ENDOGENOUS INSTITUTIONS: A NETWORK EXPERIMENT IN NEPAL

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ABSTRACT

In developing countries where formal institutions are often weak, peer monitoring represents a natural mechanism for the enforcement of agreements. This paper studies the demand for monitoring and its effectiveness in sustaining cooperation across social groups. Mapping the social networks of 19 Nepali villages, we conduct an experiment to explore the role of the endogenous choice of monitors on cooperation. The paper shows that closely knit groups are 40% points less likely to choose a central monitor, while sparse groups tend to prefer a monitor who is highly central in the network. The democratic selection of monitoring improves cooperation by up to 22% compared to an exogenous assignment, but only in sparse groups. Further, we observe that in sparse groups the positive effect of endogenous monitoring can spill-over to games played under exogenous assignment.

KEY WORDS: NETWORK, PEER MONITORING, EXPERIMENT, PUBLIC GOOD GAME.
JEL CLASSIFICATION: C93, L14, P48.

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1. Introduction

Peer based monitoring has applications from credit markets to labor outcomes (Besley and Coate 1995). However, its effectiveness for public good provision and community resource management has been understudied. In a seminal study, Ostrom (1991) suggests how such mechanisms based on peer effects and social ties sustain cooperation in community resource management rather than mere punishment.[1] One plausible channel for the effectiveness of peer based monitoring is represented by the fact that individuals care about their reputation. Breza and Chadrashekhar (2019) establishes that reputation concerns act as a plausible channel through which peer monitoring works. We extend this further in two main directions in the context of community based institutions and public good provision. First, we study the demand for peer monitors across different social groups. Second, we show that the impact of allowing people to choose their monitor is heterogeneous across different group composition.[2] We focus on the role of social networks in the choice of these institutions and their impact on cooperation.

In developing countries where formal institutions are often weak or non-existent, the enforcement of local agreements is based on the community. Its individuals coordinate to select a monitoring institution to oversee the functioning of the agreement. This is also the case in Nepal where in the recent past we have seen an upsurge in the number of community based organizations for the management of common pool resources (e.g. FUGs, Forest Users Groups). The striking power of such peer based institutions is to self-impose behaviors that bring about increased welfare through community-based responsibility and authority. Departing from this real-case study we want to generalize and deepen our understanding of how a group of people decide whom to elect as their own monitor and how this choice in turn impacts cooperative behavior.

We conduct a lab in the field experiment in 19 villages in rural Nepal to understand third party monitoring and cooperation. Villagers play a cooperation game and can choose to elect a monitor through majority voting. This monitor can impose higher cooperation through reputational concerns. Concerns of social image are important drivers of cooperative behavior since people fear bad reputation. Third party monitoring can substitute for social density by emphasizing these very reputational concerns (Greif, 1989; Bowles, 2008; Andreoni et al., 2020). Further, the impact of the monitor may depend on their position in the social network[3] and on the political process whereby it is assigned to groups. We explore the effects of monitoring induced by

[1] There exists a rich literature that studies the effect of punishment on public good games. For more details see Charness et al., 2008; Glockner et al., 2007; Kosfeld and Rustagi, 2015; Fonseca, 2018 and Fehr and Sutter, 2019.

[2] See Olken, 2007; Bjorkman et al., 2009 and Gelade, 2018. Unlike direct reporting in these papers, our experiment relies on reputational concerns affected via gossip by the chosen monitor.

[3] Central individuals in the network are shown to be particularly effective in monitoring due to their higher ability of spreading information in the form of gossip (Ballester et al., 2006 and Banerjee et al., 2019)

reputation concerns[4] rather than by material punishment. Two main pieces of evidence emerge from previous research. First, dense groups are able to sustain more cooperation than socially distant groups. Second, monitors have the power to relax the inefficiencies arising from contractual incompleteness in the context of socially distant groups (Breza and Chandrashekhar, 2019; Breza et al., 2016; Chandrashekhar et al., 2018). These studies focus on the impact of exogenously assigned monitors on cooperation in groups.

The aim of this paper is to bring the literature forward by allowing individuals to endogenously elect their preferred monitor and by studying the induced cooperative behavior. We estimate the demand for monitoring, relate it to the network structure and study its impact on cooperation by tackling three subsequent questions. First, do individuals change their demand for monitoring as a function of the social composition of the group they interact with? Second, do monitors who are endogenously chosen spur cooperative behavior compared to those assigned exogenously? Third, is the election of monitors perceived as a signal of intra-group trust? To answer these questions, we conduct a lab in the field experiment in rural Nepal and build a theoretical model supporting our experimental findings.

First, we ask whether groups with different social proximity elect different third party institutions. In line with the literature, we offer three monitoring options, according to a measure of social prominence. We present strong evidence that socially distant groups are more likely than closely-knit groups to elect a high central monitor. We find that individuals are 40% less likely to elect a monitor with their close peers compared to when they are in groups with socially distant members. This supports the idea that contractual incompleteness can be mitigated by social density, but socially distant individuals need third party institutions to enforce social norms and increase efficiency.[5]

Secondly, we investigate whether the political process by which the institution is chosen matters for cooperative behavior. Interestingly, we find that a monitoring institution that is democratically elected has strong positive effects on cooperation compared to an institution assigned randomly. Previous experimental evidence in economics (Sutter et al., 2010; Tyran and Feld, 2006; Dal Bo et al., 2010) and sociology (Grossman and Baldassarri, 2012) shows that cooperation is higher when players are given the opportunity to choose the institution rather than having an externally imposed one. We further investigate this dimension, and we offer evidence that the positive impact of endogenous institutions is limited to socially distant groups. More precisely, the magnitude of the increase in contribution ranges from 8.6% when

[4]Individuals rely on local connections for risk sharing, public good provision and information delivery. Social image and trust therefore become more important. See Kranton 1996; Leider et al., 2009

[5]In line with this reasoning Glaeser et al., 2000 establish that groups with shorter social distance have higher trust. In the same spirit, experiments in the lab (Hoffman et al., 1996; Leider et al., 2009; Goeree et al., 2010) and in the field (Etang et al., 2011; Baldassarri and Grossman, 2013) show that cooperation increases with decreasing social distance.

a socially prominent monitor is chosen to 21.9% when no monitor is chosen. In socially close groups, the point estimate is negative and not significant. The possible mechanism underlying this "democracy premium" can be explained by an increased sense of agency and control, increased sense of authority (Greif, 2006) and stronger worthiness of authority (Zelditch, 2001).

Third, we present the first evidence of heterogeneous impact of asymmetric information in different social groups. The theoretical literature of principal-agent models (Herold, 2010) shows that the proposal of a complete contract can signal distrust. On this basis, we explore if group members perceive the election outcome as a signal of intra-group trust. Individuals in closely-knit groups are particularly affected by the outcome of the vote. We find that the group interprets the outcome of the vote as a strong signal of trust when no monitor is chosen. This entails a significant increase in contribution by 17.7% in sparse groups. On the contrary, dense groups perceive the election of a high central monitor as a signal of mistrust leading to a decrease in contribution by 11.4%. This finding sheds light on the heterogeneity of the effects of signaling when we take into account the social structure of agents.

We build these results on novel network data, collected through an intensive network survey inspired by Banerjee et al. (2013). We ask questions about advice, trust, friendship and financial relationships such as “whom do you spend your free time with”, “in case of an emergency, whom would you rely on” and “whom do you borrow money from”. Based on data from the survey, we build an undirected social network where a connection between two people is established if any one of them names the other. Next, we identify the persons in the network with the highest and lowest eigenvector centrality. In other words, we identify the most influential and least influential individuals in the village. The rest of the village is divided into groups of three with varying network distance. Groups of three are an optimal choice to study questions of mutual trust inasmuch it is possible to maximize the behavioral contrast between groups which can sustain high levels of cooperation and those which cannot (Jackson et al., 2012). Players interact both in a closely knit group and in a group with socially distant individuals.

We refer to the closely knit group as “dense” and to the group with weak acquaintances as “sparse”. The term “dense” implies each individual is at most at distance 2 (average path length < 1.6) and “sparse” implies each individual is at least at distance 4 (average path length > 4). We allow individuals to either vote for no monitor, or to choose one from two monitor candidates belonging to their village: a high central monitor (very prominent individual) or a low central monitor (less prominent). Players play a contribution game both with a monitor chosen by the group (endogenous treatment) and an externally assigned monitor (exogenous treatment). The monitor does not materially punish but only observes the contributions of each player, which would otherwise be private information. Players have an initial endowment and need to decide between how much to contribute to a common pot and how much to keep for themselves. The total contribution in the common pot is augmented by 50 percent and divided equally among the three players irrespective of initial contribution. Each individual therefore plays both in a dense and in a sparse group, and in each group both with exogenous and endogenous monitoring institutions. We vary both the social composition of groups and how monitors are assigned to study the demand for monitoring and cooperation. The order of all treatments is randomized.

This paper is at the intersection of multiple strands of literature. First, it relates to the vast literature on public good games and peer monitoring. Starting with Fehr and Gachter (2000), the threat of punishment from an external monitor is seen to increase contributions to the public good (Charness et al., 2008; Guilen et al., 2006; Fiedler Harvey, 2016). In particular, Fiedler Harvey (2016) establishes that simple monitoring without punishment enforces higher contribution. DeAngelo and Gee, 2020 similarly establish that peer monitoring is better for public good provision. In Shreedhar et al., 2020 network topology is seen to be an important factor driving effectiveness of peer monitoring in the lab. To our knowledge, none of these papers studies the impact of network position on public good games with endogenous monitoring. We believe that the identity of players is an important factor in contribution games and that network position can explain behavior in public good games.
Another relevant strand of literature focuses on how altruism might drive contribution behavior in communities (See Benabou and Tirole, 2006; Bourles and Bramoulle, 2016; Acemoglu and Wolitzky, 2015; Ali and Miller, 2016). Thirdly, our paper is closely connected to the literature on reputation concern. Gossips and social image concern as an effective channel for peer minoring has been established (See Wu et al., 2015, 2016; Beersma and Kleef, 2011; Sommerfeld et al., 2007; Galbiati and Vertova, 2008). This paper is also intimately related to a growing literature of experiments on networks, where a number of papers have looked into how position in the network affects behavior in real life. Our work is closely related to field experiments by Breza and Chandrasekhar (2019) which shows that an exogenous central monitor improves cooperation in sparse groups but crowds out contributions in close groups. In a similar vein, Chandrasekhar, Kinan and Larreguy (2018) establishes that the capacity for cooperation, in the absence of contract enforcement, depends on players' network position. Our field experiment differs from these settings by allowing groups of players to choose the monitor overseeing the contribution game. We study how network position not only impacts cooperation but also the institutional choice that ensures cooperation. The institution options are based on the centrality of the monitors (Banerjee et al. (2013), Banerjee et al. (2016) for details on the role of centrality).
Finally, our work bridges experiments on public goods and networks with a strand in the literature that studies the impact of institutional choice on cooperation. Papers in the laboratory as Sutter et al. (2010), Fehr and Gachter (2000), Dal Bo (2010) and in the field as Grossman and Baldassari (2012) show that cooperation is higher when players are given an opportunity to choose the form of the institution rather than having an externally imposed one. We advance this literature by exploring the heterogeneity of this impact through network structure. We

investigate how different informal institutions – monitors – emerge endogenously from group decisions and how it affects cooperation.

The rest of this paper is organized as follows: Section 2 presents the theoretical framework. Section 3 describes the experimental protocol and the data collection process. Section 4 describes the results of the experiment and the econometric specifications. We discuss the results and conclude in Section 5.

2. Experiment

2.1 networks and data

We start by mapping the social network of villages, with a special focus on relations of trust. Given the location of these villages[6], mutual trust fundamentally shapes social interactions and the contribution to local public goods. As a first step, we assigned a unique identification code to each woman in the census. We started interviewing very few individuals, who would give us names of their closest friends and we administered the network questionnaire to those women who were nominated in the first round. This process was repeated iteratively until either all women were covered or no new individual was nominated – the elicited network is "closed". This technique has the advantage to be faster than the standard network elicitation method and simplifies considerably the issue of homonyms. Each woman was asked at least three connections for each question. The questionnaire consisted of a set of questions designed to elicit social networks, inspired by Banerjee et al.(2013). These questions are meant to elicit ties of friendship and trust and span along various dimensions of social interactions. A link between two individuals i and j is established when either i nominates j or vice versa in any of the questions. We then aggregate and collapse the networks obtained from different questions into one, undirected network. Once a network is fully mapped, it is possible to visualize it and extract important statistics that are central in our experimental design. Figure 2 in the Appendix is a snapshot of the network of a village where we conducted the experiment.

The network we obtain is thus a good representation of the social structure of the community and it is an essential variable of our study. More precisely, we use the network to create groups of contrasting social density for every participant and interact it with variations along two dimensions: monitoring centrality and the political process by which monitors are assigned, either democratically elected or exogenously given. We focus on networks of only women due to the high emigration rate of men either to Kathmandu or abroad, as shown by our pilot experiment conducted in the spring 2018. In the districts we worked in, social networks are often gender specific and women play a preponderant role: they are responsible for households' finances, for agricultural production and for their children.

[6]The villages are situated at 1200m above sea level in the mid hills of Nepal. They are a four hours drive away from Kathmandu

We look at how social density influences the demand for monitors and how it ultimately affects individual contribution to public goods. Groups are formed in order to maximize the number of participants who play in both dense groups, i.e. groups of average path length less than 1.6, and in sparse groups, i.e. with average path length higher than 4[7]. In other words, being in a dense group implies that the members of the group are at no more than 2 steps away from each other whereas in the sparse group they are at least 4 steps away. The cutoffs defining dense and sparse have been carefully chosen in order to amplify the respective contrast in trust and reputation while maximizing the number of observations. The starker is the difference between dense and sparse groups, the more different will be the behavioral response in the different treatments. Figure 9 in Appendix B shows the distribution of average path length of all groups we formed. We over sampled dense groups to make a reliable comparison with sparse ones. Players in the dense groups often belong to the same caste and have similar characteristics. We end up with 503 women who played in both sparse and dense groups, as defined by our thresholds. The summary statistics are presented in Table 9. In total, we have four observations for each participant, for a total of 2012 observations.

2.2 MONITORS AND GAME OVERVIEW

We choose monitors candidates with respect to their Bonacich centrality and their assignment to groups can be determined by either democratic election or random exogenous assignment. Underlying the framework is the assumption that participants' behavior in the experiment will likely affect market and non-market interaction outside the laboratory in real-life interactions, such as access to jobs, informal loans or other opportunities. In this context, we assume that monitors have the power to spur cooperative behavior through their capacity to report outside the laboratory bad behavior occurred within our experiment. In 2019, to provide support for our framework we conducted a survey to more than 300 random women. We shared with them a vignette of our experiment and asked several questions about the reputational power of monitors. The purpose of this survey was to capture their perceptions of the role of monitors and possible motivations behind voting for one of them. We described our study and asked subjects about whether information about misbehavior in the experiment would spread, how that would depend on the identity of the monitor, and what could be the motivations for voting to have a monitor. We find that on average respondents believe that high central monitors are able to spread information to almost 60% of the village population, while low central or average central monitors would reach less than 40% of the village population. Similarly, more than 80% of respondents declared that they would vote for a monitor in order to keep in check other group members through the threat of reputation. We present the main results in Figure 8.

We pick monitors in function of their Bonacich centrality. For every given village, we compute

[7] The dense groups would correspond to topography that is a triangle (average path=1), line (average path=1.3)

the eigenvector Bonacich centrality of all women and select for the role of monitors those with a centrality score greater than the 95th percentile or smaller than the 5th percentile. We choose eigenvector centrality because it captures how much information emanating from a monitor should spread in the network reaching also individuals who are not directly connected to the monitor. Our choice of basing our experiment on eigenvector centrality, and not on other centraliry measures, derives from the literature (Banerjee et al., 2016; Banerjee et al., 2019; Breza and Chandresekhar 2019). These works show that an individual's eigenvector centrality can explain his capacity to spread information in the larger network and that villagers are able to accurately identify central members of the community. In order to check in our context the robustness of this choice against alternative measures of centrality, we compute correlations between three centrality measures for the whole undirected network sample: degree, betweenness and (eigenvector) Bonacich centrality. While degree simply measures how many links a node has, betweenness quantifies the number of times a node acts as a bridge along the shortest path between any two other nodes. The results shown in Table 1 give us reason to think that, in our sample, attributing the roles of monitors according a measure of eigenvector centrality is robust to different centrality measures. The correlations in Table 1 are very strong and the coefficient between degree and Bonacich centrality is almost 0.92 while the coefficient between the latter and betweenness is almost 0.87. Computing the same coefficients on the subset of monitors, we obtain even stronger correlations between different measures. These figures give us reason to believe that the centrality of monitors is an intrinsic network characteristic of individuals that underlies different possible measures.

In order to neatly disentangle the different possible channels that might drive behavior, we set up an experiment where groups of three individuals are asked to privately vote for their preferred monitor and then play twice a standard public good game. The experimental session is sequenced as follows: first, players are assigned to a group formed either by their closest friends or by socially distant peers. The order of assignment to these two group compositions is randomized. Secondly, after being assigned their groups, players privately vote for their preferred monitor. Third, the choice of monitor is immediately followed by a contribution game. Each individual plays 2 rounds of a public good game within each group, once played with the elected monitor and once with a randomly picked monitor option, where we randomize the order of the two treatments. Groups are then reshuffled so that the same player is then placed in a different group composition (dense or sparse) and the game unfolds again as explained above. In total, each individual plays 4 rounds in two different groups (dense and sparse). After participants play in the experimental sessions and receive payment for their performance in the games, we administer a second questionnaire meant to capture caste, wealth, religion, membership to community based organizations and a set of other individual level characteristics. Participants are quite homogeneous in terms of wealth and networks are highly homogenous in terms of caste..

2.3 EXPERIMENTAL CONTEXT

Nepali villages are often too remote to be reached easily or too sparse to ask their members to participate to group sessions in a fixed location. We decided to conduct our experiments in the mid-hills of Nepal in the district of Makwanpur, which is around four hours drive from Kathmandu. The municipalities we chose – Palung, Bajrabarahi, and Chitlang – present an economy almost uniquely focused on agriculture and the exploitation of natural resources. Dozens of community based organizations are active in the region and people are generally involved in at least one. They are familiar with issues of coordination and with the risks of free-riding. Villages are on average composed of 70 households, for an average of 120 women per village. We covered 19 villages with more than 2000 women between 18-60 years answering our network survey. We have a census of all inhabitants living in each village and we made sure to administer the network questionnaire to every woman.

In partnership with a local research company based in Kathmandu, we hired a team of local enumerators. All enumerators were women, in order not to add any confounding factor in the network elicitation and in the experimental sessions. In each village, women who answered our network survey were invited via a phone call to take part in the experiment. We invited around 75% of interviewed women in each village and, based on a measure of (eigenvector) network centrality, we divided people into either players or monitor candidates. The individuals belonging to the top and bottom 5% of the centrality distribution were assigned the role of monitor candidates, while the others were assigned the role of players. Among those who were assigned the role of players, we oversampled groups in the periphery so as to avoid picking high centrality individuals in order to maximize the contrast between dense and sparse groups. This gives more power to the information transmission role of the monitor. As an incentive to participate, every player was given 100 Nrs (1 euro) along with the possibility to obtain additional money up to 200 Rs, as a function of their performance in the games. On average, the total gain was around 220 Rs. per individual which is half day's wage. Monitors were given a fixed sum of 250 Rs. for their participation.

The experiments were typically conducted early in the morning in schools close to each village. Women, as they arrived to schools, were assigned to either sparse or dense groups for the experiment. They were progressively sent to one of the classrooms to play the games. Once played, they got out of the room to be assigned to another group and to play again with a different group composition. The order of the dense and sparse groups was randomized. Typically, three sessions were run in parallel in separate classrooms with one session lasting for around 15 min. Two enumerators were in charge of each session: they read the instructions, conducted the game and noted down the choices of participants.

2.4 DESIGN

In our experiment, we have three treatments variables. First, group composition. Groups can be composed either by close friends or by people socially distant in the network. Second, centrality of monitors. In our experiment, we offer three monitoring options: high central monitors, low central monitors and no monitors. Third, the process whereby monitoring institutions are assigned: either democratically elected by the group or exogenously imposed. After assigning the role of high central and low central monitors, which remains fixed throughout the experiment, we divide the rest of the individuals into groups of three with varying group composition, either dense or sparse. Individuals play in groups of three in both dense and sparse treatment in a randomized order. In Figure 2, we show two possible groups for the player circled in green. She plays both with her closest friends – circled in red – and with individuals far in the social network circled in blue. By always reshuffling groups in such a way that every individual plays exactly in two different groups, we are able to extract individual fixed effects. This part of the design is of paramount importance because of the intrinsically endogenous nature of networks: the network position of player i is endogenous to her observable characteristics which are in turn affecting her contribution. This design allows a neat disentanglement of the endogenous position in the network from the contribution, through the extraction of fixed effects at the individual level.

At the start of each session, group players are gathered in a room where they can see each other, but no communication is allowed. Each member of the group receives 10 tokens of a different color, where the value of 1 token is marked at Rs 10. Each session is divided in two stages. In the first stage, each player privately casts a vote on her preferred monitoring option.[8] In Figure 3, step 1 represents the setting of the game. Players are given the option to choose between high central monitor (H), a low central monitor (L) or no monitor at all (NM). Note that this monitor is a fourth individual that remains the same for all groups within a village. The cost of choosing the monitor is 20 Rs.[9] This cost makes always choosing a monitor a non-dominated strategy. The cost is paid by participants who vote to have a monitor (either high central or low central), irrespective of the voting outcome of the group.[10] The monitor is elected by a majority rule and the result of the vote is not immediately revealed. As seen in Step 2 of Figure 3, the group is then randomly assigned to either the endogenous treatment or the exogenous one. The randomization is implemented by picking one out of two balls: if the ball drawn is green, the endogenous treatment is played first and the exogenous follows. If the ball drawn is pink then exogenous is played first followed by endogenous. The result of voting is only revealed just before playing the endogenous treatment. In the exogenous treatment, the group is randomly assigned either to a high central, low central or to no monitor treatment.

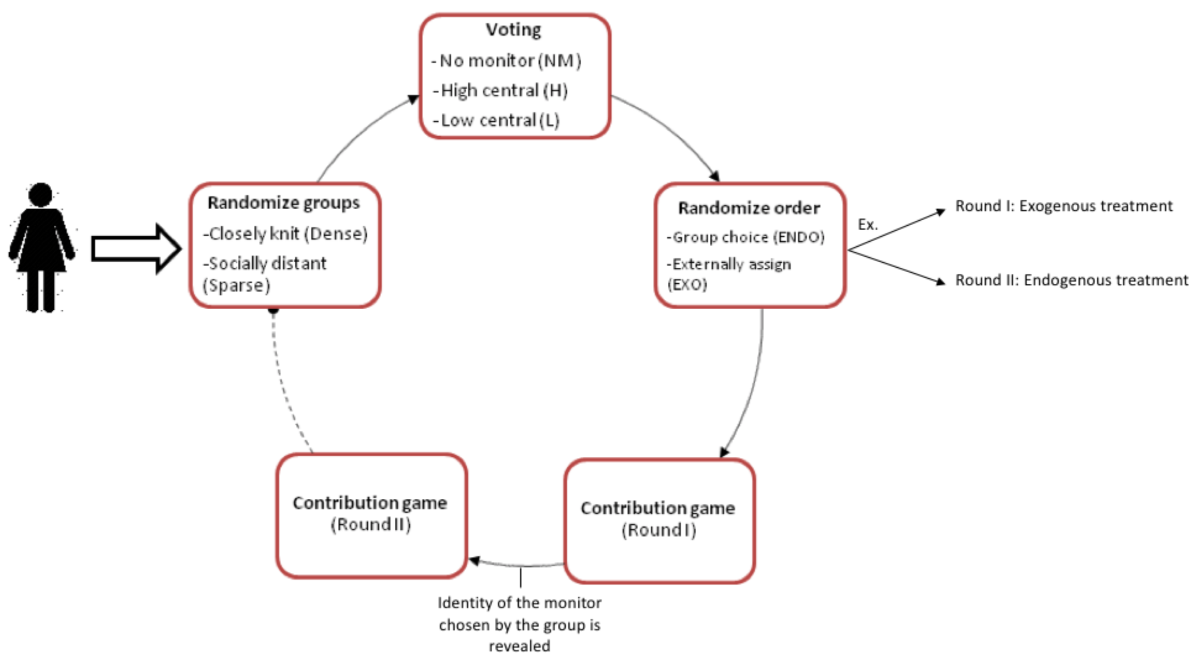
[8]In case of a tie, the monitor choice was determined by a random draw. Ties represent around 6% of cases.

[9]In line with the public good literature, the cost of the option was around 7% of the average earnings across all games. Also, the fee player i pays when choosing a monitor is directly detracted from the realized payoff of that specific round and does not directly affect the payoff of other players nor of monitors.

[10]If x votes for a monitor but no monitor is elected by the group, x stills pays the cost of voting for a monitor.

In the second stage of the experiment, the group plays a public good game where each player decides how many tokens out of the 10 is to be contributed to the public pot. They are informed that the money in the public pot would be increased by 50% and then divided equally among them. As seen from Step 3 of Figure 3, once the contributions are made, the monitor – either elected or assigned – is called into the room to see how much each player contributed in the public pot. The monitor can distinguish the contributions belonging to each player by the different colors of the tokens they were endowed with. Moreover, the monitor does not have the power to impose fines and simply observes how much each player contributed. We exploit only the informational channel whereby the players' reputation can be affected (e.g. gossips, reporting etc.), following the assumption that it would drive much of real-life interaction in the village. We study how the fear of being reported on by the monitor outside the lab drives the behavior of people and how it consequently affects the demand for third party monitoring[11]. To sum up, the contribution game is played twice in the same group without receiving any feedback, once with the monitor option chosen by the group (endogenous) and once randomly assigned monitoring option (exogenous).

Figure 1 Timeline



[11]Breza et al., 2016 do not find a significant difference between information and punishment treatments

3. The Framework

In this section we present a theoretical framework that can guide the interpretation of our empirical results. One way to think about the difference between sparse and dense groups is the level of altruism. This is in line with the literature on altruism where individuals contribute and cooperate more in closely knit dense groups (Liedler et al., 2009 and Goeree et al., 2010). This is also consistent with what we observe in our data. Following our conversation with the women, one possible mechanism driving behavior in the field is reputation concerns. Monitors can effectively spread information and enforce social norms. As shown by the results of our end-line survey in Figure 8, monitors are perceived as capable of spreading information thus affecting reputation. We build a model of altruism and reputation concerns that provides a framework for our results.

TYPES

Agents are embedded into a fixed network of relations. We model the contribution behavior of individuals with an *altruism* parameter α. We think of this parameter as representing how much an individual cares about the material utility of others and as determining the propensity of higher contribution. As people become more altruistic, i.e the value of α increases, individuals care more about the material utility of others and are more likely to contribute a higher amount. Each individual i has a level of altruism α_i that depends on the group she plays in, where $\alpha_i \in \{\alpha_l, \alpha_h\}$ and $\alpha_h > \alpha_l$. Player i knows her own level of altruism α_i and has a prior $\mu_{0i}(\alpha_j)$ on the level of altruism of the other player j . The prior $\mu_{0i}(\alpha_j)$ is distributed uniformly in $(0, 1)$ and it is homogeneous across agents. Let us assume that agent's i ex-ante subjective probability of j being a high type $\mu_{0i}(\alpha_j = \alpha_h) = \alpha_h$ depends on how close they are in the network. Agents i and j can form a group of type $G(ij) = G(ji) = \{d, s\}$, i.e. they can form either a dense group or a sparse group. In this context, i's prior about j being type α_h is higher in dense rather than in sparse groups.

$$\mu_{0i}(\alpha_j = \alpha_h)_{G(ij)=d} > \mu_{0i}(\alpha_j = \alpha_h)_{G(ij)=s}$$

Even though we do not model network interactions explicitly, the effects of social interactions are introduced in the mechanics of the model through the different initial priors and through the power of the monitor, as explained in the next paragraph. This mimics the fact that in dense groups people perceive their neighbors to be more altruistic than those to whom they are not directly connected.

[11] We present here a simplified model with two agents for the sake of exposition, but we extend the main results to three agents in the Appendix to match the experimental design

TIMING, ACTIONS AND PAYOFFS

Agents play a two-stage game. In the second stage, agents play a voluntary contribution game which can be either overseen by a third-party monitor or by no one. The third party monitor can be assigned either through a random lottery or can be elected through a democratic vote, which happens in the first stage. More precisely, the game unfolds as follows. First, agents simultaneously vote for their preferred monitor $m_i \in \{0, 1\}$, where $m_i = 0$ implies no monitor is chosen by individual i and $m_i = 1$ means i votes for having the monitor. Once participants cast their votes, a monitoring technology is assigned to the group according to the following voting rule

$$m^* = \begin{cases} 1 & \text{if } m_i = m_j = 1 \\ 0 & \text{if otherwise} \end{cases}$$

where m^* denotes the outcome of the vote. Second, agents make their contribution decision $c_i \in \mathbb{R}_+$. The action profile of agent i is then $(m_i,\, c_i)$. The total contribution of all players is increased by 50 % and divided equally among the group members, implying that the rate of return for the contribution game with two players is $\frac{3}{4}$. The utility of player i is a function of both c_i and c_j, the level of altruism α_i and the rate of return of the contribution game. We assume a convex cost of contributing to represent the behavioral burden of contributing and to ensure the existence of an interior solution. Further, we believe that in this context belief-dependant motivations deeply affect players' actions and, in the spirit of psychological games[12], we assume that how much player i values the utility of player j depends on i's belief about the altruism of player j, $\mu_{0i}(\alpha_j)$. In this regard, we take inspiration by Rabin (1993) which models the reciprocity of one agent as a function of beliefs about the other agent. The payoff of player i in the contribution game without a monitor is then

$$U(\alpha_i|m^* = 0) = W - c_i - c_i^2 + \frac{3}{4}(c_i + c_j) + \alpha_i \cdot \mu_{0i}(\alpha_j)\Big(W - c_j - c_j^2 + \frac{3}{4}(c_i + c_j)\Big)$$

In the case where a monitor is elected, we add two terms to the above utility function: a cost of monitor election mc and a reputation cost $-\delta P(c_i < \theta)$. Voting for the monitor is costly and i pays mc if she votes for the monitor, irrespective of whether the monitor is elected or not. If elected, the monitor can impose a reputation cost on the players. The parameter $\delta > 1$ represents the penalty from a contribution lower than the social norm θ in the presence of the monitor. As corroborated by qualitative evidence presented in Table 8 and for the sake of exposition, we use a fixed value of δ. However, we could incorporate a varying power of monitors depending on their centrality by allowing $\delta \in \{\delta_H,\, \delta_L\}$, where $\delta_H > \delta_L$, i.e. high central monitors are more effective in spreading information and can inflict stronger reputational penalties. The social norm is a stochastic parameter representing the fact that different groups

[12] For a review on psychological game refer to Dufwenberg (2008) and Attanasi and Nage (2008).

would have different norms about what is considered an acceptable cooperative behavior[13]. It is assumed to be uniformly distributed between $[0, \bar{\theta}]$ where $\bar{\theta}$ is the highest possible contribution. It can also be interpreted as a reference point that varies with each monitor (Kahneman and Tversky, 1991), i.e. it hinges on the distribution of θ. The probability of one's contribution to be higher than the norm is then simply $\frac{c_i}{\bar{\theta}}$ and the probability of contributing below the acceptable social norm – as perceived by the monitor – can thus be represented as

$$P(c_i < \theta) = \begin{cases} 1 - \dfrac{c_i}{\bar{\theta}} & \text{if } c_i < \theta \\ 0 & \text{otherwise} \end{cases}$$

The utility of agent i when a monitor is elected ($m^* = 1$) can be written as

$$\begin{aligned} U_i(\alpha_i | m^* = 1) = & W - \hat{c}_i - \hat{c}_i{}^2 + \frac{3}{4}(\hat{c}_i + \hat{c}_j) - mc - \delta P(\hat{c}_i < \theta) + \\ & \alpha_i \cdot \mu_{0i}(\alpha_j) + \Big(W - \hat{c}_j - \hat{c}_j{}^2 + \frac{3}{4}(\hat{c}_i + \hat{c}_j) - mc - \delta P(\hat{c}_j < \theta) \Big) \end{aligned}$$

Moreover, players are Bayesian and i updates her prior about j's type $\mu_{0i}(\alpha_j)$ to $\mu_{1i}(\alpha_j)$ depending on the outcome of the voting , m^*. When players do not observe the outcome of the group vote, e.g. when third-party monitoring is exogenously assigned, i does not receive a signal on j's type and cannot update her prior.

EQUILIBRIUM

We assume that the altruism parameter α_i of individual i fully determines her demand for peer monitoring. More formally, we consider an equilibrium of the form below. An (altruistic) player i of type α_h cares strongly about the utility of the other player irrespective of j's type. She would therefore prefer not to elect a monitor[14] in order to avoid the other player being punished through the spread of bad reputation in case of low contribution. For a player i of type α_l, however, the cost of electing a monitor and the negative reputation effects for both herself and j is outweighed by the increase in group contribution driven by the presence of the monitor. Thus, agents would contribute differently depending on their type α_i, the outcome of the vote m^* and the updated belief μ_{1i} about player j, once the outcome of the vote is revealed. The separating equilibrium would then be

$$\sigma_i(\alpha_i) = \begin{cases} m_i = 0 & \text{if } \alpha_i = \alpha_h \\ m_i = 1 & \text{if } \alpha_i = \alpha_l \end{cases}$$

[13]This would vary across dense and sparse groups. In dense groups individuals would be supposed to contribute more than in sparse ones.

[14]Given that dense groups have higher subjective probability of being altruists, the demand of peer monitoring should be lower than that in sparse as seen in Fig 4.

Given the equilibrium above, when $\alpha_i = \alpha_l$, agent i would always vote for a monitor. Given the voting rule m^* defined above, she is able to perfectly infer the voting choice of player j. In this case, i updates her prior to $\mu_{1i}(\alpha_j = \alpha_h) = 1$ if $m^* = 0$ and $\mu_{1i}(\alpha_j = \alpha_h) = 0$ if $m^* = 1$. On the other hand, type α_h always votes for $m_i = 0$ and no monitor is elected ($m^* = 0$) irrespective of the vote of the other player. In this case player i cannot infer anything about j's type and she keeps the original prior $\mu_{1i}(\alpha_j) = \mu_{0i}(\alpha_j)$. First, we solve the above set of equations and calculate the value of optimal contributions across the different scenarios. Secondly, given c_i, we study when the above separating equilibrium holds true. We find that for type α_l, voting for the monitor is an optimal strategy for certain values of initial prior $\mu_{0i}(\alpha_j) < \overline{\mu_{0i}}(\alpha_j)$. On the other hand, for type α_h it is always a dominant strategy to vote for no monitor. Therefore, in order to have a separating equilibrium people should have a low prior on the proportion of altruists, which by construction occurs in sparse groups. In what follows, we present our theoretical results in the same order of the empirical ones to match and guide progressively the experimental findings.

Proposition 1. *Let us assume that δ is large and θ is small enough. Then, there exists a value of the initial prior $\overline{\mu_{0i}}$ such that for $0 < \mu_{0i} < \overline{\mu_{0i}}$, the separating equilibrium σ exists, where low types α_l vote for the monitor and high types α_h vote for no monitor.*

Proposition 1 just says that the separating equilibrium σ holds only in sparse groups, while in dense groups both types pool their actions and do not vote for the monitor. We believe that the assumption of large δ is quite natural, given that in our context formal institutions are weak, and reputation concerns drive most of the social interactions. This assumption is also supported by the experimental evidence that low central monitors are very rarely chosen by participants. Similarly, the ex-ante level of cooperative behavior of these villages is quite modest, hence justifying the assumption of low values of θ. The mechanism underlying this proposition lies in the fact that high type players α_h always vote for no monitor, irrespective of the group they are in. Moreover, Proposition 1 gives us reason to believe that a story of reciprocal altruism well describes the voting behavior we see in the experimental data, i.e. players vote more often for having a monitor in sparse groups (low μ_{0i}) rather than in dense ones. This Proposition also gives theoretical support to our experimental results presented in Table 4.

Proposition 2. *In the game with exogenous monitors, high-type players α_h contribute always more than low-type ones α_l. Moreover, at equilibrium the contributions of both players' types are higher in the presence of the monitor than without,*

$$\hat{c}_i^{exo} > c_i^{exo}$$

for $i = h, l$. Moreover, the increase in contributions caused by the monitor is stronger for high central monitors and in sparse groups.

where $\hat{c}_i^{exo}$ indicates the optimal contribution when the contribution game is played in presence of a monitor and c_i^{exo} when there is no monitor overseeing the game. The result is simply driven by the reputation effect of the monitor, which can entail the penalty δ in case of contributions lower than the social norm θ. The second part of Proposition 2 derives simply by the fact that high central monitors have a stronger capacity of imposing reputational penalties compared to low central monitors, i.e. $\delta_H > \delta_L$. Similarly, the impact of the monitor is stronger in sparse groups since we assume that the social norm of contribution is higher in dense groups rather than in sparse ones. These results match our empirical results presented in Table 5.

We now study the optimal contributions in the setting with the endogenous election of the monitor. In this case, the elected monitor serves as a signal of each other's types. Players are Bayesian and update their prior beliefs about the opponent's type, knowing their own vote in the election stage. In Proposition 3 below we study the effect on contribution of having a monitor who is endogenously chosen by the group.

Proposition 3. *In sparse groups, endogenously chosen monitoring increases average contribution for all election outcomes, while in dense groups it decreases contribution.*

Having a monitor chosen by the group has a positive effect for $\mu_{0i} < \overline{\mu_{0i}} = \frac{5\alpha_l+2\alpha_h}{6(\alpha_l+\alpha_h)}$, i.e. for sparse groups, while in dense groups the effect is negative. The election of monitors – or the lack thereof – serves as a signal for agents who can infer other players' types as the game unfolds. In the case of exogenously assigned monitors, i's benefit of contribution increases linearly with the prior belief of j's being of high type, which is higher in dense groups. On the other hand, in the case of endogenous monitors the outcome of the election is internalized in the agents' optimization problem and the benefit of contributing is not anymore uncertain as agents update their beliefs accordingly and their priors are pushed either up or down. Given that in sparse (dense) groups there are more low (high) types than high (low) types, low type agents α_l drive the result in sparse groups while high type agents α_h drive those for dense groups. When an agent i is of type α_l and observes that the group decided not to have any monitor, it received a perfectly informative signal about the fact that both his group members are of type α_h. After the revelation of the vote outcome, there is no uncertainty and contribution increases since $\mu_{1i} = 1$. When an agent i of type α_l observes that the group elected the monitor, she knows that with probability 2/3 one of the two group members is of high type and at least one group member is of type α_l. Consequently, her posterior is higher than the prior if the former is smaller than 2/3, i.e. in sparse groups. In dense groups, the prior is already high and the signal affects negatively contribution. Symmetric arguments can be done for α_h types in dense groups. This result guides our experimental analysis and gives support to the findings shown in Table 6 and Table 7.

4. Results

The hypothesis is that the individual demand for peer-monitoring varies depending on the composition of groups, i.e. across dense and sparse groups. In particular, we expect individuals in dense groups not to choose a monitor and to enforce co-operation on their own in the second stage of the game. This result would not hold for socially sparse groups where the ex-ante level of contribution is lower, given the lower level of reciprocal trust. Thus, socially sparse groups might have a stronger incentive to pay the fixed cost of electing a monitor that is able to strengthen the reputation channel and spur cooperative behavior. The presence of a monitor – even more so for a high central one – increases the possibility of being reported on outside the lab in case of "defection". On the other hand, we expect socially close groups to be more cooperative than sparse groups, irrespective of the treatments[15]. Finally, we also expect to find a different impact between the endogenous and the exogenous assignment monitors: the group's choice about the preferred monitor is revealed only in the endogenous treatment, and it can affect contributions by carrying additional information about the group's altruism level.

4.1 PRELIMINARY FINDINGS AND POSSIBLE LIMITATIONS

We start the analysis by looking at the individual level variation in the choice of the monitor. In Table 2, the numbers along the diagonal represent the percentage of individuals that always choose the same voting strategy irrespective of group composition. The largest proportion being 34.95% that always chooses to have no monitor, followed by 19.68% that always vote to have a high central monitor. The voting result shows substantial variation in voting strategy. Looking at the aggregate demand for peer monitoring, both dense and sparse groups vote more often to not have a monitor. Figure 4 shows that in dense groups, around 32% of players vote for a high central monitor, while in sparse groups more than 39% of players do so. Low central monitor is seldom chosen accounting for around 13% in both dense and sparse groups. For contribution, exogenous monitoring increases contribution only in sparse groups as seen from Table 3. We want to study how this differs when individuals play under the monitor that has been endogenously chosen by the group. To begin with, we compare the outcomes under endogenous and exogenous institutions, clubbing all three monitor treatments together for the later in Figure 5. The political process whereby the monitoring institution is obtained matters only for sparse groups where endogenous monitoring in blue increases contribution compared to the exogenous one.

Before presenting the results, we highlight two possible threats to our results and point to possible solutions. First, a number of recent studies have focused on the role that group inequality could play in contribution games (e.g. Nishi et al., 2015; Fehr and Schmidt, 1999; Bolton and Ockenfels, 2000). We build three variables in order to capture inequality along dimensions that are particularly relevant to our context: wealth, caste and education. The inequality indices are simply the group variance of the indices we constructed with our questionnaire on individual level characteristics. We observe that the 19 villages where we conduct our experimental sessions display very high degrees of homogeneity along these three dimensions. We control

[15] Socially close or distant is characterized by the average social distance (path length) in a group

for these variables in all regressions under the label "Group Characteristics", which embed also a set of socio-economic characteristics at the individual level. None of these variables has a significant impact on cooperative behavior and our results are robust to their inclusion among the regressors. Second, our result could be sensitive to the process of network elicitation. We ask for at least three "nominations" of friends. In most interviews, women named an average of 4 women which may not be fully exhaustive and may lead to have networks that are sparser than they actually are. This could imply an overestimation of social distance, i.e. individuals are actually socially closer than what they appear to be, which in turn may bias our results. However, it does not represent a threat to the validity of our results. On the contrary, it implies that the estimated effects of our treatments represent a lower bound of the real effect.

4.2 STATISTICAL ESTIMATION

4.2.1 IMPACT OF GROUP COMPOSITION ON MONITOR VOTING: THE ELECTION

As suggested by the preliminary results shown in Figure 4, we conduct a Mann-Whitney test to understand whether the proportion of participants choosing a given monitor is significantly different across group compositions. We find that no monitor is chosen significantly more often in dense groups rather than in sparse groups (p-value 0.07) and that high central monitors are chosen more often in sparse rather than in dense groups (p-value 0.002). In order to estimate how the demand for monitor varies depending on the group composition, we use a multinomial logistic regression with individual and round fixed effects. Since players vote once in a dense and once in a sparse group in a random order, we can include both individual and round fixed effects, therefore exploiting a "within" design and getting rid of the confounding effect deriving from the intrinsic endogeneity of real networks. The fixed effect multi logit model is therefore defined by the logistic probability of choice of monitor y_{jt}, where y_{jt}=0 represents no monitor is chosen, y_{jt}=1 that a low central monitor is chosen and y_{jt}=2 represents a high central monitor. We take y_{jt}=0 as the base category and can write the fixed effect logit as

$$Pr(y_{jt} = 1) = \frac{1}{1 + e^{-(\alpha+\beta_1 G_{jt}+\beta_2 X_g+\rho_j+\nu_t+\epsilon_{jt})}}$$

$$Pr(y_{jt} = 2) = \frac{1}{1 + e^{-(\alpha+\beta_2 G_{jt}+\beta_3 X_g+\rho_j+\nu_t+\epsilon_{jt})}}$$

where y_{jt} is the chosen level of monitoring, G_{jt}: dummy for group composition equal to 1 if the treatment is for dense groups, X_g: group characteristics ν_t: round fixed effect and ρ_j: individual fixed effects.

We present in Table 4 the results of the multinomial fixed effect regression of individual monitor choice (voting) on the social composition of the group (dense/sparse). In the first column, we find that dense groups are less likely to elect a high central monitor by 40% points compared to sparse groups. In the second column, we see that this is also true when we control for individual level characteristics, such as age, caste, education, wealth and others[16]. Importantly, we also include three indicators of group inequality that span three dimensions: wealth inequality, as well as differences in caste and education. The inclusion of such controls do not undermine our result as shown in Table 4. More details on voting as a function of individual characteristics is presented in Appendix C. This result is in line with our theoretical result of Proposition 1, whereby dense groups would prefer not to have monitoring whereas individuals in sparse groups would want a high level of monitoring.

4.2.2 IMPACT OF DIFFERENT EXOGENOUS MONITORING

For contribution, we start with the baseline case where monitors are assigned exogenously and study the difference in contribution between sparse and dense groups. As seen from Table 5, in sparse groups, average contributions increase significantly (p-value 0.014) by Rs 7.4[17] (15.8% of the mean) in the presence of a high central monitor (H) as compared to no monitor (NM). In dense groups, there is a Rs 4.5 increase (8.3% of the mean) but the difference is not significant. This result is in line with the literature that suggests presence of a central monitor increases cooperation only in sparse groups (Breza et al., 2016). Further, the cost of the monitor being 8% of the average payoff, it is optimal for sparse groups to vote for a monitor but not dense. Taking only the exogenous monitor treatment, we run a linear regression with fixed effects on the contribution with respect to the type of monitor that was assigned and the group composition. It takes the following form:

$$c_{jt} = \alpha + \beta_1 \cdot Dense + \beta_2 \cdot H + \beta_3 \cdot L + \beta_4 \cdot H \times Dense + \beta_5 \cdot L \times Dense + \rho_j + \nu_t + \epsilon_{jt}$$

where c_{jt}: contribution of individual j in round t, *Dense*: dummy equal to 1 if the group is dense, H: dummy equal to 1 if a high central monitor is assigned, L: dummy equal to 1 if a low central monitor is assigned, ρ_j: individual fixed effect and ν_t: round fixed effects. We also check the robustness of our empirical results against the inclusion of three variables measuring wealth, education and caste inequality. Finally we check also the robustness of our results to the application of individual level fixed effects and individual characteristics.

We are particularly interested in the coefficient β_2 that shows the effect of being assigned a high central monitor and in the coefficient β_4 that shows the difference in the effect across dense and sparse groups. In Table 5, the dependant variable is the individual level contribution. We see that individuals in dense groups generally contribute Rs 13.7 higher (23% of the mean) than sparse ones. Next, contribution increases by Rs 7.25 (11% of the mean) in the presence of a

[16]The number of individuals in the sample drops from 503 to 459 because we do not have data on individual level characteristics for all women. The same applies also for all other regressions of the paper

[17]Note that the value of 1 token is Rs 10. The regression is in terms of tokens but all the results are expressed in terms of Rs.

High central monitor (H). As seen from the interaction term[18], the effect is starker in sparse groups. The effects are robust, and even stronger, when including for groups characteristics and individual-level fixed effects. In all four specifications we control for the monitor choice of the individual. Without individual fixed-effects, the regression shows that monitor choice and contribution are indeed strongly correlated, but with our "within" design we show that individual fixed effects completely absorb away that effect. Finally, this evidence is line with our theoretical results of Proposition 2, whereby the presence of monitors increases contribution due to the threat of reputational penalty δ and that its effect is stronger for high central monitors and in groups where social norms are lower, i.e. in sparse groups.

4.2.3 IMPACT OF ENDOGENOUS V/S EXOGENOUS MONITORING: INCREASE IN CO-OPERATION

The process whereby the monitoring institution is chosen can impact cooperative behavior, and we investigate this possibility in two steps. First, we run a linear regression on the whole set of observations, similar to that we used in the previous section. Now we include the variable "Endogenous" which takes value 1 when participants play in the endogenous treatment, i.e. when they play with the monitor chosen by the group. The specification we use is

$$\begin{aligned} c_{jt} = \alpha + \beta_0 \cdot Endogenous + \beta_1 \cdot Dense + \beta_2 \cdot H + \beta_3 \cdot L + \beta_4 \cdot H \times Dense + \beta_5 \cdot L \times Dense + \\ \beta_6 \cdot Endogenous \times Dense + \beta_7 \cdot Endogenous \times Dense \times L + \beta_8 \cdot Endogenous \times Dense \times H + \\ \rho_j + \nu_t + \epsilon_{jt} \end{aligned}$$

where the main coefficient of interest is β_0, which captures the effect of the endogenous treatment. The results are presented in Table 6. The effect of the endogenous treatment is very strong, highly significant and robust to the inclusion/exclusion of group characteristics (wealth, caste and education inequality), individual characteristics and individual level fixed effects. Moreover, we observe that this effect is at work mostly in sparse groups. Secondly, we estimate a linear fixed effect regression that takes care of participants' self-selection into the monitoring "technology"[19]. In the endogenous treatment, individuals select into an institution that in turn drives their contribution behavior. In order to overcome this selection problem, we keep monitoring fixed and compare groups which play both exogenous and endogenous treatment under the same monitor. Our identification strategy is to overcome selection by comparing the same group, with the same monitor treatment, differing only on how this monitor was obtained. Inspired by Dal Bo et al. (2010), an individual i's action in the game may depend on the group density $G \in \{dense, sparse\}$, on the elected monitor $M \in \{NM, H, L\}$, and on the mechanism that selected the monitor $I \in \{Endo, Exo\}$ and her type α_i. The probability of cooperation is

[18] $H \times Dense$ being an interaction term represents $[(H = 1) - (H = 0)|Dense] - [(H = 1) - (H = 0)|Sparse]$

[19] We are able to extract fixed effects at the individual level even in this case, since each participant plays twice – once in the endogenous and once in the exogenous treatments – in the same group composition

therefore determined by

$$P_i = f(M, G, I, \alpha_i)$$

We fix the group G and monitor M to determine the effect of the mechanism by which the monitor is elected. More formally,

$$E(P_i|G = dense, M = NM, \alpha_i, Endo) - E(P_i|G = dense, M = NM, \alpha_i, Exo)$$

By doing so, we eliminate the threat of self-selection and we are able to disentangle the effect of the exogenous vs endogenous treatments. In terms of regression, it translates into the following fixed effect equations.

$$c_{jt} = \alpha + \beta_1 \cdot (Endo \mid G = S, M = H) + \rho_j + \nu_t + \epsilon_{jt}$$
$$c_{jt} = \alpha + \beta_1 \cdot (Endo \mid G = D, M = H) + \rho_j + \nu_t + \epsilon_{jt}$$
$$c_{jt} = \alpha + \beta_1 \cdot (Endo \mid G = S, M = NM) + \rho_j + \nu_t + \epsilon_{jt}$$
$$c_{jt} = \alpha + \beta_1 \cdot (Endo \mid G = D, M = NM) + \rho_j + \nu_t + \epsilon_{jt}$$

where c_{jt}: contribution of individual j in round t, *Endo*: is a dummy variable that takes value 1 if monitor is endogenously chosen , given group $G : \{D = dense, S = sparse\}$ and monitor choice $M : \{NM = No\, monitor, H = High\ central\ monitor\}$[20], ρ_j: individual fixed effect and ν_t: round fixed effect. We are primarily interested in the coefficient β_1 that captures the effect of having an endogenous monitor as compared to being assigned exogenously.

Figure 6 shows the average contributions for sub-samples that are free from selection effect. We see that for a sparse group contribution increases under an endogenous monitoring setting as seen form the red bars. In particular, with endogenous no monitor, contribution increases significantly (p-value 0.009) by Rs 9.1 while with a high central monitor it increases by Rs 5 but not significantly. The change in dense groups across endogenous and exogenous monitoring institutions is not significantly different. We find in sparse groups that giving individuals opportunity to chose their own monitoring institution leads to better outcomes than externally imposing a third party monitor.

The first four columns in Table 7 report results for individuals who self-selected into high monitoring institution in sparse groups followed by dense groups in the third and fourth column. The next four columns report the same but for the case where groups self selected into no monitoring. We see that a sparse group electing a high central monitor (H) endogenously increases contribution by Rs 5 (8.6% of the mean) whereas there is no effect for the dense

[20]We also tried to do individual level analysis by looking at variation in monitor choice within groups. We find that 50% of the groups vote unanimously for the same monitor option hence not much power to study this effect.

group. Similarly, sparse group electing no monitor (NM) endogenously increases contribution by Rs. 9.13 (21.9% of mean) with no effect in the dense groups. As we have done previously, we check the robustness of our results to the introduction of individual fixed effects as well as to group and individual characteristics. Consistent to our theoretical framework and to Proposition 3, we observe that contribution in the endogenous treatment increases in sparse groups, where the effect is strong and highly significant. In dense groups, even if the effect is not statistically significant, we observe that the point estimates are negative. The fact that the effect is stronger and more significant when no monitor is chosen is in line with the fact that in sparse groups, where trust and reciprocal altruism is lower, the election of no monitor by the groups sends a very strong signal of trust to group members[21]. This result presents evidence to believe that there exists a sort of endogeneity premium in socially sparse groups: individuals facing the same monitoring institution behave differently depending on whether the institution is chosen by the group itself or imposed.

4.2.4 IMPACT OF ORDER ENDOGENOUS/EXOGENOUS ON CONTRIBUTIONS

In order to further investigate the impact of the endogenous treatment, we study whether the order whereby endogenous and exogenous treatments are played affects the average contribution in a given social group, conditioning on the monitoring technology. That would be equivalent to studying whether the effect of the endogenous treatment spills over to the exogenous treatment, in case the former is played before the latter. In presenting this comparison, we plot the average contribution in treatments across the two rounds. Since the order of endogenous and exogenous is randomized, we compare cases where Endogenous was played first to where it was played second. The result of the vote is only revealed in the endogenous case. Hence, if Endogenous is played first, the information revealed through the vote outcome[22] could affect contribution in both rounds. We focus on cases where participants play with No Monitor and High central monitors because of the very few observations we have for Low central monitor. We can see in Figure 7 an evidence of a possible significant effect of the order, especially in sparse groups. The election of a high central monitor in dense groups decreases contribution by Rs 8.1. When no monitor is elected, contribution increases by Rs. 9.6 in sparse groups (p-value 0.06) and Rs 8.9 in dense groups. We run OLS regressions controlling for individual level characteristics to further investigate this effect. Our variable of interest takes value 1 if the endogenous round is played first and 0 otherwise. The dependent variable is represented by the average contribution across the endogenous and exogenous treatments[23]. We use the following econometric specification

[21] This explanation is also in line with the separating equilibrium σ we presented in the theoretical section, where in sparse groups there are more agents of type α_l than α_h. Consequently, low types agents in sparse group observing that no monitor was chosen by the group infer that group members are surely high types, while observing that a monitor was chosen they infer that it is likely that at least of of the other two group members is of high type. Hence, the weaker effect for sparse groups electing a high central monitor

[22] We hypothesize that this information could act as a signal of the level of trust in the group vis à vis each other.

[23] We are not able to extract fixed effects at the individual level because we take the average of contributions across endogenous and exogenous treatments and condition on the monitoring technology

$$c_{jg} = \alpha + \beta_1 \cdot (Order \mid G = S, M = H) + \beta_2 \cdot X + \epsilon_{jt}$$
$$c_{jg} = \alpha + \beta_1 \cdot (Order \mid G = D, M = H) + \beta_2 \cdot X + \epsilon_{jt}$$
$$c_{jg} = \alpha + \beta_1 \cdot (Order \mid G = S, M = NM) + \beta_2 \cdot X + \epsilon_{jt}$$
$$c_{jg} = \alpha + \beta_1 \cdot (Order \mid G = D, M = NM) + \beta_2 \cdot X + \epsilon_{jt}$$

where c_{jt}: average contribution of individual j in group g, $Order$: is a dummy variable that takes value 1 if endogenous treatment is played first , given group $G : \{D = dense, S = sparse\}$ and monitor choice $M : \{NM = No\, monitor, H = High\, central\, monitor\}$, X: individual characteristics (caste, wealth, age and education). We are primarily interested in the coefficient β_1 that captures the effect of having played an endogenous monitor round first followed by the exogenous one.

In Table 8, we see that in sparse groups where No monitor was chosen, the effect of revealing the group's choice has such a strong positive effect that it spills over to the exogenous round, thus increasing average contribution when endogenous is played before the exogenous treatment. Average contribution increases significantly by Rs. 11.6 (17.7 % of mean) for sparse groups when groups played endogenous first and elected No monitor (NM). On the contrary, average contribution decreases slightly by Rs. 3.05 (6.3 % of mean) in dense groups that played endogenous first and elected a high central monitor (H). This result is also in line with our theoretical framework and our previous empirical findings. At the center of this evidence is the story that signalling is stronger in sparse groups, where individuals mostly differentiate their actions according to their types and have a lower prior about the altruism level in their group.

5. Conclusion

By using original network data and a novel design, we try to understand how the varying demand of peer monitoring depends on group density and how this in turn affects cooperation. We divide the network into groups of three individuals with varying network distance, where dense implies each individual is at most at distance 2 (average path length < 1.6) and sparse implies each individual is at least at distance 4 (average path length > 4). To begin with, we show that dense groups prefer to not have a monitor whereas sparse groups choose to have a central one, reflecting variation in trust. Low central monitors are seldom chosen. In line with previous literature, when individuals are socially close (dense), they can sustain a higher level of cooperation without outside intervention. Dense groups contribute higher than the sparse group in the contribution game.

Next, we show that "how" an institution is assigned matters for cooperation. The endogenous choice of monitoring increases cooperation only in sparse groups. Looking at the order of the monitor treatment, the outcome of the vote being revealed in endogenous treatment carries an additional information regarding individual preferences and hence, when revealed, acts as a signal to the group. When endogenous treatment is played first and no monitor is chosen by the group, individuals tend to contribute higher in both groups. However, when endogenous treatment is played first and a monitor is chosen, contribution decreases only in dense groups due to a stronger prior about the level of altruism. This is an interesting finding that suggests monitoring should be catered to the needs of the community. It is also in line with the argument that repeated interactions in dense groups imply higher concern for reputation.

Given the increased popularity of community-based interventions and focus on peer monitoring, it is important to understand the role social networks play in small scale societies. We propose here a theoretical framework followed by a simple experiment that show that the effect of a monitor can be very different depending on the density of the network. Our work opens avenues for further research. We would like to understand the choice of the monitors further by presenting individuals with a panel of monitor options rather than just the high and low central ones.

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Figures

Figure 2 Example of formation of groups

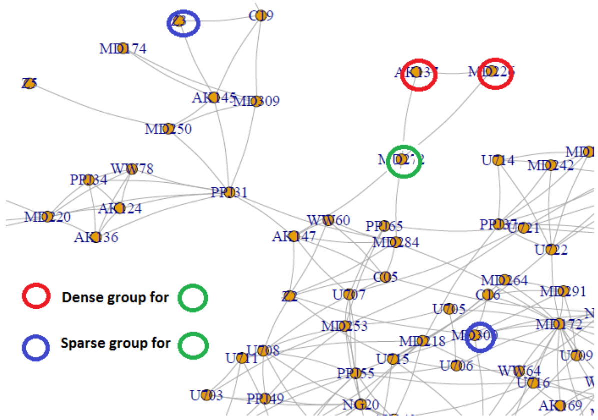
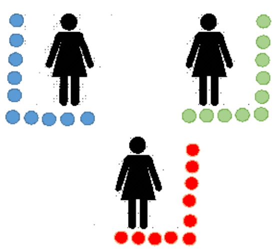
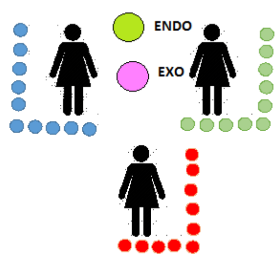


Figure 3 Experimental Design

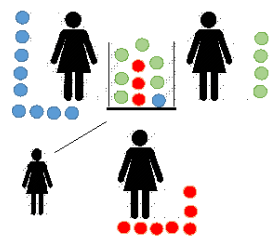
(a) 1



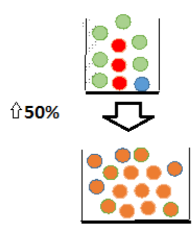
(b) 2



(c) 3



(d) 4



(e) 5

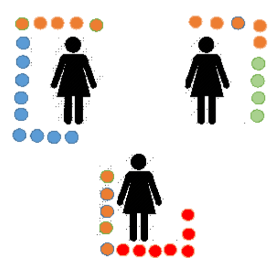


Figure 4 Percentage of individuals voting in Sparse and Dense groups

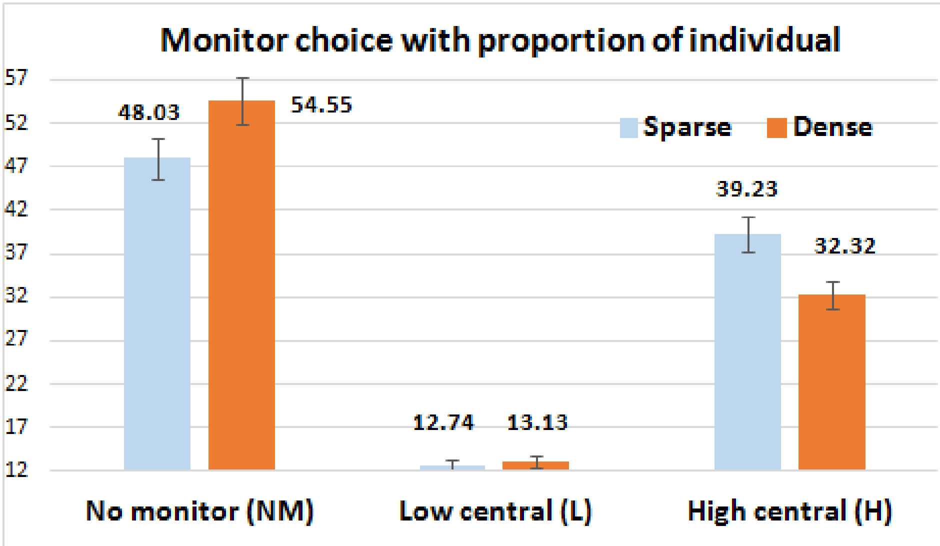


Figure 5 Average contribution endogenous v/s exogenous monitors with selection

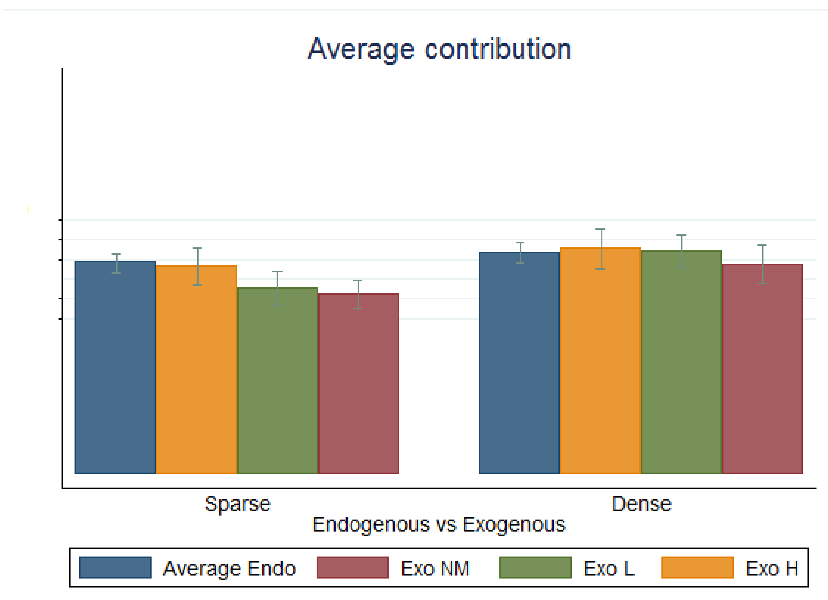
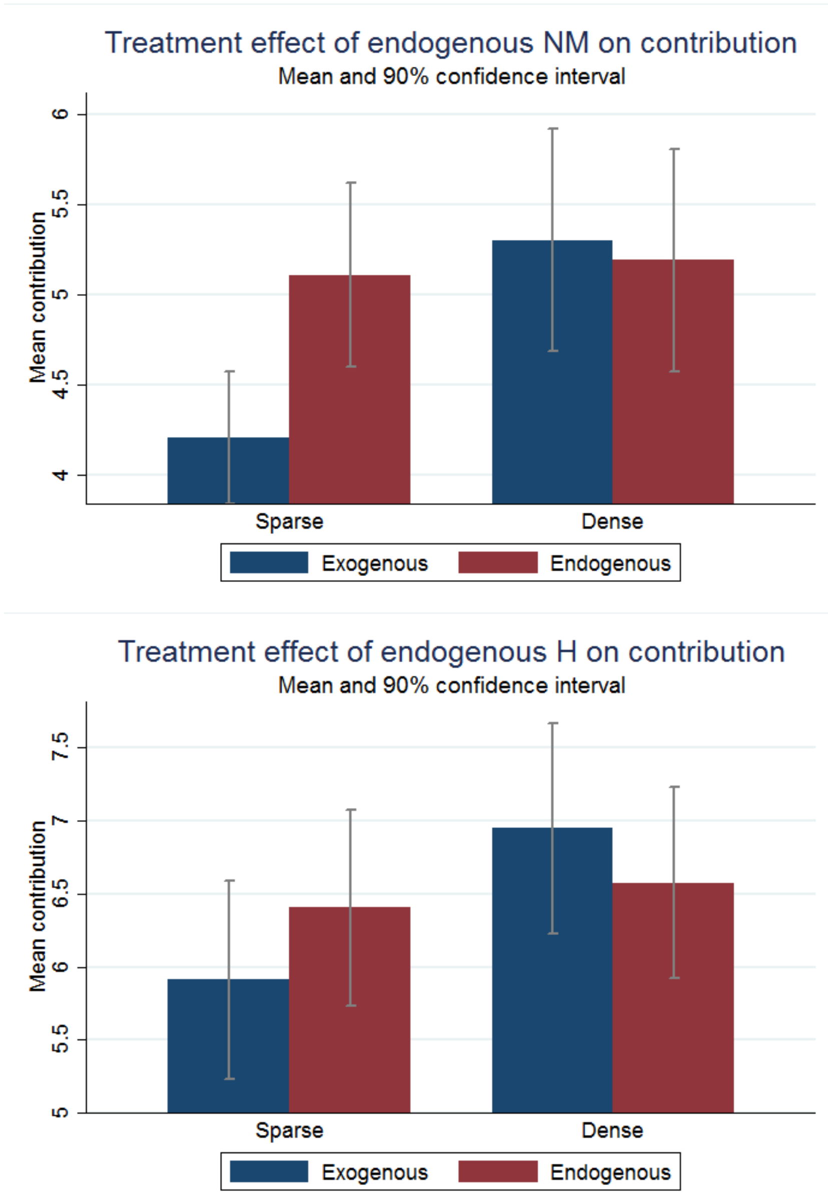
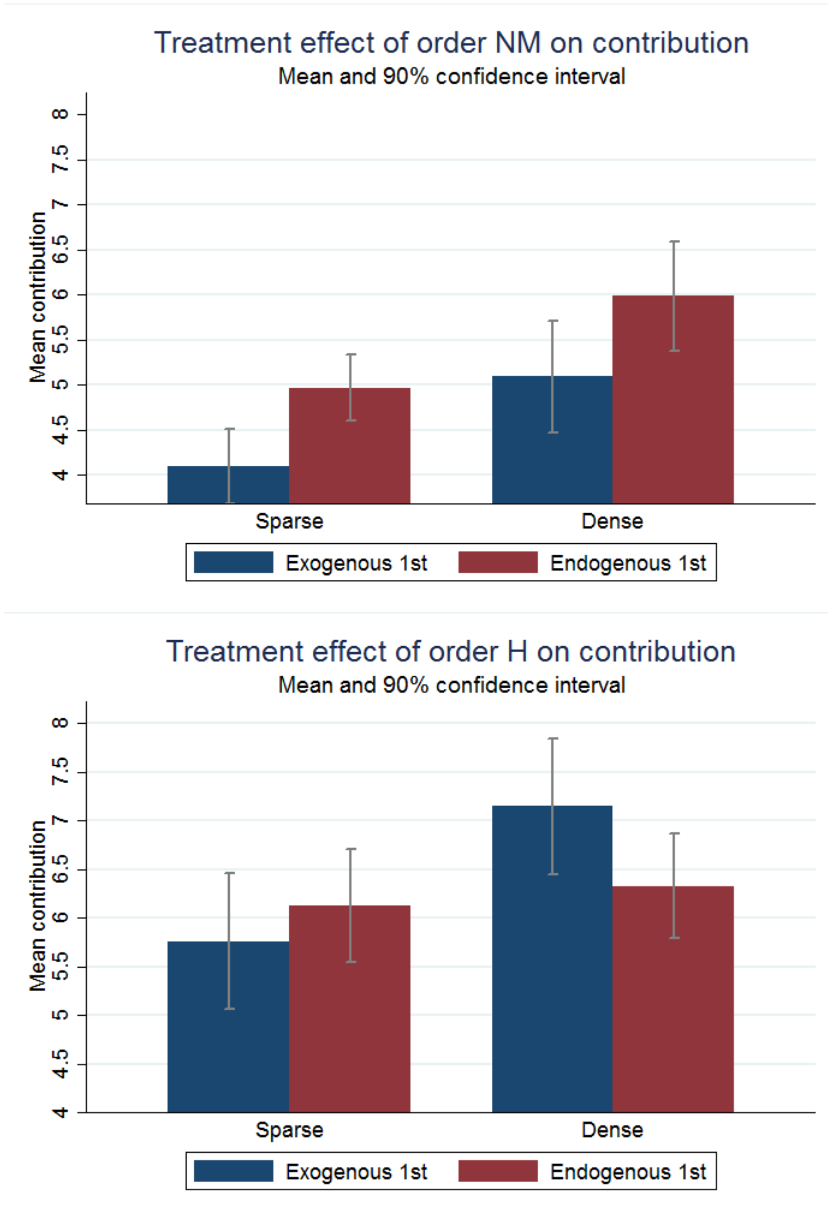


Figure 6 Contribution with Endogenous and Exogenous Monitors



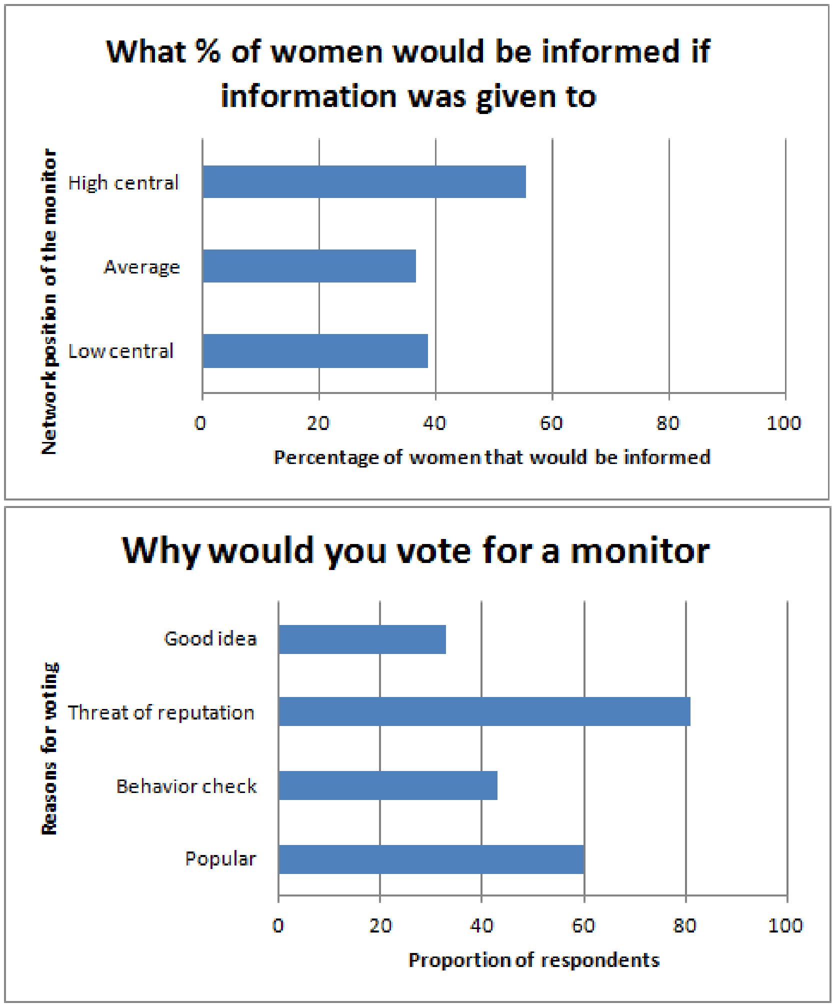
Notes: Contribution with endogenous v/s exogenous monitors without selection. In the bar graph, x-axis represents group composition and y-axis represents average contribution. We focus on a sub sample where the same group plays under the same monitoring condition both exogenously and endogenously.

Figure 7 The Order of Endogenous and Exogenous Monitor Treatment



Notes: Order of endogenous and exogenous monitors. In the bar graph, x-axis represents group composition and y-axis represents average contribution. We focus on a sub sample where the same group plays under the same monitoring condition both exogenously and endogenously. The blue bar represents monitoring institutions being assigned exogenously as compared to the red bar where monitor is assigned endogenously.

Figure 8 Supplemental Survey Evidence



Tables

Table 1 Correlations between Different Centrality Measures

	Degree	*Betweenness*	*Bonacich Centrality*
Degree	1	0.7844	0.9161
Betweenness	0.7844	1	0.8686
Bonacich Centrality	0.9161	0.8686	1

Table 2 Variation in Voting within Individual across Different Groups

		Dense group		
		No monitor	*Low central*	*High central*
Sparse group	*No monitor*	34.95%	4.57%	9.34%
	Low central	5.17%	4.37%	2.98%
	High central	14.71%	4.17%	19.68%

Table 3 Average Contribution in the Exogenous Treatment

	NM	**L**	**H**
DENSE	5.39	5.71	5.84
SPARSE	4.67	4.76	5.41

Note: dense group contribute more than the sparse ones. In the presence of a high central monitor, contribution increases significantly in sparse groups.

Table 4 Multilogit Regression on Monitor Choice

	Monitor choice	Monitor choice	Monitor choice	Monitor choice
Low central				
Dense	0.02	0.015	-0.062	0.062
	(0.20)	(0.21)	(0.24)	(0.20)
High central				
Dense	-0.31	-0.39***	-0.407***	-0.466**
	(0.14)	(0.14)	(0.18)	(0.20)
N	503	459	503	459
Group characteristics	No	Yes	No	Yes
Individual Fixed Effects	No	No	Yes	Yes

* $p<0.10$, ** $p<0.05$, *** $p<0.01$

Notes: No monitor is the base outcome. Monitor choice refers to the individual choice out of: No monitor, High central monitor and Low central monitor. Elected monitor is choice at the level of the group. Dense is a dummy variable that takes value 1 if the group is dense (average path length <2) and 0 otherwise. Group characteristics include: measures of group-differences in wealth, education and caste as well as individual level characteristics.

Table 5 Contribution under Exogenous Monitors

	contribution	contribution	contribution	contribution
Dense	0.859**	0.893***	1.407***	1.614***
	(0.38)	(0.39)	(0.31)	(0.33)
H	0.617	1.309***	0.760**	0.939**
	(0.4)	(0.41)	(0.36)	(0.38)
H × Dense	-0.117	-0.134	-0.933**	-1.088**
	(0.41)	(0.41)	(0.43)	(0.44)
L	0.02	0.47	0.646*	0.748*
	(0.62)	(0.61)	(0.38)	(0.39)
L × Dense	-0.55	-0.49	-0.972**	-1.170***
	(.11)	(0.50)	(0.42)	(0.45)
Choice	0.615***	0.632***	0.082	0.111
	(0.14)	(0.14)	(0.14)	(0.14)
N	503	459	503	459
Group characteristics	No	Yes	No	Yes
Individual Fixed Effects	No	No	Yes	Yes

* p<0.10, ** p<0.05, *** p<0.01

Note: Dense is a dummy variable that takes value 1 if the group is dense (average path length < 2) and 0 otherwise. H is a dummy variable which is 1 if a High central monitor is elected and L is a dummy which is 1 if a Low central monitor is elected. We include also group characteristics and fixed effects at the individual level. Group characteristics include: an index of wealth inequality among group members, an index of education inequality and a variable representing whether group members belong to the same caste

Table 6 Endogenous v/s Exogenous Contribution

	contribution	contribution	contribution	contribution
Endogenous	0.611**	0.597*	0.574***	0.571***
	(0.30)	(0.30)	(0.20)	(0.20)
Dense	0.868**	0.886**	1.235***	1.285***
	(0.35)	(0.35)	(0.23)	(0.23)
L	0.152	0.124	0.419*	0.399*
	(0.33)	(0.33)	(0.23)	(0.23)
H	0.780**	0.763**	0.851***	0.855***
	(0.33)	(0.34)	(0.23)	(0.23)
Endogenous × L	-0.571	-0.505	-0.116	-0.085
	(0.56)	(0.56)	(0.38)	(0.38)
Endogenous × H	-0.066	-0.060	0.046	0.033
	(0.45)	(0.45)	(0.31)	(0.31)
Endogenous × Dense	-0.162	-0.160	-0.583**	-0.591**
	(0.44)	(0.44)	(0.29)	(0.29)
Dense × L	0.134	0.143	-0.623*	-0.623*
	(0.47)	(0.47)	(0.33)	(0.33)
Dense × H	-0.312	-0.297	-0.796**	-0.815**
	(0.49)	(0.49)	(0.33)	(0.34)
Endogenous × Dense × L	-0.650	-0.699	0.014	-0.005
	(0.78)	(0.78)	(0.53)	(0.53)
Endogenous × Dense × H	-0.477	-0.470	-0.036	-0.008
	(0.64)	(0.64)	(0.44)	(0.44)
N	503	459	503	459
Group characteristics	No	Yes	No	Yes
Individual Fixed Effects	No	No	Yes	Yes
Monitor Choice	Yes	Yes	Yes	Yes

* $p<0.10$, ** $p<0.05$, *** $p<0.01$

Table 7 Endogenous v/s Exogenous Contribution without Self-Selection: Fixed Effects

	Sparse(H)	Sparse(H)	Dense(H)	Dense(H)	Sparse(NM)	Sparse(NM)	Dense(NM)	Dense(NM)
Endogenous	0.517	0.519**	-0.368	-0.365	0.904**	0.907***	-0.089	-0.092
	(0.59)	(0.26)	(0.59)	(0.23)	(0.40)	(0.22)	(0.55)	(0.21)
N	104	104	104	104	172	172	130	130
Group Characteristics	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Fixed Effects	No	Yes	No	Yes	No	Yes	No	Yes

* $p<0.10$, ** $p<0.05$, *** $p<0.01$

Note: Contribution is the amount given by individuals under each sub group. Sparse (H) refers to sparse groups (average path length $>$ 4) who played both endogenous and exogenous treatment under a High central monitor (H). Dense NM refers to dense groups (average path length $<$ 2) who played both endogenous and exogenous treatment under no monitor. Endogenous is a dummy that takes value 1 if contribution was made with choice of the group. We control for individual and round fixed effects.

Table 8 Effect of Order on average contribution across endogenous and exogenous round

	Sparse(H)	Dense(H)	Sparse(NM)	Dense(NM)
Order	0.779	-0.305	1.160**	0.987
	(0.62)	(0.55)	(0.51)	(0.79)
N	170	106	130	104
Group Characteristics	Yes	Yes	Yes	Yes

* p<0.10, ** p<0.05, *** p<0.01

Note: Order is a dummy that takes value 1 if endogenous treatment was played first. Contribution is the amount given by individuals under each sub group. Sparse (H) refers to sparse groups (average path length > 4) who played both endogenous and exogenous treatment under a High central monitor (H). Dense NM refers to dense groups (average path length < 2) who played both endogenous and exogenous treatment under no monitor.

Appendix

5.1 appendix A

IMPORTANT CLARIFICATION

The text in italic is not meant to be read aloud to experiment participants. It has the explanation of what experimenters should do. The remaining text that is not in italics is meant to be read aloud to experiment participants.

EXPERIMENT

Divide the research team into two groups: team A and team B. As participants enter the venue, team A must welcome them and locate their ID number based on their name from the individual identification list. The research team must then provide the participants with the consent forms, read the forms aloud, explain to them the contents of the forms and that the participants are free to leave at their discretion, answer any questions participants may have, and obtain their consent. [Go to Consent Form]

Then, team B should be ready to enter data on contributions.

EXPERIMENT BEGINS

Thanks for coming today! We are researchers from Rooster Logic. You are participating in a study on daily decision-making. Today you will play a series of short games. The information gathered here will be confidential and used for research purposes only.

OVERVIEW

Today, we will ask you to play a game with two different groups of people for two rounds each. You will randomly be placed in groups of three for the game, whose identity will be known. In each game, you and your group members will make some decisions. The result of these

decisions will determine how much money you will earn today.
The games will represent situations and decisions you make every day in your life. You earn some money, you keep some money for yourself, you might give some money to your neighbors or friend, use the money to fund a common project etc.

EXPLANATION OF PAYMENT

Let us now discuss how you will make money today. First, you will receive 100 Rs. for simply participating in our games. Second, you will make money from the decisions made during the game.
You will play the same game with two different groups. In the beginning of each game, you will get some income in the form of tokens in a bag we call an 'INCOME POT'. The game is easy and all that you need to do is decide how many tokens you want to keep for yourself and how many tokens you want to contribute to the 'PUBLIC POT'. The total amount collected in the 'PUBLIC POT' will be increased in value by 50%. In both games, the experimenter will collect the tokens that you want to contribute in two different 'PUBLIC POT'.

At the end of the experiment, we will pick one 'PUBLIC POT' out of the 4 and the total amount with the additional 50% increase will be equally divided among the four players in your corresponding group. You will receive equal share, irrespective of how much you put in the 'PUBLIC POT', Respectively, the tokens you decided to keep for yourself in the 'INCOME POT' corresponding to that game will be yours.

Demonstrate: The experimenter should explain that they will be playing four rounds during the day with two different groups of people. Please show them the graphical image and explain how the contribution game works and how they would earn.

See then that the decisions you make in all rounds count but you will only be paid the amount in one randomly chosen game. Before I explain the game you will play today in detail, are there any questions?
Answer any questions that they may have.

EXPLANATION OF THE GAME

The game I will explain to you is a very simple one. In this game, you will be matched randomly with 3 more people who you will interact with. You are not allowed to talk to each other throughout this game. At the beginning of the game, you and your partners will get some money that you can either keep for yourself or contribute to a common pot.
There are two stages in this game: First you will be given the choice to elect a monitor to oversee the contribution game that we just briefly explained. The monitor vote will be followed by the contribution task. Let me explain in detail what the contribution task is.
At the beginning of each game, each of you will be given an initial income of Rs 100. All

earnings during the games will be represented by tokens, each with a value of Rs 10. Then, each of you will be provided with 10 tokens that are worth Rs 100 in total. This cup will be known as 'INCOME POT'.

Demonstrate procedure, the objective you should have in mind is that individuals acquire a sense of the physicality of the game.

Now, we will explain how you can use your income in the game. You can either keep the tokens for yourself in the INCOME POT or you can contribute to the PUBLIC POT. The money that you decided to keep in the INCOME POT will be yours. The tokens that you will put in the PUBLIC POT will be added to the tokens that rest of your group put in the PUBLIC POT. The total amount contributed by the group will then increase in value by 50%.
The amount you contribute to the PUBLIC POT will not be revealed to the rest of the members of your group. To contribute to the PUBLIC POT, you will give the number of tokens you want to contribute to the experimenter in the PUBLIC POT. Remember that 1 token is worth 10 Rs.

Demonstrate the procedure via the chart again. Explain to them that 2 tokens= 20 Rs

In the first stage, you will be given a chance to elect a monitor to oversee this contribution task. The monitor will observe the amount contributed by each individual to the PUBLIC POT which is otherwise not known. In order to choose a monitor, you will put a tick next to one of the two choices: either having a monitor or not having a monitor. If you decided to have a monitor by putting a tick on the square, you will choose the name of the person you want to elect in the same sheet. If you decide to vote for having a monitor, you will be charged 10 Rs from the money you have been given for participation in the game.

Demonstrate the voting sheet to participants.

We will consider the choices of everyone in your group. The option that gets the highest number of votes will be chosen. Now, to see whether the majority choice will be implemented or an external option will be randomly assigned, we will pick a ball from this box without looking. In the box which we will call the CHOICE BOX.
We have two balls, 1 Pink and the other Green. We will pick a ball from the box, if a green ball is chosen, then the option chosen by the group will be implemented. If a pink ball is chosen instead, we will randomly assign one of the 3 options to your group.

Demonstrate the voting procedure to the participants with four enumerators. Make sure they understand the use of the CHOICE BOX

Do we have any questions at this point? Have you understood the two stages of the game?

Now, we will demonstrate the complete game.

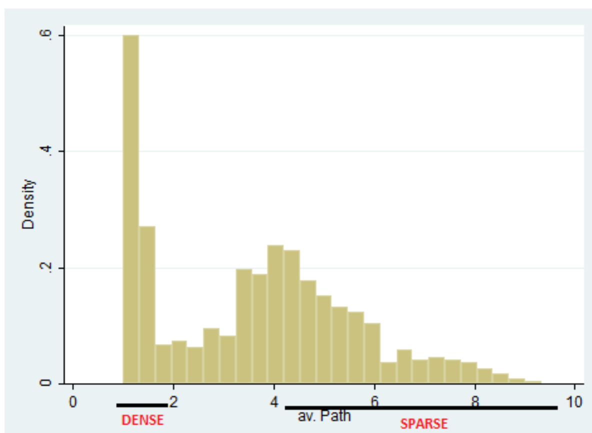
Five members of the team of experimenters should do the demonstration. Four of them should take the role contributors. The fifth person should represent himself and we will refer to him/her as the experimenter.

Do you have any questions?
Now, we will practice the game. Note that this will only be practice rounds and that you will not actually play with your actual partner. You will play the actual games with your actual partners after we explain the contribution game, practice them and we answer any question you might have about the games.

Participants play three rounds of the game and information is recorded exactly as if the game was actually being played.

5.2 APPENDIX B

Figure 9 Distribution of Groups' Average Path Length



Notes: This is the distribution of average path length in the 1006 groups we formed. Average path length is defined as the average number of steps along the shortest paths for all possible pairs of the group. We over sampled closely knit groups with average path length <2 (dense).

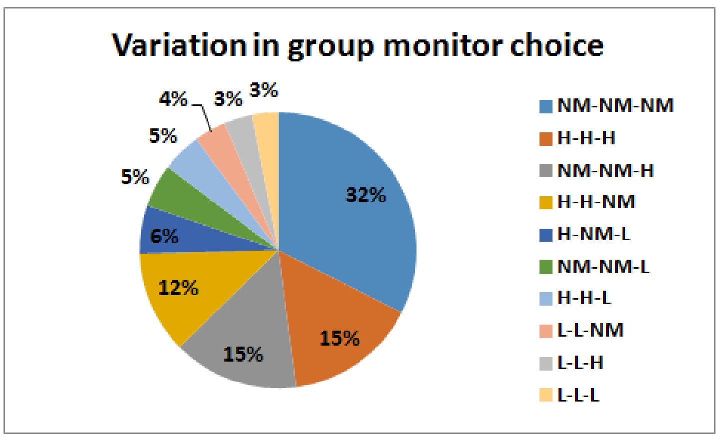
Sparse group is defined as groups with average path length >4.

Table 9 Summary Statistics

	Mean	**Std.dev**	**N**
Individual Characteristics			
age	35.8	11.43	503
education	3.06	3.85	503
no, of links	11.38	4.46	503
centrality	0.052	0.071	503
wealth index	-0.253	1.503	503
Group Characteristics			
Same caste	0.74	0.438	503
Same education	0.3801	0.485	503

5.3 APPENDIX C: MONITOR CHOICE

Figure 10 Variation in Individual Choice within a Group



Notes: It shows the variation in individual choice within a group. NM: no monitor being chosen, L: low central monitor and H: high central monitor is chosen. In most groups, all three members vote for NM followed by all three group members voting for H.

Table 10 OLS Regression for Monitor Choice Behavior

	Monitor	
	Dense	Sparse
Age	-0.0004	-0.003*
	(0.002)	(0.001)
Caste	0.021	0.090***
	(0.02)	(0.02)
Education	-0.030**	-0.052***
	(0.01)	(0.01)
Wealth	0.014	0.050***
	(0.01)	(0.01)
Favor return strangers	0.002	-0.048***
	(0.01)	(0.01)
Help friends	-0.009	0.038***
	(0.01)	(0.01)
Centrality	0.181	0.566**
	(0.30)	(0.29)
Distance to H	-0.001	0.032***
	(0.01)	(0.01)
Distance to L	0.005	0.010*
	(0.01)	(0.01)
N	842	842

* p<0.10, ** p<0.05, *** p<0.01

Note: Monitor is a dummy that takes value 0 if no monitor is elected and 1 if either a high or low monitor is elected. The first column (Dense) regresses individual characteristics with outcome of the vote and the second column does the same but for sparse groups.

5.4 APPENDIX D: MODEL WITH THREE AGENTS

We expand the two agent model presented in the main body of the paper to three agents, for it to be more representative of the interaction we observe in the experiment.

Proof of Proposition 1

We divide the proof in three steps. First, we compute the optimal contributions for both α_l and α_h types when the monitoring technology is exogenously assigned. Second, we compute the optimal contributions when the monitoring technology is endogenously chosen and the election of a monitor acts as a signal to group members. Third, we compute the equilibrium utilities and find conditions for which the separating equilibrium σ exists.

1. Let us first consider the exogenous case with no signalling. Since the monitoring technology is randomly assigned and not chosen by the group, there is no update of the prior μ_{0i}. The voting rule m^* is slightly different with no tie possible. For types α_h the utilities when the monitor is elected ($m^* = 1$) or not elected ($m^* = 0$) write

$$
\begin{aligned}
U(m^*=1) = \mu_{0i}(1-\mu_{0i}) \cdot [&U(\hat{c_h}^{exo}, \hat{c_h}^{exo}, \hat{c_l}^{exo}) + U(\hat{c_h}^{exo}, \hat{c_l}^{exo}, \hat{c_h}^{exo})] + \\
&\mu_{0i}^2 \cdot [U(\hat{c_h}^{exo}, \hat{c_h}^{exo}, \hat{c_h}^{exo}) + U(\hat{c_h}^{exo}, \hat{c_l}^{exo}, \hat{c_l}^{exo})] \\
U(m^*=0) = \mu_{0i}(1-\mu_{0i}) \cdot [&U(c_h{}^{exo}, c_h{}^{exo}, c_l{}^{exo}) + U(c_h{}^{exo}, c_l{}^{exo}, c_h{}^{exo})] + \\
&\mu_{0i}^2 \cdot [U(c_h{}^{exo}, c_h{}^{exo}, c_h{}^{exo}) + U(c_h{}^{exo}, c_l{}^{exo}, c_l{}^{exo})]
\end{aligned}
$$

while for types α_l they write

$$
\begin{aligned}
U(m^*=1) = \mu_{0i}(1-\mu_{0i}) \cdot [&U(\hat{c_l}^{exo}, \hat{c_h}^{exo}, \hat{c_l}^{exo}) + U(\hat{c_l}^{exo}, \hat{c_l}^{exo}, \hat{c_h}^{exo})] + \\
&\mu_{0i}^2 \cdot [U(\hat{c_l}^{exo}, \hat{c_h}^{exo}, \hat{c_h}^{exo}) + U(\hat{c_l}^{exo}, \hat{c_l}^{exo}, \hat{c_l}^{exo})] \\
U(m^*=0) = \mu_{0i}(1-\mu_{0i}) \cdot [&U(c_l{}^{exo}, c_h{}^{exo}, c_l{}^{exo}) + U(c_l{}^{exo}, c_l{}^{exo}, c_l{}^{exo})] + \\
&\mu_{0i}^2 \cdot [U(c_l{}^{exo}, c_h{}^{exo}, c_h{}^{exo}) + U(c_l{}^{exo}, c_l{}^{exo}, c_l{}^{exo})]
\end{aligned}
$$

where $\hat{c}_i^{exo}$ denotes the contribution of player i when there is the monitor and c_i^{exo} when there is no monitor. Solving for each contribution level c_l^{exo}, c_h^{exo}, $\hat{c_l}^{exo}$, $\hat{c_h}^{exo}$ we get, for the exogenous assignment of monitoring technology, that the optimal contributions are

$$
\begin{aligned}
\hat{c_l}^{exo} &= \frac{2\alpha_l\ \mu_{0i} - 1}{4} + \frac{\delta}{2\theta} \qquad & c_l^{exo} &= \frac{2\alpha_l\ \mu_{0i} - 1}{4} \\
\hat{c_h}^{exo} &= \frac{2\alpha_h\ \mu_{0i} - 1}{4} + \frac{\delta}{2\theta} \qquad & c_h^{exo} &= \frac{2\alpha_h\ \mu_{0i} - 1}{4}
\end{aligned}
$$

2. In the endogenous case we have to take into account the election rule and now the monitor outcome (m^*) becomes a signal according to which players update their belief about other players' types. Given the updated priors, we can write the utility function for type α_h, considering the fact that the election of the monitor is perceived as a perfectly informative signal whereby an agent α_h can infer that with probability one the other two group members are types α_l. On the contrary, when no monitor is elected, the beliefs are updated to reflect that with probability 2/3 one of the other two players in group is of low type. The utilities write

$$
\begin{aligned}
&U(\alpha_i = \alpha_h, \cdot, m^* = 1) = U(\hat{c_h}^{end}, \hat{c_l}^{end}, \hat{c_l}^{end}) \\
&U(\alpha_i = \alpha_h, \cdot, m^* = 0) = \mu_{0i}(1-\mu_{0i})[U(c_h{}^{end}, c_h^{end}, c_l{}^{end}) + U(c_h{}^{end}, c_l^{end}, c_h{}^{end})] + \mu_{0i}^2 U(c_h{}^{end}, c_h^{end}, c_h{}^{end})
\end{aligned}
$$

Following a symmetric argument for type α_l, we can write

$$U(\alpha_i = \alpha_l, \cdot, m^* = 0) = U(\hat{c_l}^{end}, \hat{c_h}^{end}, \hat{c_h}^{end})$$
$$U(\alpha_i = \alpha_h, \cdot, m^* = 0) = \mu_{0i}(1-\mu_{0i})[U(c_l{}^{end}, c_h^{end}, c_l{}^{end}) + U(c_h{}^{end}, c_l^{end}, c_h{}^{end})] + \mu_{0i}^2 U(c_l{}^{end}, c_l^{end}, c_l{}^{end})$$

Solving for each contribution level c_l^{end}, c_h^{end}, $\hat{c_l}^{end}$, $\hat{c_h}^{end}$ we get,

$$\hat{c_l^{end}} = \frac{4\alpha_l - 3}{12} + \frac{\delta}{2\theta} \qquad c_l^{end} = \frac{2\alpha_l - 1}{4}$$
$$\hat{c_h}^{end} = -\frac{1}{4} + \frac{\delta}{2\theta} \qquad c_h^{end} = \frac{4\alpha_h - 3}{12}$$

3. In order to show the existence of the separating equilibrium, we evaluate the utilities of players at the optimal contributions computed in steps 1 and 2 and compare them with respect to the two possible actions of voting for the monitor or not. For players of type $\alpha_i = \alpha_l$ we can write

$$\begin{aligned} U(m_i = 1) = \mu_{0i}(1-\mu_{0i}) \cdot [&U(\hat{c_l}^{exo}, \hat{c_h}^{exo}, \hat{c_l}^{exo}) + U(\hat{c_l}^{exo}, \hat{c_l}^{exo}, \hat{c_h}^{exo})] + \\ \mu_{0i}^2 \cdot [&U(c_l{}^{exo}, c_h{}^{exo}, c_h{}^{exo}) + U(\hat{c_l}^{exo}, \hat{c_l}^{exo}, \hat{c_l}^{exo})] \\ U(m_i = 0) = \mu_{0i}(1-\mu_{0i}) \cdot [&U(c_l{}^{exo}, c_h{}^{exo}, c_l{}^{exo}) + U(c_l{}^{exo}, c_l{}^{exo}, c_h{}^{exo})] + \\ \mu_{0i}^2 \cdot [&U(c_l{}^{exo}, c_h{}^{exo}, c_h{}^{exo}) + U(\hat{c_l}^{exo}, \hat{c_l}^{exo}, \hat{c_l}^{exo})] \end{aligned}$$

It is easy to show that when δ is large enough there exists a $\overline{\mu}_{0i=\alpha_l}$ st. for $\mu_{0i} < \overline{\mu}_{0i=\alpha_l}$, agent i of type α_l is better off voting for the monitor rather than not, i.e. the difference $U(\alpha_i = \alpha_l | m_i = 1) - U(\alpha_i = \alpha_l | m_i = 0)$ is positive.

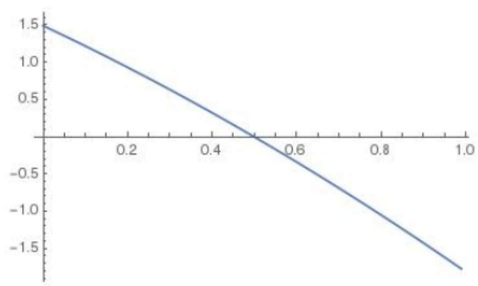


Figure 11 $U(m_i = 1) - U(m_i = 0)$ in function of μ_{0i}

Similarly, we can write for type $\alpha_i = \alpha_h$

$$U(m_i=1) = \mu_{0i}(1-\mu_{0i}) \cdot [U(\hat{c_h}^{exo}, \hat{c_h}^{exo}, \hat{c_l}^{exo}) + U(\hat{c_h}^{exo}, \hat{c_l}^{exo}, \hat{c_h}^{exo})] +$$
$$\mu_{0i}^2 \cdot [U(c_h{}^{exo}, c_h{}^{exo}, c_h{}^{exo}) + U(\hat{c_h}^{exo}, \hat{c_l}^{exo}, \hat{c_l}^{exo})]$$
$$U(m_i=0) = \mu_{0i}(1-\mu_{0i}) \cdot [U(c_h{}^{exo}, c_h{}^{exo}, c_l{}^{exo}) + U(c_h{}^{exo}, c_l{}^{exo}, c_h{}^{exo})] +$$
$$\mu_{0i}^2 \cdot [U(c_h{}^{exo}, c_h{}^{exo}, c_h{}^{exo}) + U(\hat{c_h}^{exo}, \hat{c_l}^{exo}, \hat{c_l}^{exo})]$$

In calculating the difference, it easy to see that for any value of the prior μ_{0i} $U(\alpha_h|m_i = 1) - U(\alpha_h|m_i = 0) < 0$, and a high type would always vote for no monitor, irrespective of the group he plays in. Combining the two results above, there exists an interval of μ_{0i} where type α_l would choose a monitor whereas type α_h would choose no monitor. Therefore the σ separating equilibrium exists only for $0 < \mu_{0i} < \overline{\mu}_{0i}*_{\alpha_l}$. If $\mu_{0i} > \overline{\mu}_{0i}*_{\alpha_l}$ there is no separating equilibrium and both types vote for no monitor.

□

Proof of Proposition 2

Given the level of contribution under the exogenous monitor we computed in Proposition 1 it easy to compare contributions with or without the monitor. Irrespective of agents' types, the positive impact on optimal contributions of the monitor Δc writes

$$\Delta c = \frac{\delta}{2\theta}$$

Then, it follows immediately that the impact Δc is higher for δ_H, i.e. high central monitors, and for low θ, which we assume regulate interactions in sparse groups. □

Proof of Proposition 3

We compare the total contribution prompted by endogenous monitors, i.e. after the priors are updated, with the average contribution when no such signalling occurs, i.e. for exogenously assigned monitors. In particular, we pool together the contributions of both α_l and α_h types to have get a more general result. However, the same results can be derived comparing contributions taking into consideration self-selection into monitoring technologies imposed by the separating equilibrium σ. In that case, the contrast would be even more neat.
The total contribution before the elected monitor is revealed writes

$$\frac{2\alpha_l\ \mu_{0i} - 1}{4} + \frac{\delta}{2\theta} + \frac{2\alpha_l\ \mu_{0i} - 1}{4} + \frac{2\alpha_h\ \mu_{0i} - 1}{4} + \frac{\delta}{2\theta} + \frac{2\alpha_h\ \mu_{0i} - 1}{4}$$

while the total contribution after the elected monitor is revealed is

$$\frac{4\alpha_l - 3}{12} + \frac{\delta}{2\theta} + \frac{2\alpha_l - 1}{4} + -\frac{1}{4} + \frac{\delta}{2\theta} + \frac{4\alpha_h - 3}{12}$$

Comparing the two total contributions we find that the latter is greater than the former only when

$$\mu_{0i} < \frac{5\alpha_l + 2\alpha_h}{6(\alpha_l + \alpha_h)}$$

which concludes the proof. □