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Communication Networks in Common-Pool Resource Games: Field Experimental Evidence

Cesar Mantilla
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Abstract/Resumen

This work explores the role of the communication structures and message types in an artefactual field experiment emulating the open access extraction of a common pool resource. We introduce two network structures that allow participants to transmit non-binding suggestions to the nodes with whom they were connected. In a centralized structure, \good" (cooperative) recommendations have a positive but temporary effect reducing the aggregate extraction levels, while \bad" (self-regarding) recommendations have a negative and permanent effect. In a decentralized structure the positive effect of \good" suggestions is permanent, while \bad" suggestions do not have any effect on aggregate extraction levels. Although allocation within the network was exogenous, we found a positive correlation between network centrality and other-regarding behavior.

Keywords: Communication, Exogenous Social Networks, Artisanal Fishermen *JEL: C93, Q56*

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1. Introduction

Self-governance arrangements are determinant in the management and sustainability of common pool resources (henceforth CPR) under open access (Ostrom et al., 1992, 1994; Ostrom, 2002). In the last two decades, lab-in-the-field experiments have been useful in the recreation of CPR social dilemmas under different institutional arrangements. Empirical evidence suggests that one of the simplest but most powerful rules is to allow players to engage in face-to-face communication. It improves the group's social welfare through the establishment of non-binding agreements and endogenously elected rules, especially when participants are actual users of common pool resources (Cárdenas and Ostrom, 2004; Ostrom, 2006; Cárdenas, 2011; Cárdenas and Carpenter, 2011). Face-to-face communication is costless and in consequence is considered "cheap talk" (Bicchieri and Lev-on, 2007). Despite the "cheap" label, communication lessens conflict, promotes coordination opportunities and reveals shared social norms in games with payoff structures depending on social interactions (Sally, 2005).

Vélez et al. (2006) show that communication and self-regulatory norms explain between-group and within-group variation in the contribution levels in a public goods game conducted with actual users of a CPR. Between-group variation might be explained by the existence of social norms, usually adopted by members of the same group but varying across groups (Boyd and Richerson, 1985). The within-group variation, on the other hand, might be explained through differences in their social preferences but also in their connectivity degree among commoners sharing a particular resource. CPR users might not be fully connected due to geographic, economic and cultural constraints. According to the scale of the resource, we can consider a wide range of configurations of the communication structure between these participants, ranging from unconnected nodes to very hierarchical networks, that may affect how the disseminated information can be useful as a coordination mechanism.

These heterogeneities in the connectivity degree of participants have not been explored in depth, especially in artifactual field experiments emulating the CPR extraction. Face-to-face communication is based on "global" rather than on more "local" interactions. In the former type of interaction, every utterance reaches all the group members, maximizing the coordination opportunities and minimizing the degree of conflict. Meanwhile, the latter type of interaction restrains the scope of the transmitted messages and endows power on those subjects who are better connected. Switching from a "global" to a "local" interactions environment will contribute to the understanding on how communication affects individual behavior depending on (i) the entire network structure and (ii) the specific position of a node in this given network.

The introduction of different network structures into the analysis of CPR extraction raises two questions. First, conditional on the ammount of transmitted information (i.e. total number of messages), how determinant is the configuration of the communication structure in the final outcome? Second, what are the consequences, for themselves and for the rest of their group, of the power granted to central nodes by their hierarchical position in the network?

To address these questions we propose two different communication structures represented by networks. The network will define who is connected to whom in the transmission of non-binding suggestions. The two different structures are a star, in which non-central players exchange messages exclusively with a central node, and a directed cycle, in which messages are transmitted in a clock-wise direction, in such a way that no player is sending and receiving a message from the same node. The former structure emulates communities where social capital is built around a few visible leaders, highly connected to subgroups poorly linked to each other. The latter, although not very realistic among CPR users, is a very useful counterfactual because all the subjects are sending and receiving only one message, as they are the non-central players in the star.

To reproduce local interactions in a lab-in-the-field setting, we need to make these messages anonymous, thus guaranteeing that subjects' location within the network remains private and abstract and guaranteeing that exchanged communications will be unambiguous and easy to collect and deliver. The compliance to these two characteristics give us three empirical advantages. First, we were able to block the confounder effect of the face-to-face interaction from the transmitted information *per se*. Second, non-central nodes in the star network exchange the same amount of information than nodes in the cycle network, but the received message is common knowledge only in the former structure. The third advantage is that we gain some control over the local interactions by controlling exogenously the suggestions of one of the fives nodes, even as the other subjects will perceive it as endogenously chosen.

To achieve the latter point, in two-thirds of the sessions a randomly selected participant, the one assigned to Node A, tosses a coin that defines the message transmitted for the rest of the game. He might be selected to send a "good" suggestion, corresponding to the individual extraction level socially desirable, or a "bad" suggestion, corresponding to the individually rational but socially inferior extraction level.

In the star network, the exogenous suggestions allow us to evaluate the difference between "good" and "bad" centralized signals on the aggregate extraction level. As these suggestions are common knowledge, they are potential coordination mechanisms at disposition of the central nodes or "network leaders".

Levy et al. (2011) reveal that in a public goods game, non-binding recommendations from a leader influence the contribution decisions on the part of group members. The leader's suggestion defines the upper-bound contribution from the group, independent of whether the leader was elected or randomly chosen[2]. If these suggestions come from a leader, they are followed by the other players and determine the group's social welfare. In contrast, if they are transmitted as public and exogenous signals there are no effects from these recommendations.

Koukoumelis et al. (2012) complemented this result by showing that one-

[2] In the elected leader treatment each participant must write a platform that will be read by the other three group members. Then, each subject proceeds to vote for a platform offered by someone else. The proposer of the elected platform will send, in each round, a suggestion of the form "Let's contribute X to the group account."

way communication (ongoing from a randomly selected player) substantially increases contribution in a public goods game, even in one-shot games where communication does not imply strategic concerns.

In our experimental design, we explore not only the implications of "good" centralized suggestions but also the effect of the "bad" ones (an interpretation is the effect of "good" versus "bad" leaders). In addition, all the group members are simultaneously sending and receiving suggestions. As remarked by Corazzini et al. (2012), the persuasion bias suggests that the attention that agent X pays to the message received from agent Y depends positively on the amount of messages received by node Y.

In our game the network is providing a communication structure, but it does not directly affect the payoffs function. The empirical evidence shows that for small networks where the connectivity degree directly affects the payoff functions, the star is the most efficient arrangement for cooperation dilemmas (Fatas et al., 2010). However, for larger network structures the consequences from the network's topology on cooperation rates in public goods remains unclear (Cassar, 2007; Suri and Watts, 2011).

The experiments were conducted in June 2012 with artisanal fishermen from Cispata Bay off of Colombia's Atlantic Coast, all of them men. Two reasons motivate us to conduct this experiment with actual users of a CPR. First, villagers show a larger response to face-to-face communication than do students (Cárdenas, 2011). If the subjects' pool responds more to "global" interactions, it is more likely we would find differential effects between our different treatments involving "local" interactions in this pool. Second, network structures can be associated to social capital, which is considered a second-best when legal institutions and state organizations are not functioning properly (Durlauf and Fafchamps, 2005). The importance of community leaders in this Colombian region makes more salient the role of central nodes and their hierarchical position in the game.

Our main finding is that the non-binding suggestion from a central node works as a costless coordination mechanism, but its effectiveness depends on the message type. On the one hand, "good" suggestions provide a temporary improvement in social welfare through a reduction in aggregate extraction. On the other hand, "bad" suggestions increase aggregate extraction permanently. In the decentralized network, "good" suggestions lead to a permanent but smaller decrease in the extraction level, but we do not find any effect from the "bad" messages in this network. In addition, we found that subjects exogenously assigned to the central node in the star reduced their levels of extraction with respect to the equivalent node in the cycle. The effect was larger for those subjects who must transmit a predetermined exogenous message than for those sending an endogenous suggestion.

The paper proceeds as follows: In Section 2 we describe the theoretical model, the experimental design and the characteristics of our participants and study site. Section 3 presents the experimental results, followed by a discussion of our findings in Section 4. The conclusions are presented in Section 5.

2. Experimental and Field Approach

2.1. Theoretical model

The CPR game is an adaptation of the experimental design in Cárdenas (2004); n users share a common-pool resource under an open access scheme. Each one of them must decide, in each round, their extraction level $x_i \in \{1, e\}$; e is the fishermen's endowment at each round. The user's earnings are increasing and concave in x_i, and linearly decreasing with the group's aggregate extraction $\sum_{i=1}^{n} x_i$. The last term captures the negative externality due to a reduction in the indirect benefits from the resource conservation; see equation (1).

$$\pi_i(x_i, x_{-i}) = \left(ax_i - \frac{bx_i^2}{2}\right) + \beta\left(ne - \sum_{i=1}^{n} x_i\right) \quad (1)$$

We obtain the Nash Equilibrium (NE) of the game by maximizing equation (1) with respect to the extraction level. This is given by $x_i^{NE} = \frac{a-\beta}{b}$. The socially optimal (SO) extraction level can be obtained by adding n times equation (1) and then maximizing $\pi_i(x_i, x_{-i})$ with respect to the extraction level.

This level is given by $x_i^{SO} = \frac{a-n\beta}{b}$. Parameters were kept as in previous works: $a = 60$; $b = 5$; $\beta = 20$; $n = 5$ and $e = 8$ (Cárdenas, 2004, 2011). For this set of parameter values the socially desirable extraction level is negative. As the minimum level of extraction allowed in the experimental setting is 1 unit, we will define this value as our social optimum. Therefore, we have that $x_i^{NE} = 8$ and $x_i^{SO} = 1$.

2.2. Experimental design

Each session consists of a group with five subjects. Participants interacted for fifteen rounds split into two stages, plus an initial practice round to check that instructions were understood. Full instructions are available in the Appendix. During the first stage, from Round 1 to 5, subjects selected their extraction level without any kind of communication. The only feedback received at the end of each round was the group's aggregate extraction. With this information in mind, participants calculated their round's earnings using a payoffs table identical to Table A.1. If they needed assistance with their calculations a monitor helped them.

The timing of each round in the first stage was: *(i)* each participant chooses its extraction level, and *(ii)* the experimenter collects the individual decisions and publicly announces the group's aggregate extraction. Each round's earnings are calculated individually.

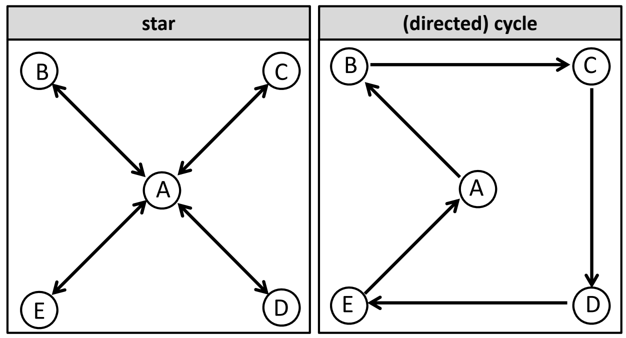
Our adaptation from the standard experimental design involves the transmission of non-binding recommendations, introduced in the second stage of the game, from Round 6 to 15. Once the first stage ended, the experimenter announced the new rule for the game: all the players were able to suggest a level of extraction to their neighbors. Each subject's neighborhood was determined by the network structure shown graphically by the experimenter. The experimenter displayed a poster indicating the nodes and connections between them and indicate, in private, the specific node for each participant. This guaranteed that the communication network was common knowledge, while each subject's position in the network remained private information. The exchanged suggestions were anonymous and abstract, in order to make interactions "local" and blocking confounding effects derived from face-to-face communication (Cárdenas and Ostrom, 2004; Sally, 1995, 2005).

The timing of each round in the second stage goes as follows: *(i)* each participant writes a number between 1 and 8, corresponding to the units that he will recommend to his neighbors to extract. In case he does not want to send any suggestion, he writes "NO" instead of a number. *(ii)* The experimenter collects the suggestions and put them in a board designed to show each message only to the recipient. Players were informed in stron terms that the incoming messages were non-binding suggestions. *(iii)* The experimenter delivers, privately, the suggestions for each node. If the sender selected "NO," the recipient gets a blank card indicating that no suggestion was sent to him. *(iv)* Each participant chooses his extraction level. *(v)* The experimenter collects the individual decisions and publicly announces the group's aggregate extraction. The round's earnings are calculated individually.

The experimental design included two different network structures: a star, where non-central players exchange messages exclusively with the central node, labeled as node A, and a directed cycle, where messages are transmitted in a clock-wise direction, so that no player is sending and receiving a message from the same node. Nodes B to E from both networks are sending and receiving only one suggestion. While Node A in the cycle is symmetric to the other nodes, its hierarchical position in the star implies that his suggestion reaches all four other nodes and simultaneously receives four different suggestions from them (see Figure 1).

In two-thirds of the sessions the randomly selected subject assigned to Node

Figure 1: Networks for transmission of non-binding suggestions



A sent a predetermined message. The subject in this node tossed a coin[3]. The outcome of this toss indicates the message to be transmitted in the remaining ten rounds: a low extraction suggestion of 1 unit, the *good message* treatment, or a high extraction suggestion of 8 units, the *bad message* treatment. In the remaining third of the sessions, subjects located in node A were free to choose their desired suggestion. This is our *endogenous* treatment. In all three treatments the subject in node A was reminded that he was free to choose his own extraction level, independent of the transmitted suggestion.

Before we move to the expected results we will discuss whether our manipulation of Node A's suggestion implies deception. The main concern is that participants in Nodes B through E do not know that the subject in Node A is transmitting pre-established recommendations. The results from Levy et al. (2011) suggested that, unless the exogenous messages could be perceived as endogenous by the other participants, they will not have an impact on the subsequent decisions. Following this argument, we needed to maintain control on the transmitted suggestions to be able to contrast "good" versus "bad" central-

[3]To guarantee that the other players could not guess the identity of player A, the coin was tossed during an individual talk with each participant. For the remaining four participants, this one-to-one conversation was used to verify that the assigned network structure and the new instructions were understood. Meanwhile, node A received indications about the suggestion he must write for the following ten rounds, according to the result of the coin toss.

ized messages by giving additional instructions to node A in private.

Although we did not reveal to the participants all the information, we did not lie to them. We did not say that the received message was endogenously selected by the player in Node A, but neither do we say the contrary. Following the argument proposed by Ellingsen et al. (2010), honesty does not imply revealing everything to the participants[4]. In addition, as we argued before, recommendations do not lead to commitment on the part of any of the parties. Some minor concerns might be that Node A perceives the message randomly selected as an imposition to himself. Nevertheless, we insisted to node A that his action set remained unrestricted, independent of the transmitted suggestion.

It is expected that the transmission of messages have a greater impact on individual behavior in the star than in the cycle. Non-central nodes in the star receive a suggestion, but they also realize which is the suggestion received by the other group members. Even if a subject is not likely to follow an incoming suggestion, he is aware that the central node is providing a coordination signal to the group, and thus deviations from this action might be costly for himself.

In terms of the recommendation types, a larger and persistent effect from the "bad" messages is expected because they align the incentives of self-regarding individuals and conditional cooperators reciprocating negatively. On the other hand, the aggregate effect of the "good" messages is less clear. Although they will provide a coordination mechanism for conditional cooperators, they will also increase the individual benefits of the more self-regarding subjects. Unlike linear public good games, the non-linearities in the CPR payoff structure generate a larger the marginal utility of extraction for low aggregate extraction levels, crowding-out the cooperative behavior.

[4] Although we did not reveal during the experiment that messages from node A were exogenously defined, after we conducted all the planned sessions we invited all the participants for a debrief meeting in which, apart from presenting the different treatments, we had the chance to discuss the implications and lessons from the experiment.

2.3. The study site and the participants

Cispata Bay is located on the Caribbean Sea; it is in the department of Córdoba in the northwestern region of Colombia. The zone was declared a District of Integrated Management (DIM) by Colombian environmental authorities, for purposes of regulation and conservation of the mangrove ecosystems in the zone. The DIM is divided into zones of recuperation, conservation and production. Fishermen are allowed to extract resources only in the production zones. These zones total 7,756 hectares, equivalent to 26.2% of the total DIM area. Sánchez and Ulloa-Delgado (2003) reported an estimate of 551 active fishermen, while Rojas and Sierra-Correa (2010) reported a hundred more fishermen seven years later, reaching 5.6% of the DIM's total population. While the number of fishermen increased, the fish catch decreased nearly 40% between 2001 and 2007.

The population of Cispata Bay is characterized by high poverty conditions, with income levels below the national and municipal average (Rojas and Sierra-Correa, 2010; Sánchez and Ulloa-Delgado, 2003). The area's main economic activities are agriculture, forestry in the mangroves and fishing in the wetlands. Income from these activities is considered low.

The recognition and acceptance of local leaders in these communities highlights the opportunity to transmit the importance of organized communication through our experiment. According to a survey conducted half a year after the experiment, leaders from fishermen's associations strongly agree that their central role consists of keeping a channel between governmental authorities and other fishermen. They also agree that the transmission of information to their associates is more efficient through large meetings jointly organized by groups of fishermen's associations. In addition, when they are asked to explain the success of an association, they consider the internal organization and collective work to be the main reasons of success.

In Cispata Bay In June of 2012 we conducted thirty sessions of the experiment, reaching a total of one hundred and fifty participants. Almost all of the subjects who took part in the activity were fishermen from the zone (96.7%), all of them men. Women in the zone participate in this economic activity by preparing the fish caught for sale, but they do not fish on the high seas. On average, the participants were 40.7 years old; only 38.3% of them had reached a level of study above elementary school[5], 28.9% had only finished elementary school and 16.7% had not attended school at all. In terms of marital status 18.0% were married, 56.7% reported cohabitation without marriage, 21.3% were single and the remaining 4.0% were widowed or divorced.

Of the 145 fishermen who took part in the activity, 26.9% were dedicated exclusively to fishing. The rest of fishermen combine this task with other economic activities, mainly agriculture (40.7%), but also tourism (9.7%), mangrove harvesting (8.3%), masonry (8.3%) and motorcycle taxi driving (7.6%). The fishing technologies most frequently used are drift nets, with 45.0% of the participants, followed by hand-lining (or line-fishing) with 35.0%, and the cast net with 27.1%. Less frequent methods are harpoon (8.6%), fish farming (5.7%) and manual harvesting of mollusks and crustaceans (2.1%).

Confirming the fishermen's low income reported in previous literature (Rojas and Sierra-Correa, 2010), we found that the average income in our sample corresponds to 62.6% of the Colombian minimum wage[6]. In addition, income differences between full-time fishermen and the participants who combine fishing with other economic activities are not statistically significant.

The results reported here include all 150 participants in our experiment, for a total of 2,250 observations (extracted level and transmitted suggestion are available for 1,500 of the observations). Once the experiment finished, a post-experimental survey was conducted. Earnings from the activity were privately delivered. Each session lasted between 140 and 180 minutes. On average, each participant received 25,800 Colombian pesos (14.5 usd) with a standard deviation of 3,300 Colombian pesos (1.9 usd)[7].

[5]Ten participants (6.71%) had pursued a technical career.

[6]The weekly minimum wage is calculated using daily the minimum wage of 18,890 Colombian pesos (cop) for 2012.

[7]Exchange rate 1 usd = 1,776 cop as of July 2012.

3. Experimental results

3.1. The effect of network configuration and suggestion type on extraction

In the first stage, before the exchange of non-binding suggestions, the average extraction level was 4.50 units (std. dev. 2.13). This intermediate extraction level, characteristic in field CPR games (Cárdenas, 2004, 2005, 2011), is usually explained by other-regarding preferences, social norms and institutional arrangements (Bowles, 2003; Ostrom, 2002)).

We do not find sistematic differences betweeen treatments in the extraction levels during the first stage (see Table A.2). The only differences that are marginally significant (two out of fifteen comparisons) are between the *endogenous cycle* and the *bad message star* (p-value 0.091), and between the *good message star* and the *bad message star* (p-value 0.067). We have excluded two experimental sessions from the data. For the first stage, average extraction level in these sessions is 2.54 units[8]. Our explanation, that will be discussed in depth in a separate work, is based on the fact that the only two community leaders who participated in the experiment were present in these sessions.

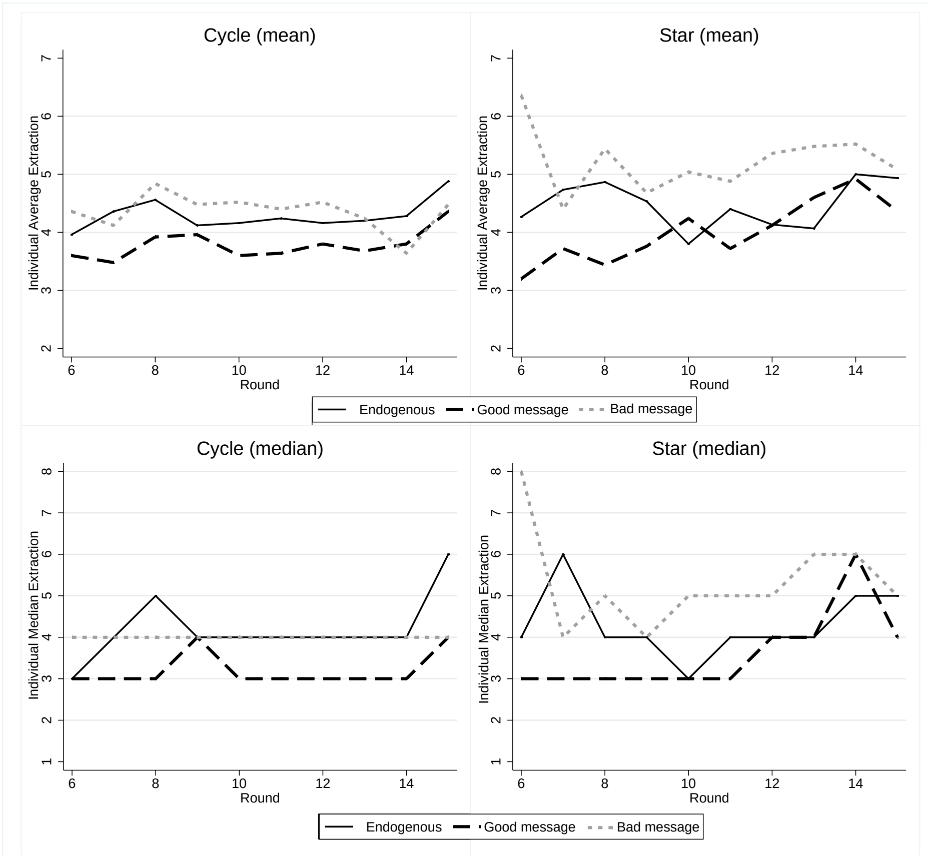
Figure 2 gives the average and median extraction levels once non-binding suggestions are introduced. Average values appear on top panels while median values, reported in other experimental works involving centralized suggestions in public goods games (Levy et al., 2011; Koukoumelis et al., 2012), appear on bottom panels.

For the *endogenous cycle* we found an average extraction level of 4.35 units in the first stage, and 4.29 units in the second stage. The difference, 0.06, is statistically non-significant (p-value 0.806). This result suggests that decentralized non-binding suggestions have no effect on aggregate behavior.

What happens when a single subject is exposed repeatedly to a "good" or a "bad" suggestion? A comparison between the *endogenous cycle* and the *bad*

[8]The difference with respect to the other sessions, 1.96 units, is statistically significant (p-value 0.000)

Figure 2: Mean and median extraction levels (by treatment)



message cycle shows that isolated "bad" messages have no effect. Average extraction levels are 4.29 and 4.36 respectively, and the difference between those levels is non-significant (p-value 0.733). On the contrary, the comparison between the *endogenous cycle* and the *good message cycle* reveals that "good" messages, even from a non-central node, reduce the average extraction level to 3.78 units. The difference, 0.51 units, is statistically significant (p-value 0.012).

The median extraction levels reveal the same result. The median in the *endogenous cycle* is 4 units in 7/10 of the rounds. For the *bad message cycle*, whose mean extraction level is not statistically different from the *endogenous* *cycle*, the median extraction value is 4 in 10/10 rounds. On the other hand, the median extraction level in the *good message cycle* is 3 in 8/10 of the rounds.

Does network centrality matter? Let us begin by analyzing the differences in the *endogenous star* before and after the introduction of non-binding suggestions. The average extraction level actually increases from 4.32 to 4.47, although its difference, 0.15, is not statistically significant (p-value 0.6404). This result suggest that centrality *per se* does not matter. However, "good" and "bad" centralized suggestions significantly alter the aggregate outcome. Consider first the *bad message star*: the average extraction level is 5.22 units, 0.75 higher than in the *endogenous star* (p-value 0.001). While isolated "bad messages" do not have an effect, centralized "bad messages" permanently increase the average extraction level. Consider now the *good message star*: the average extraction level from rounds 6 to 15 is 4.00, which means it is 0.47 units lower than in the *endogenous star* (p-value 0.066). However, if we consider only the game between Rounds 6 and 10, when the centralized "good" suggestion has a larger effect, the average extraction level with respect to the *endogenous star* is 0.77 lower (p-value 0.031).

For the star network the median extraction levels also reflect the same patterns found for the mean values of extraction. With the initial central suggestion, in Round 6, the median extraction level in the *bad message star* reaches 8 units. Although the median extraction level falls to 4 units in Round 7, it exhibits an increasing trajectory in subsequent rounds. On the other hand, the median extraction level in the *good message star* is 3 units between Rounds 6 and 11, but then it started increasing progressively, reaching 6 units in Round 14.

Our findings were tested econometrically using an OLS model with individual and session fixed effects. Estimation results are reported in Table 1. In regressions (1) to (3) all the participants are included. But given that subjects in Node A might behave differently given that they are transmitting an exogenously selected message and that the ammount of exchanged information vary across networks, we also perform the analysis excluding them. This cleaner test,

Table 1: OLS results: individual extraction level

VARIABLES	All nodes included			Node A excluded		
	(1)	(2)	(3)	(4)	(5)	(6)
Star	0.175	-1.426***	-2.988***	-0.0613	-2.206***	-2.997***
	(0.253)	(0.452)	(0.780)	(0.290)	(0.494)	(0.789)
Good message	-0.543**	-2.962***	-0.717	-0.810***	-3.620***	-0.761
	(0.219)	(0.463)	(0.790)	(0.246)	(0.506)	(0.802)
Bad message	0.0355	0.471	-0.788	-0.208	0.666	-0.781
	(0.211)	(0.448)	(0.780)	(0.233)	(0.491)	(0.789)
Star×Good message	-0.717	2.402***	3.054***	-0.0601	3.365***	2.954**
	(0.540)	(0.741)	(1.143)	(0.623)	(0.810)	(1.165)
Star×Bad message	0.159	1.826**	6.782***	0.487	2.085**	6.635***
	(0.503)	(0.742)	(1.141)	(0.573)	(0.812)	(1.163)
Round	0.00844	0.000362	0.00923	0.0118	0.00262	0.0117
	(0.0318)	(0.0289)	(0.0225)	(0.0351)	(0.0317)	(0.0255)
Round×Star×Good message	0.141**	0.266***	0.128***	0.151*	0.274***	0.153***
	(0.0712)	(0.0634)	(0.0496)	(0.0821)	(0.0695)	(0.0560)
Round×Star×Bad message	0.0728	0.0801	0.0721	0.0974	0.107	0.0975*
	(0.0641)	(0.0620)	(0.0483)	(0.0728)	(0.0680)	(0.0546)
Others' Mean Lagged extraction	-0.0363	-0.687***	0.0277	0.0153	-0.629***	0.00756
	(0.0579)	(0.0678)	(0.0581)	(0.0653)	(0.0755)	(0.0660)
Constant	4.432***	7.774***	4.258***	4.209***	7.706***	4.339***
	(0.342)	(0.482)	(0.633)	(0.388)	(0.531)	(0.660)
Session Fixed Effects	No	Yes	Yes	No	Yes	Yes
Individual Fixed Effects	No	No	Yes	No	No	Yes
Observations	1,260	1,260	1,260	1,008	1,008	1,008
R-squared	0.037	0.194	0.556	0.052	0.249	0.557

Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

reported in regressions (4) to (6), confirms our results.

We previously stated that "bad messages" do not have an effect within the cycle but they do permanently increase average extraction in the star. The *Bad message* coefficients are non-significant, while the *Star* × *Bad message* coefficients are positive and significant once we control for session and individual fixed effects. In addition, the terms *Round* × *Star* × *Bad message* are not statistically significant, suggesting that the negative effect of the "bad messages" does not change over time.

We also stated that "good" messages have a permanent effect in the cycle and only a temporary effect in the star. The *Good message* coefficients are negative and significant before the introduction of individual fixed effects, indicating the positive effect (the reduction in extraction is welfare enhancing) of low extraction messages. In addition, the positive and significant coefficients of the the terms *Star* × *Good message* and *Round* × *Star* × *Good message* confirm that the reduction in the extraction level under the centralized structure is only temporary.

When individual fixed effects are introduced, the significance of the *Good message* coefficient disappears. We argue that the effect of the good messages is driven by unobserved characteristics of particular individuals, such as fairness and reciprocity concerns, as well as their propensity to follow the incoming non-binding suggestions.

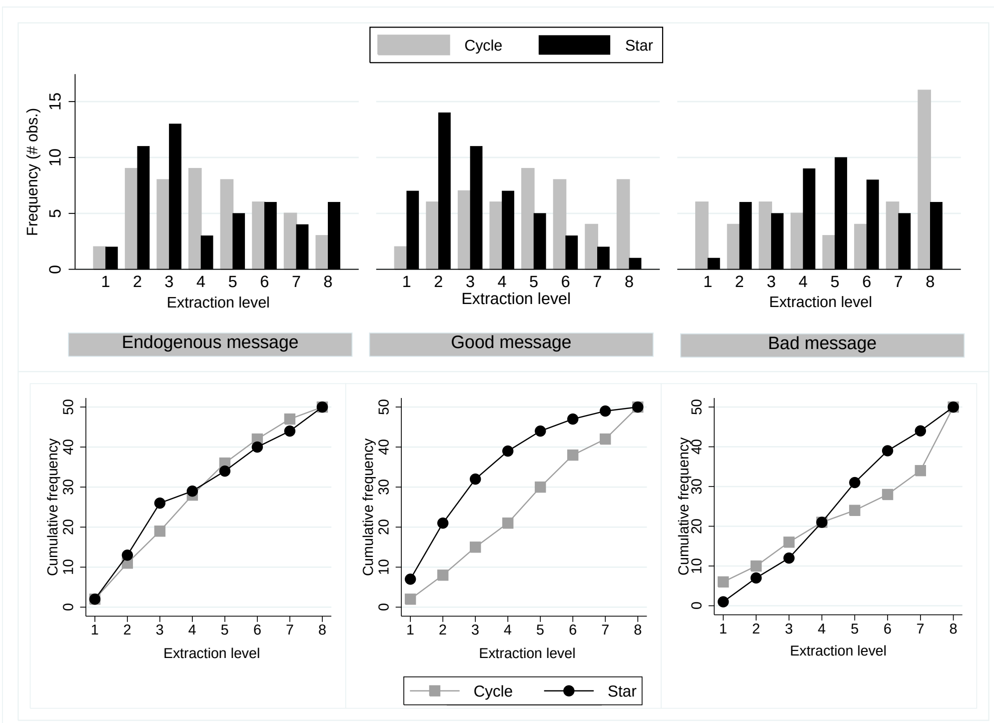
An additional result in the regression, though not seen clearly in Figure 2, is that the *Star* coefficient is negative and significant, suggesting that centrality *per se* reduces extraction levels. This effect, however, might be conditioned to specific characteristics of a session, such as participants' closeness or the group's aggregate extraction in early rounds, given that it does not appear in regressions (1) and (4).

As a robustness check, we estimate the models in Table 1 introducing left and right censoring in our dependent variable. Given that our action set is $x_i \in \{1, 2, \ldots, 8\}$, decisions are limited by the minimum and maximum extraction levels allowed. Tobit estimation results are shown in Table A.3 in the Appendix. In this two-sided censored model, significance levels do not change and coefficients are larger (in magnitude) with respect to the OLS regression.

3.2. Centrality and prosociality

Although subjects in central nodes may take advantage of their relative position, by suggesting a low level and then extracting more than suggested, we found that fishermen randomly assigned to Node A in the star engage in a more cooperative behavior than those assigned to Node A in the cycle. The distribution and the cumulative frequency of the extraction levels from subjects located in node A are shown in Figure 3.

Figure 3: Frequency (top) and cumulative frequency (bottom) of extraction levels from subjects randomly assigned to node A



Exogenous “good” messages from the central node shift the distribution of extraction to the left, i.e. towards lower extraction levels, as is also reflected in the cumulative frequency graph. For a centralized “bad” message the distribution is shifted in the same direction, but in this case the largest differences between networks lie on the intermediate extraction levels. For the star, 54% of the observations lie in $x \in \{4, 5, 6\}$ while for the cycle this share only reaches the 24%. This is also evidenced in the bottom panel, where the cumulative frequency in the star only surpasses the cumulative frequency in the the cycle when $x \geq 4$.

The relationship between centrality and cooperative behavior is less pronounced for the endogenous message treatment. The only signal of more cooperative behavior in the star comes from the frequency peak between 2 and 3 extraction units. 48% of the observations lie within $x \in \{2, 3\}$ in the star, compared to only 34% in the cycle. Nevertheless, the differences between network structures are less evident when we examine the cumulative frequencies.

We tested the correlation between node's centrality and lower extraction levels via an OLS regression. Our estimates, including individual fixed effects, are shown in Table 2. In Model (1) the interaction *Star*×*Stage 2*, a difference-in-difference estimator, is negative and significant, confirming the engagement in prosocial behavior from the central nodes once their position in the network is revealed for the second stage of the game. In this model, the *Star* coefficient is also significant, suggesting preexisting differences between subjects. However, as is shown in Model (2), this effect disappears once we exclude from our regression the two sessions with community leaders discussed in subsection 3.1.

In Models (3) and (4) observations from the first stage are excluded in order to test our result using a single differences estimator. Our parameter of interest, comparing Node A between networks in the same stage, is now the *Star*. This coefficient is negative and significant (p-value 0.061 and 0.069 in models (3) and (4) respectively). In addition, in these models the R-squared value also increases with respect to Models (1) and (2).

4. Discussion

Results show that "good" and "bad" suggestions have different effects according to the network structure through which they are spread. "Good" sug-

Table 2: OLS results: Node A's extraction level

VARIABLES	Stages 1 and 2		Stage 2 only	
	(1)	(2)	(3)	(4)
Star	-1.040*	-0.944	-1.291*	-1.292*
	(0.630)	(0.654)	(0.687)	(0.703)
Star×Stage 2	-0.617**	-0.747**		
	(0.299)	(0.338)		
Good message	0.904	0.866	0.770	0.762
	(0.650)	(0.668)	(0.719)	(0.737)
Good message×Stage 2	-0.363	-0.253		
	(0.351)	(0.378)		
Bad message	0.328	0.269	0.786	0.787
	(0.638)	(0.657)	(0.688)	(0.704)
Bad message×Stage 2	0.117	0.211		
	(0.346)	(0.369)		
Star×Good message	-0.374	-0.397	-0.963	-0.956
	(0.847)	(0.869)	(0.990)	(1.014)
Star×Bad message	0.371	0.355	-0.0204	-0.0181
	(0.844)	(0.866)	(0.973)	(0.996)
Constant	3.849***	3.761***	4.250***	4.318***
	(0.648)	(0.673)	(0.752)	(0.777)
Excluded Sessions	No	Yes	No	Yes
Observations	450	420	300	280
R-squared	0.476	0.445	0.556	0.533

Included controls: Round, average lagged extraction from the rest of the group and individual fixed effects. Robust standard errors in parentheses.

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

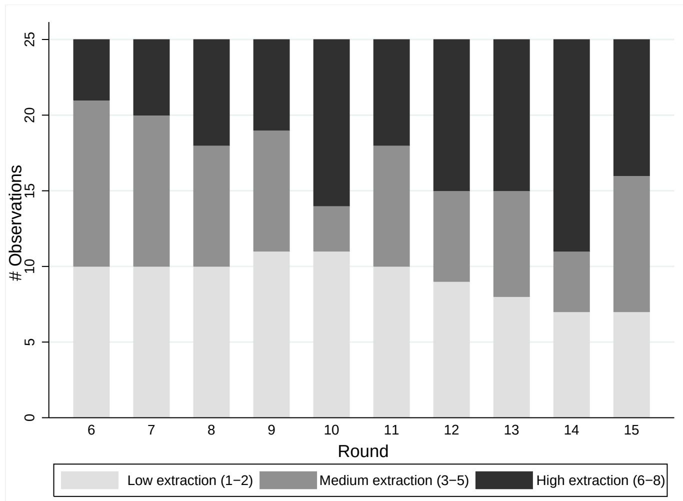
gestions, those that promote lower extraction levels, have only a temporary impact when they are transmitted by a central node. The same suggestion, transmitted by a non-central node, has a long-standing impact on the aggregate extraction level. "Bad" suggestions, encouraging higher extraction levels, lead to a permanent increase in aggregate extraction when they are transmitted by a central node. However, the effect disappears when these exogenous "bad" messages are transmitted by a non-central node.

Given that the network structure is known beforehand among subjects, the outgoing suggestion from the star's central node is also common knowledge. Therefore, the incentives to coordinate through this public signal depend on the message type and the presence of conditional cooperators. A commonly known "bad" suggestion will update the expectations about others' behavior towards higher extraction levels, aligning the expected responses from conditional cooperators and self-regarding subjects in the same direction. On the contrary, an incoming "good" suggestion will update conditional cooperators' initial expectations towards lower extraction levels, i.e., in the opposite direction of the self-regarding subjects' expected behavior. When feedback on aggregate behavior reveals the presence of non-compliers to the coordination signal, presumably self-regarding subjects, conditional cooperators will react by increasing their extraction level.

The following exercise is proposed to analyze if the increase in the average extraction level with the public "good" message is due to the crowding out of conditional cooperators. Figure 4 shows, for the *good message star* treatment, the cumulative frequency of extraction levels categorized as Low (1-2), Intermediate (3-5) and High (6-8). In early rounds, when the "good" message has an effect, the share of low extractors is held constant. The increasing share of high extractors is compensated by a reduction in the number of intermediate extractors. Only when the aggregate extraction level is large enough, does the share of low extractors start declining. This result suggests that low and intermediate extractors respond reciprocally to the increase in total extraction, but at different aggregate extraction levels.

Let us go back to the between-network analysis. In the cycle, the exogenous suggestion does not provide a coordination signal because this message is received by a single subject, as are the other messages transmitted in this network. If a "bad" suggestion is not common knowledge it is no longer a coordination signal costly to omit. This argument could explain why "bad" messages did not have an impact in the cycle. However, this argument is not enough to ex-

Figure 4: Number of observations for low (1-2), medium (3-5) and high (6-8) extraction levels in the *good message star*



plain why "good" suggestions reduce average extraction within this network. We speculate that the reason why "good" suggestions are followed, even when they are private and not public suggestions, is because they are seen as a chance for participants to commit to a mutually beneficial strategy.

Some may argue that the comparison between the star and the cycle, given an exogenous "good" or "bad" message, is not entirely valid. In the former network this message is being received by four subjects, while in the latter it is being received by only one subject. Therefore, the "ideal" counterfactual for the *good message star* (*bad message star*) will be a cycle in which all subjects, independent of each other, recommend to their neighbor to extract 1(8) unit(s). Although we do not have one single round in which all participants in the cycle suggested 1 or 8 units, we construct two approximate counterfactuals for each comparison of interest as is shown in Table 3.

To assess the effect of centralized "good" suggestions we took a subsample of sessions that, in a given round, are characterized by *(i)* an average suggestion of less than 2 units or *(ii)* a median suggestion of 1 unit. Results show that, for the first five rounds, the difference in average extraction level between the star

Table 3: Extraction differences between-networks with suggestions' similarity

	Mean extraction under a "good" suggestions' environment					
	All ten rounds (6-15)			First five rounds (6-10)		
	Star	Cycle	Difference	Star	Cycle	Difference
Average suggestion < 2	4.071	3.657	0.414	3.175	3.657	-0.482
	(N=70)	(N=35)	($p = 0.439$)	(N=40)	(N=35)	($p = 0.384$)
Median suggestion $= 1$	4.066	3.100	0.966*	3.171	3.100	0.071
	(N=75)	(N=30)	($p = 0.074$)	(N=35)	(N=30)	($p = 0.899$)
	Mean extraction under a "bad" suggestions' environment					
	All ten rounds (6-15)			First five rounds (6-10)		
	Star	Cycle	Difference	Star	Cycle	Difference
Average suggestion ≥ 6	5.433	4.573	0.860*	7.200	4.573	2.627**
	(N=30)	(N=75)	($p = 0.065$)	(N=5)	(N=75)	($p = 0.007$)
Median suggestion ≥ 7	5.866	4.738	1.128**	7.600	4.738	2.862***
	(N=45)	(N=65)	($p = 0.007$)	(N=10)	(N=65)	($p = 0.000$)

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

and the cycle is non-significant. The results are similar if we take into account the whole second stage under condition *(i)*. For the remaining condition we found that the extraction level is lower in the cycle than in the star. This result supports the statement that "good" messages have a longer impact under decentralized communication structures.

Similarly, the *bad message star* is compared to a subsample of sessions that, in a given round, are characterized by *(i)* an average suggestion of at least 6 units or *(ii)* a median suggestion of at least 7 units. As shown in the bottom of Table 3, for subsamples *(i)* and *(ii)*, for 5 and 10 rounds, the extraction levels are larger in the star than in the cycle and the difference between networks is statistically significant. Given that all subjects were receiving "bad" suggestions in both networks, the additional extracted level in the star can be attributed to the common knowledge of the centralized message.

The other result described in this work is the positive correlation between network centrality and cooperative behavior, in particular when the central node transmits an exogenous message. Brañas-Garza et al. (2010) and Kovarik et al.

(2012) previously noted the positive correlation between other-regarding attitudes and centrality parameters from an endogenous network. Therefore, part of our contribution is to extend the importance of highly-connected individuals in the emergence of prosocial behavior to exogenously defined networks.

One remaining question is why the engagement in cooperative behavior is more notorious in central nodes transmitting exogenous rather than endogenous suggestions. One may think that the exogenous message is perceived by the transmitter as a hint or a normative cue provided by the experimenter. However, if this hypotheses is true, we should expect less instead of more cooperative behavior in the *bad message star*. Another possibility is that the additional instructions make the participant feel that the experimenter's attention is focused on him. Nevertheless, even if this magnification of the "observer effect" is driving our results, we could posit that the additional attention perceived by the central node is also perceived in endogenous networks from real life due to their non-anonymity in these leadership positions.

Even if we do not find differences between networks for the endogenous messages, it still implies that subjects in the central node in the star were not exerting all the power granted by their key position in the network. According to the empirical literature in sociology, this is the result of the commitment relationships developed by those subjects in a hierarchical position within the network (Cook and Emerson, 1978).

5. Concluding remarks

Communication structures are determinant in the provision of cheap coordination signals that are able to modify, at least temporarily, individuals' behavior towards the open access CPR extraction. We introduced anonymous non-binding suggestions in the experimental design originally proposed in Cárdenas (2004). These messages were transmitted through a network structure determining who sends a message to whom.

We studied how both the network structure, centralized or decentralized, and the message type, “good” or “bad,” affect the individual’s extraction levels. In centralized networks “good” suggestions have only a temporary effect while “bad” suggestions have a permanent effect. In decentralized networks “good” suggestions have a permanent effect while “bad” suggestions do not have any impact. We provided an explanation suggesting that messages from the central node are public signals potentially used as coordination mechanisms. These are more effective if they align the expectations of conditional cooperators and self-regarding subjects towards the same direction, which occurs for the “bad” but not for the “good” message.

The positive correlation between node’s centrality and cooperative behavior extend the importance of hierarchical positions in the emergence of prosocial attitudes from endogenous networks previously explored in the literature to the exogenous networks implemented in this work. This finding may motivate further studies that seek to disentangle the effects of the intrinsic characteristics of the leaders from the structural features of their network’s position.

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Appendix

A.1. Experimental instructions

The following instructions were presented in Spanish to the players. These instructions were read to the participants from the script below by the same person during all sessions. The participants could interrupt and ask questions at any time. Whenever the following type of text and font e.g. [. . .MONITOR: distribute PAYOFFS TABLE to participants. . .] is found below, it refers to specific instructions to the monitor at that specific point.

Instructions

Greetings. We want to thank everyone here for attending the call, and special thanks to the *(local organization that helped in the logistics)* that made this possible. We will spend about two hours 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 Monday (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 have earned during the game. The funds to cover these expenditures have been donated by the Latin American and Caribbean Environmental Economics Program.

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 in which a group of families must make decisions about how to use the resources of, for instance, the sea, a mangrove, a fishery, or any other case where communities use a natural resource. 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 selected to participate in a group of five people among those who have signed up for playing. 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. You will play for several rounds equivalent, for instance, to 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. . .]

The PAYOFFS TABLE

We call this game **THE FISH MARKET** given the similarity between the **PAYOFFS TABLE** and the mechanism that assigns the price of the fish based on the aggregated catch. [. . .MONITOR: Explain that when fish is abundant the price decreases and the earnings per unit caught are reduced. As an analogy, explain that when fish is scarce its price increases. After this basic explanation, ask participants what will happen with the earnings of a hypothetical player with low extraction when the rest of the group has high levels of extraction. Similarly, ask participants about the inverse case. . .] If we have understood the payoffs in each round, now we can introduce the **PAYOFFS TABLE**.

Table A.1: Payoffs table

		MY LEVEL OF EXTRACTION							
		1	2	3	4	5	6	7	8
THEIR LEVEL OF EXTRACTION	4	2273	2370	2453	2520	2573	2610	2633	2640
	5	2213	2310	2393	2460	2513	2550	2573	2580
	6	2153	2250	2333	2400	2453	2490	2513	2520
	7	2093	2190	2273	2340	2393	2430	2453	2460
	8	2033	2130	2213	2280	2333	2370	2393	2400
	9	1973	2070	2153	2220	2273	2310	2333	2340
	10	1913	2010	2093	2160	2213	2250	2273	2280
	11	1853	1950	2033	2100	2153	2190	2213	2220
	12	1793	1890	1973	2040	2093	2130	2153	2160
	13	1733	1830	1913	1980	2033	2070	2093	2100
	14	1673	1770	1853	1920	1973	2010	2033	2040
	15	1613	1710	1793	1860	1913	1950	1973	1980
	16	1553	1650	1733	1800	1853	1890	1913	1920
	17	1493	1590	1673	1740	1793	1830	1853	1860
	18	1433	1530	1613	1680	1733	1770	1793	1800
	19	1373	1470	1553	1620	1673	1710	1733	1740
	20	1313	1410	1493	1560	1613	1650	1673	1680
	21	1253	1350	1433	1500	1553	1590	1613	1620
	22	1193	1290	1373	1440	1493	1530	1553	1560
	23	1133	1230	1313	1380	1433	1470	1493	1500
	24	1073	1170	1253	1320	1373	1410	1433	1440
	25	1013	1110	1193	1260	1313	1350	1373	1380
	26	953	1050	1133	1200	1253	1290	1313	1320
	27	893	990	1073	1140	1193	1230	1253	1260
	28	833	930	1013	1080	1133	1170	1193	1200
	29	773	870	953	1020	1073	1110	1133	1140
	30	713	810	893	960	1013	1050	1073	1080
	31	653	750	833	900	953	990	1013	1020
	32	593	690	773	840	893	930	953	960

To be able to play you will receive a **PAYOFFS TABLE** equal to the one shown in the poster. [. . .MONITOR: show PAYOFFS TABLE in poster and distribute **PAYOFFS TABLES** to participants. . .] This table contains all the information that you need to make your decision in each round of the game, as we will see now. The numbers that are inside the table correspond to the money that you would earn in each round.

To play in each round you must write your decision number between 1 and 8 on the yellow **GAME CARD** like the one I am about to show you. [. . .MONITOR: show **GAME CARDS** and show in the poster. . .] When you choose your desired level of extraction, you are selecting the column of the **PAYOFFS TABLE** corresponding to the earnings of the round. It is very important that we keep in mind that the decisions are absolutely individual,

that is, that the numbers we write in the **GAME CARD** are private and that we do not have to show them to the rest of members of the group if we do not want to.
The monitor will collect the **5 GAME CARDS** from all participants, and will add the total units of extraction that the group has decided to allocate. The difference between the total extraction of the group and your individual extraction will indicate the row in the **PAYOFFS TABLE** to calculate your round earnings. Please remember, your level of extraction indicates the column and the level of extraction of the rest of the group indicates the row in the **PAYOFFS TABLE**. With this information, the monitor will help calculate the points that you earned in the round, and you will write your earnings in the **DECISION FORM**.
In this game we assume that each player extracts a maximum of 8 units of a resource like fish or oysters. In reality this number could be larger or smaller, but for purposes of our game we will assume 8 as maximum. In the **PAYOFFS TABLE** this corresponds to the columns from 1 to 8. Each of you must decide from 1 to 8 in each round and, given that you will only know your own decision, the monitor will publicly announce the group's total extraction. With this information you will be able to calculate your earnings using the **PAYOFFS TABLE**. If you need help the monitor will calculate your payoff in each round. Let us explain again with some examples. Suppose you decide to extract 2 units and the monitor announces that the group extracted 22 units. Your earnings correspond to the cell in the second column in which the rest of the group extracted 20 units. Let us look at other examples in the poster [. . .MONITOR: show an example with each player. Then, show more examples where participants explain to others how they calculate their earnings].

The DECISIONS FORM (First Stage Rounds 1 to 5)

To play each participant will receive one green **DECISIONS FORM** like the one shown in the poster in the wall. We will explain how to use this sheet. [. . .MONITOR: show the **DECISIONS FORM** in the poster and distribute the **DECISIONS FORMS**. . .]. With the same examples, let us see how to use this **DECISIONS FORM**. Now, suppose that you decided to play 2 units in this round. In the yellow **GAME CARD** you should write 2. Also you must write this number in the second column of the decisions form. The monitor will collect the 5 yellow cards, will add and will inform the total of the group. In this example 22 units were extracted. He will help you complete the last two columns of the **DECISION FORM** with the average extraction from the other players and your period earnings.
It is very important to clarify that nobody, except for the monitor, will be able to know the number that each of you decides in each round. The only thing announced in public is the group total, without knowing how each participant in your group played. It is important to repeat that your game decisions and earnings information are private. Nobody in your group or outside of it will be able to know how many points you earned or your decisions during rounds. If at this moment you have any question about how to earn points in the game, please

raise your hand and let us know. [. . .MONITOR: pause to resolve questions. . .] If there are no further questions about the game, then we will assign the numbers for the players and the rest of forms needed to play.

Preparing for playing

Now write down your player number and name in the **DECISIONS FORM**. Also write the current date and time. Now we will summarize for you the steps to follow to play in each round. Please raise your hand if you have a question. [MONITOR: Summarize the steps to follow in each round. . .]

We will start with a practice round to test that the activity instructions have been understood. The earnings from the practice round will NOT be included in the total earnings of the game. After practicing the game in this initial round we will play for 15 rounds for cash. Once we complete the fifth round we will pause to give you a new **DECISIONS FORM** and to introduce a new rule in the activity. To start the first round of the game we will organize the seats and desks to guarantee that your decisions and earnings information are private. Finally, to get ready to play the game, please let us know if you have difficulties reading or writing numbers. If so, one of the monitors will sit next to you and assist you with these. Also, please keep in mind that from now on there should be no conversation nor should you make any statements during the game, unless you are allowed to. We can now start with the practice round, the earnings of which will NOT count toward your real earnings, as they are just for practicing the game.

Given that we understand how the activity works, now we can proceed to sign the **INFORMED CONSENT** that will be read now [. . .MONITOR: Read the **INFORMED CONSENT** and verify that all participants sign it. . .]

The DECISIONS FORM (Second Stage Rounds 6 to 15)

We have completed Round 5 and, as we announced at the beginning of the exercise, we will introduce a new rule. From now on you can send **RECOMMENDATIONS** with the level of extraction desired from other players, in a number from 1 to 8. The number of participants that will receive your message will depend on your location in the **NEIGHBORS STRUCTURE** shown in the poster. [. . . MONITOR: show the poster with the **NEIGHBORS STRUCTURE**. . .] In this structure each one of you is represented by one of the white circles labeled with the corresponding player number. These numbers will allow you to determine your location and your connections to other participants. Each one of the lines corresponds to a connection between two players. The number of lines will indicate the number of connections for each one of you.

Remember that you will not be able to know the player number of the rest of players before, during or after the conclusion of the game. This means that sent and received **REC-**

OMMENDATIONS will remain anonymous. To confirm that you have understood the **NEIGHBORS STRUCTURE** the monitor will ask you about the connections of a particular circle [. . .MONITOR: Use the poster to ask for the neighbors of a couple o nodes. . .]
Now you will receive the new **DECISIONS FORM** like the one shown in the poster. [. . . MONITOR: show the poster with the DECISIONS FORM and distribute the **DECISIONS FORM** to participants. . .] This new form includes an extra column. Let's see how to use it according to the new rule of the game. At the beginning of each round, and only if you want, you can write in the second column the **UNITS OF EXTRACTION** that you recommend to your neighbors. In case you'd rather not send any recommendation you should write **"NO"** in the second column. The monitor will collect all the recommendations and he will privately show to each one of you the RECOMMENDATIONS received using the **MESSAGE EXCHANGING BOARD**. [. . . MONITOR: show the **MESSAGE EXCHANGING BOARD**. . .] You will be able to decide your **EXTRACTION LEVEL** only after the monitor shows you the **RECOMMENDATIONS** sent to you.

It is important to clarify that sending or receiving a particular **RECOMMENDATION** does not imply any kind of commitment from you or from any other participant. You're not obligated to follow the sent or received **RECOMMENDATION**; hence, if you want you can extract a different level from this **RECOMMENDATION**.

The rest of the **DECISIONS FORM** will be completed as in the first part of the game. You will write your **LEVEL OF EXTRACTION** in the third column and in the **GAME CARD**. The monitor will collect the five **GAME CARDS** and will announce the total extraction of the group. Finally, the monitor will help you complete the last two columns of the **DECISIONS FORM** with the extraction of the rest of the group and your earnings of the round.

Remember that your decisions and earnings information are private, and not even your neighbors according to the **NEIGHBORS STRUCTURE** will access this information. The new rule of the game introduces a preliminary step in each round to exchange **RECOMMENDATIONS** according to the **NEIGHBORS STRUCTURE**. After this step each round will be similar to the first stage of the activity. Please remember that you're not obligated to send a **RECOMMENDATION**, and that these messages do not directly affect your earnings. If at this moment you have any question about how to earn points in the game, please raise your hand and let us know. [. . .MONITOR: pause to resolve questions. . .]

Now write down your player number and name in the new **DECISIONS FORM**. We will next summarize for you the steps to follow to play in each round. Please raise your hand if you have a question. [MONITOR: Summarize the steps to follow in each round. . .] We will play with the new rule for another ten rounds.

Flipping a coin to determine the exogenous RECOMMENDATION (Player A only)

You have been selected to play a special role in this game: your sent **RECOMMENDATION** will be determined by a coin toss. You will toss this coin. If the coin lands on this side (heads) during the next 10 rounds you will send a **RECOMMENDATION** to extract **1 UNIT**. If the coin lands on this side (tails) during the next 10 rounds you will send a **RECOMMENDATION** to extract **8 UNITS**. Please bear in mind that the coin indicates the **RECOMMENDATION** that you must send, but you can freely choose your desired level of extraction. Please take into account that **NOBODY BUT YOU** knows that you were selected to play this role in the game. Only you know that your sent **RECOMMENDATION** will be determined by the COIN FLIPPING.

If you don't have any more questions please flip the coin I've just given you to determine your **RECOMMENDATION** to the other players. [. . . MONITOR: Give the coin to the participant, observe the outcome and confirm that the player's **RECOMMENDATION** procedure is clear. . .]

A.2. Additional Tables

Table A.2: Differences in extraction levels across treatments in the baseline

	Endogenous cycle	Good message cycle	Bad message cycle	Endogenous star	Good message star	Bad message star
Endogenous cycle	0.000					
	(1.000)					
Good messase cycle	-0.312	0.000				
	(0.263)	(1.000)				
Bad message cycle	-0.128	0.184	0.000			
	(0.648)	(0.500)	(1.000)			
Endogenous star	0.032	0.344	0.160	0.000		
	(0.922)	(0.279)	(0.618)	(1.000)		
Good message star	0.016	0.328	0.144	-0.016	0.000	
	(0.953)	(0.221)	(0.594)	(0.959)	(1.000)	
Bad message star	-0.448*	-0.136	-0.320	-0.480	-0.464*	0.000
	(0.091)	(0.595)	(0.216)	(0.106)	(0.067)	(1.000)

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

Table A.3: Tobit regression results: individual extraction level

VARIABLES	All nodes included			Node A excluded		
	(1)	(2)	(3)	(4)	(5)	(6)
Star	0.279	-1.818***	-3.875***	-0.0211	-2.749***	-3.900***
	(0.331)	(0.589)	(1.003)	(0.376)	(0.649)	(1.023)
Good message	-0.645**	-3.793***	-0.717	-0.982***	-4.693***	-0.750
	(0.290)	(0.612)	(0.958)	(0.329)	(0.678)	(0.981)
Bad message	0.0999	0.645	-0.698	-0.204	0.894	-0.690
	(0.286)	(0.579)	(0.934)	(0.324)	(0.639)	(0.952)
Star×Good message	-1.191*	2.991***	3.704***	-0.381	4.274***	3.532**
	(0.700)	(0.974)	(1.431)	(0.799)	(1.079)	(1.474)
Star×Bad message	0.101	2.461**	10.11***	0.542	2.870***	10.02***
	(0.691)	(0.967)	(1.636)	(0.786)	(1.068)	(1.679)
Round	0.00937	-0.000496	0.00974	0.0131	0.000858	0.0130
	(0.0414)	(0.0378)	(0.0279)	(0.0470)	(0.0417)	(0.0317)
Round×Star×Good message	0.199**	0.355***	0.185***	0.215**	0.365***	0.223***
	(0.0908)	(0.0838)	(0.0625)	(0.103)	(0.0926)	(0.0720)
Round×Star×Bad message	0.0931	0.0962	0.0863	0.122	0.126	0.115*
	(0.0891)	(0.0812)	(0.0594)	(0.102)	(0.0899)	(0.0681)
Others' Mean Lagged Extraction	-0.0559	-0.895***	0.0439	0.0148	-0.822***	0.0291
	(0.0761)	(0.0900)	(0.0723)	(0.0877)	(0.101)	(0.0829)
Constant	4.509***	8.748***	4.083***	4.196***	8.618***	4.131***
	(0.457)	(0.630)	(0.771)	(0.524)	(0.699)	(0.813)
Group Fixed Effects	No	Yes	Yes	No	Yes	Yes
Individual Fixed Effects	No	No	Yes	No	No	Yes
Observations	1,260	1,260	1,260	1,008	1,008	1,008

Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Model censored at 1 extraction unit as lower limit and 8 extraction units as upper limit

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