the total amount of fish caught he will announce the price paid for each unit of fish according to the following table (See Table 1). [MONITOR: Show the table with the conditional contract.]. The monitor will pay, at the end of the game the amount earned by the fish sold.

6.A. FINISHING THE GAME (FIXED PRICE TREATMENT)

The game will finish once we reach the 10th week, or equivalently period 10. However, if the resource reaches a level below 13 units (only twelve magnets in the RESOURCE BOARD) the game will finish in advance. If, at some point of the game, the FISH UNITS caught by the group exceed the remaining FISH UNITS in the board, you will receive a proportion of the remaining units equal to the proportion of your FISH UNITS with respect to the group's FISH UNITS caught in that week. For example, suppose that you caught 6 FISH UNITS and the total group caught 24 FISH UNITS but there were only 20 FISH UNITS remaining in the board. According to our rule, you will receive the fourth part of the remaining units, this is 5 FISH UNITS.

6.B. FINISHING THE GAME (CONDITIONAL CONTRACT TREATMENT)

The game will finish once we reach the 10th week, or equivalently period 10. However, if the resource reaches a level below 13 units (only twelve magnets in the RESOURCE BOARD) the game will finish in advance. If, at some point of the game, the FISH UNITS caught by the group exceed the remaining FISH UNITS in the board, you will receive a proportion of the remaining units equal to the proportion of your FISH UNITS with respect to the group's FISH UNITS caught in that week, and they will be paid according to the total FISH UNITS the group was expecting to catch. For example, suppose that you caught 6 FISH UNITS and the total group caught 24 FISH UNITS but there were only 20 FISH UNITS remaining in the board. According to our rule, you will receive the fourth part of the remaining units, this is 5 FISH UNITS and will be paid at $3 each.