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Leaders' distributional & efficiency effects in collective responses to policy: Lab-in-field experiments with small-scale gold miners in Colombia

Luz A. Rodriguez [a,*], María Alejandra Velez [b], Alexander Pfaff [c]

[a] School of Environmental and Rural Studies, Pontificia Universidad Javeriana, Colombia
[b] School of Economics and Center for the Study of Security and Drugs (CESED), Universidad de Los Andes, Colombia
[c] Sanford School of Public Policy, Duke University, United States

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ABSTRACT

Globally, small-scale gold mining (SSGM) is an important economic option for many rural poor. It involves local uses of shared resources, like common-pool contexts for which self-governance has avoided 'tragedies of the commons'. Yet even ideal local governance of SSGM is not societally efficient given non-local damages that suggest external interventions for desired shifts. Because transactions costs are high for rewarding reductions in damages on remote mining frontiers, states could gain if rewards based on low-cost, group compliance measures could successfully induce cooperation in response to policy. However, as group-level rewards invite free-riding, such success requires local collective action. Since that guarantees neither efficient coordination nor equitable distributions of net benefits from compliance, we consider the impacts of emergent leaders on local responses to external policy. We employ framed lab experiments with 200 small-scale gold miners in Colombia's Pacific to explore leaders' impacts on equity and efficiency in collective responses to external incentives. Allowing communication before individual choice, which raises efficiency but not always equity, we can identify emergent leaders of groups' communications. Leaders raise compliance and affect how its costs are distributed, suggesting access to leadership roles matters.

1. Introduction

Globally, many rural poor depend on natural resources in livelihoods strategies. For such contexts, studies have highlighted collective action as central in avoiding the 'tragedy of the commons' for local public goods (e.g., see Agrawal, 2002; Baland & Platteau, 1996; McKean, 1992; Ostrom, 1990). However, locally efficient self-governance may not be sufficient for contexts where appropriation also generates external effects on distant actors, as occurs within small-scale gold mining (SSGM). Given many regional and global public goods that are affected by local decisions within mining, we study external incentives to shift to cleaner practices and focus on collective local responses.[1]

Most studies of collective action presume symmetry, i.e., identical roles for all local participants (Vedeld, 2000). Yet assuming relatively homogeneous groups ignores important heterogeneities in culture, wealth, power, interest and cost, that affect the ability to act collectively (Lobo, Velez, & Puerto, 2016), plus who gains or loses from collective management of resources (Adhikari, 2005; McKean, 1992).[2] We explicitly focus on asymmetric roles, i.e., leadership and its consequences for local responses.

* Corresponding Author at: Pontificia Universidad Javeriana, Transversal 4 No 42-00 Piso 8, Edificio José Rafael Arboleda, Bogotá, Colombia.
E-mail addresses: rodriguez.luza@javeriana.edu.co (L.A. Rodriguez), mavelez@uniandes.edu.co (M.A. Velez), alex.pfaff@duke.edu (A. Pfaff).

[1] Collective responses are required if incentives are based on collective compliance. Examples include payments to communities for aggregate ecoservices or limits on total allowable catch (Kotchen & Segerson, 2019). Collective rewards in mining include community permits, certifications, or development funding. Compliance measures include satellite deforestation data, river water samples, or numbers of machines (dredges and backhoes) that affect outcomes.

[2] Olson (1965) argues some heterogeneity supports collective action, since those with higher stakes may take a lead. As when leaders incur extra costs leadership is a '2nd-order' collective challenge (Ostrom, 1998), greater gains from taking action – due to leaders' endowments, valuations, or gains shares – may be needed (Arbak & Villeval, 2013).

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For collective responses to external incentives[3], we explore leaders' efficiency and equity impacts using a lab-in-field experiment framed in terms of mining and implemented with 200 members of mining communities bordering the Yurumanguí River in Colombia's Pacific region. We confirm our baseline results are similar to those in Rodríguez, Pfaff, & Velez, 2019, with other mining communities, then add communication. We also confirm that communication improves coordination (Cardenas, Ahn, & Ostrom, 2004; Lopez & Villamayor-Tomas, 2017; Ostrom, Walker, & Gardner, 1992), then identify emergent leaders of groups' communications, so we can explore how our leaders influence efficiency and equity.

Research has highlighted that leaders establish goals, motivate, coordinate, monitor, and sanction – all helping to solving local dilemmas. They build up consensus, and coordination, plus determine how norms are interpreted, what cooperation is expected, and the punishments for non-cooperation (Calvert, 1992). That raises cooperative efficiency and there is evidence leaders increase efficiency within both observational (Baland & Platteau, 1996; Lobo et al., 2016; Laerhoven, 2010) and behavioral/experimental studies (e.g., Glowacki & von Rueden, 2015, Kosfeld & Rustagi, 2015) – although leadership often has not been considered within studies of collective action and equity.[4]

Our study of asymmetries focuses on leaders and equity, i.e., impacts on distributions of outcomes. Leaders can lower equity by allocating resources disproportionately (Esteban & Hauk, 2009) or via "anti-social" punishment (Kosfeld & Rustagi, 2015). Yet, given repetition, even quite opportunistic leaders may act fairly in allocating resources, and/or in sanctioning, in order to sustain cooperation from which they gain (van der Heijden, Potters, & Sefton, 2009). This may correlate with efficiency. Going beyond communication's impacts on efficiency, we find that communication raises equity.

Yet while that is the case on average, sometimes communication lowers equity – even stably so, over time – thus we explore why and how that could occur. Within the communications dynamics, we focus upon the roles of "endogenous leaders" (the participants who drove the communications within our groups – though we must acknowledge that any result concerning leaders necessarily is conditioned on how leaders arise). We find leaders play key roles not just in raising compliance but also in affecting equity, i.e., how compliance costs are distributed among the groups' members.

Below, Section 2 briefly reviews some prior, mostly experimental research concerning leadership. Section 3 describes mining and in particular small-scale gold mining in Colombia's Pacific region. Section 4 lays out our experiment, and Section 5 our results, then Section 6 discusses implications.

2. Leadership literature

Leadership can arise from taking early action oneself or actively coordinating others (von Rueden, Gurven, Kaplan, & Stieglitz, 2014). It includes generating ideas, motivating people, negotiating, and resolving conflicts (Singh & Eallabh, 1994) and may be more pivotal for initiating than sustaining cooperation (Bianco & Bates, 1990; Van Belle, 1996). Whether others follow is affected by the leaders' understanding of dilemmas (Baland & Platteau, 1996), their reputations and legitimacy (Tyler, 2002), connections to others (Bodin & Crona, 2008), and their socioeconomic characteristics (Jack & Recalde, 2016).

Hermalin (1998) study early actions as one way leaders induce others to follow them in solving a team problem. The phrase 'lead by example' highlights that leaders need not hold formal authority. Better information may do – and leadership is, in part, about transmitting information to followers. In this model, the leader's action informs others' beliefs since the leader uniquely holds some facts. Further, such asymmetry can be superior to symmetric information as it induces the leader to work (Komai, Stegeman, & Hermalin, 2007 show that creating such situations can help the whole group). Leading 'by example' has been studied by focusing upon first-movers: cooperative or 'pro-social' leadership has more impact on contributions (Gächter & Renner, 2018; Gächter, Nosenzo, Renner, & Sefton, 2012; Harrell & Simpson, 2016; Levy, Padgitt, Peart, Houser, & Xiao, 2011; Sahin, Eckel, & Komai, 2015). Effects rise if the leader has more information (Potters, Sefton, & Vesterlund, 2007), if followers can see that leader suggestions and contributions are consistent (Houser, Levy, Padgitt, Peart, & Xiao, 2014), if leaders help generate identity (De Cremer & Van Vugt, 2002; Drouvelis & Nosenzo, 2013), and can exclude non-cooperators (Guh, Levati, Sutter, & van der Heijden, 2007), since an ability to sanction free-riding clearly could allow leaders to raise efficiency. Hermalin does not, however, consider how the leader is chosen. Most experimental studies of leadership chose group leaders exogenously, including randomly. However, some allowed volunteering for leadership (Arbak & Villeval, 2013) or conducted elections to choose their leaders (Guh et al., 2007; Levy et al., 2011).

Most but not all experimental studies of leadership have been conventional lab experiments, with students as participants. Yet Jack and Recalde (2015) studied local authorities in Bolivia, finding that voluntary contributions rise if democratically elected authorities lead by example. Three studies in Colombia local leaders and contributions: Rodríguez et al., 2019 (as discussed above); D'Adda (2012) and Rodríguez, Roldán, Zuluaga, and Usma (2017). D'Adda (2012), after identifying leaders in a pre-game social ranking, finds larger contributions when leaders make larger contributions. In a common-pool game, Rodríguez et al. (2017) find efficiency gains of leaders if groups communicate, in which case more leaders (traditional or administrative) lowered extraction. Yet, without communication, leaders raised extraction. Communication may make leaders more visible – facilitating leadership 'by example', in which leaders' lower extraction is reciprocated. That visible leaders matter more supports our focus on leaders who emerge in communications, i.e., drove our groups' discussions.

Coming finally to our focus on leaders and distribution, a few studies employing field populations have also considered distributions of outcomes – e.g., von Rueden et al. (2014) explore leadership among the Tsimane' forager-horticulturalists of Bolivia and its effects on the division of rewards. Within such an egalitatarian society, leaders did not claim larger reward shares, perhaps desiring altruistic reputations. Kosfeld and Rustagi (2015) studied how different approaches to punishment – as a means to enforce cooperation – affect contributions within a commons dilemma, for a case of forest-commons management within Ethiopia. They combine experimental data for real-world leaders, from a third-party punishment game, with observational data about the actual performance of their groups. They find that leaders who emphasize equality and efficiency in their punishments have more positive forest outcomes – compared to leaders who do not punish – and that antisocial leaders, i.e., those who punish indiscriminately (even cooperators), have more negative outcomes.

[3] Collective incentives when monitoring of individuals is difficult might strengthen a community's rules (Clements et al., 2010; Hayes, Murtinho, & Wolff, 2015), in turn shifting local behavior (Hayes, Murtinho, & Wolff, 2017), depending on communities' capacities. Group-performance contracts can motivate farmers to share conservation burden (Narloch, Drucker, & Pascual, 2017).

[4] In field studies, Sommerville, Jones, Rahajaharison, and Milner-Gulland (2010) see net benefits and net costs from community-based PES in Madagascar. Zabel, Bostedt, and Engel (2014) examine shares of village rewards for improved carnivore conservation in Sweden. In lab experiments on distribution, communication and peer monitoring are foci (Cardenas et al., 2004) but not leadership.

3. Sectoral & geographic context

3.1. Local mining, broader concerns

SSGM is an important economic sector in many developing frontiers, central for local livelihoods and cultures (e.g. Bryceson & Jonsson, 2010; Cartier & Burge, 2011; Hilson & Maconachie, 2017). Yet, it has significant costs for the environment, both locally and beyond, in terms of water quality, habitat, carbon emissions, and more – making even ideal local governance societally inefficient.

However, state regulation of SSGM has been ineffective (Cremers & de Theije, 2013; Hilson, 2003, Maconachie & Hilson, 2011; Verbrugge & Besmaos, 2016). SSGM is often on frontiers beyond a regulator's reach (Peluso, 2018), where transaction costs are large. Gold deposits often are alluvial, while gold is 'lootable'[5], adding challenges. Further, most miners work outside formal economies. They lack property rights – forget clear incentives for clean choices[6] (Siegel & Veiga, 2009) – and applying large-scale mining policy has not worked for SSGM. That even can raise informality (Hilson, Hilson, Maconachie, McQuilken, & Goumandakoye, 2017). On such isolated frontiers, SSGM is driven mainly by longstanding poverty and traditions. Top-down efforts to repress it can increase social unrest in mining regions instead of resolving the broad economic and socio-political issues involved in this sector (Geenen, 2012).

In such contexts, inclusive, bottom-up cooperation can outperform top-down governance (Geenen, 2012; Hilson & Maconachie, 2017; Johnson, 2019; Zvarivadza & Nhleko, 2018). Frontiers can often feature even longstanding informal, local governance institutions that mimic or compete with state governance (Peluso, 2018; Van Bockstael, 2014), with better local knowledge and local monitoring. Nonetheless, for best local function such governance may require complementary state institutions (Hook, 2019; O'Faircheallaigh & Corbett, 2016) – though that can require revisions of legislation.

States have another role too: encouraging local internalization of external – even global – impacts. External rewards for local contributions to globally efficient outcomes can contribute to solving broader collective-action problems (Kotchen & Segerson, 2019). Such solutions face well-known challenges from free-riding, however, as limited information prevents external rewards from being provided at individual levels. Funds transfers will be conditioned on outcomes for, e.g., villages.

3.2. Small-scale gold mining in Colombia's Pacific region

Colombia has roughly 200,000 small-scale gold miners, with 1,200,000 dependents (Hilson & Maconachie, 2017) and the highest per-capita mercury pollution in the world (Siegel, 2013). Small-scale gold mining is *de facto* open access, though the state owns the subsoil.[7] Per the Colombian Mining Census, 86% of metallic mineral production occurs in small units without mining titles (Cabrera & Fierro, 2013). Most are informal, lacking both permits and environmental licenses. Yet in total they account for perhaps 70% of the gold produced in the country (Sarmiento, Giraldo, Ayala, Uran, Soto, & Martinez, 2013).

About 40% of gold production in Colombia is in the Pacific region, within which over 90% comes from small-scale mining by locals and by migrants – the latter often connected with armed groups (Giraldo & Muñoz, 2012; Sarmiento et al. 2013). The Pacific region is inhabited mainly by Afro-Colombian communities with collective land titles. Their land is managed by community councils with locally elected representatives (Velez, 2011).[8] The community councils are, in fact, formally recognized in Colombian law as responsible for natural-resource management in their territories.

In this region, SSGM has been a traditional, culturally embraced economic activity since colonial times (Sarmiento et al., 2013). While in the past most mining was carried out using artisanal tools such as pans, as superficial gold has been depleted traditional tools have been joined by machines such as pumps, for small miners, or far bigger backhoes and dredges to move land.[9] Pumps draw water out of mines and separate gold from riverbanks using water pressure to flush out deposits. Their impacts on forests, sedimentation, and the paths of rivers simply increase with their number. While under Colombian law the only mining not requiring a concession is use of pans (*barequeo*), communities consider low-horsepower pumping to be 'artisanal'. Some community councils have crafted rules for SSGM management concerning revenue sharing and allowed mining techniques.

Our setting is a mining community in the Yurumanguí River within the rural area of Buenaventura, the main Colombian port in the Pacific coast. Buenaventura is economically important, yet poverty is common in its rural areas and most of the Pacific region (with ~80% below the poverty line). SSGM is the only economic alternative for many. Yurumanguí, with a population under 3000, is far from the city along the Yurumanguí River, which is the only transport option (a day-long trip).

Unlike in many communities where migrant miners conflict with both authorities and local miners, within Yurumanguí the gold mining is exclusively by community members or miners from nearby communities with relatives in Yurumanguí. The council assembly – based on ethnic authority – has been able to exclude external miners. Using a form of collective mobilization (*mingas*), community members have literally blocked any entrance into the river for external miners' heavy machines. Internal regulatory institutions also affect mining practices by community members. For instance, both mercury and heavy machinery are locally forbidden. The community does, though, allow the use of pumps, if they are below a certain power, while limiting the number of pumps.

Yurumanguí is an exception in its local governance (Lobo & Vélez, 2020). For instance, in our field surveys we found that in Yurumangui, 72% of the participants believed that the community-council assemblies make decisions which can influence or could effectively control gold mining. This percentage was only 30% for other community councils closer to the city of Buenaventura.

4. Experimental design

In our field-lab experiment, based on Rodríguez et al., 2019, an external authority: provides a group – a 'community' of five participants – with an environmental target; monitors group compliance with that target; and, given compliance, provides a reward shared

[5] High value-to-weight ratio and relatively easily appropriated/transported by unskilled workers (Maconachie, 2009).

[6] Subsoil and non-renewable resources may belong to the state, making it questionable to invest in costly technologies or even otherwise efficient agreements. Property rights for miners could "unlock capital" and generate development (Siegel & Veiga, 2009, per De Soto, 2000) – yet, with negative externalities, rights would not yield societal efficiency (Clausen, Barreto, & Attaran, 2011). States could also complement good local governance with incentives for 'clean'.

[7] In Colombia, there are approximately 9,400 mining concessions (43% for gold), which cover 5.6 million hectares.

[8] See Velez (2011) per institution building regarding collective territories in the Colombian Pacific, and in particular Buenaventura. To date, roughly six million hectares have been collectively granted to more than 170 communities.

[9] Techniques vary widely. Mercury is used mainly by migrant miners in the Pacific. Some Afro-Colombian and other communities have social norms against it (Sarmiento et al., 2013 & our 2013–14 interviews, focus groups, and surveys).

equally by the group's members. Each participant chooses a number of mining pumps.[10] If the total number of pumps within a group is below the target, a reward (extra payment) is equally distributed among the group's members. Equity is driven not by distributions of the collective payment but only by the costs of compliance.

Groups played for 8 rounds, with each group member choosing 0, 1, 2, or 3 pumps in each round. We employ this repeated, within-subject interaction to allow for the development of group 'trust', or 'social capital', as we hypothesize that effects of external interventions will vary with the degree of group function. In addition, since policy instruments such as we consider would be implemented within communities, we would actually expect to observe repeated interaction among participants.

We care about treatment order, as incentives' impacts are likely to vary with prior play. The initial round is a baseline, without any policy target, to be compared to rounds with targets. Rounds 2–7 are treatment rounds, with targets of either 10 or 5 total pumps. We shift that target after Round 4: groups starting with a target of 10 pumps in Rounds 2–4 face a target of 5 pumps for Rounds 5–7 (and vice versa). Finally, Round 8 is like Round 1, i.e., another pumps decision without any target. Participants did not know in advance the number of rounds, nor that the targets might be changed.

Table 1 below shows the payoffs table presented to the miners. The first column shows the mining benefits per level of intensity (number of pumps chosen), the second the individual share received from the collective reward if the target is met, and the third column shows the total benefits (i.e., the sum of the first and second column) if the aggregate number of pumps is at or below the limit.

This game can reflect cooperation dilemmas, once there is a reward for meeting a collective target. For instance, from Table 1 we can work out that were the collective target to be 10 and were all of one's group members expected to choose 2, one does best by cooperating and choosing 2 as well (choosing 3 pumps would earn $7, as there would be no reward, while choosing 2 would earn $12). Even for the lowest target of 5, doing 1 is best when all other members are expected to choose 1 (choosing 3 pumps would earn $7, as there would be no reward, while choosing 1 would earn $10).

Since this is a coordination game, there are multiple Nash equilibria, symmetric and asymmetric. Efficient equilibria include one symmetric equilibrium, in which each individual chooses exactly one fifth of the aggregate target (1 for target 5, 2 for 10). There are many asymmetric equilibria[11], i.e., combinations of pumps that sum up to the exactly the target, as overcomplying is inefficient. The inefficient Nash equilibrium is 'symmetric full non-compliance' where each uses three pumps.

Instructions were read aloud. Questions were answered individually and privately. After reading the instructions and explaining the payoffs table, we administered a quiz by giving each participant a form indicating a decision (marked by the experimenter) and asking if the collective reward was obtained and what the participant earned. We checked these, individually explained the payoffs if necessary, then redid the quiz. In each round, on a decision sheet showing Table 1, each participant marks with an X the number of pumps chosen. A facilitator collects those sheets, sums the pumps, and then communicates both total pumps and individual earnings by privately returning the sheets.

In a group, participants knew who the other members were.[12] Family members were not allowed in the same group, else all the participants in any session were distributed randomly among groups. At the end of the session, participants answered a survey to gather socio-economic characteristics.

To explore the effects of communication, half of the groups were allowed to talk for a few minutes before making each decision. We recorded and coded all of the conversations before each round.[13] In summary, then, as we show within Table 2, we ran four treatments using a between-group design in which we varied the group's target number of pumps (10 or 5), as well as the ordering in which such targets were introduced, and finally the possibility (or not) to discuss among group members.

We invited adults in the mining villages of Juntas and San Antoñito, which are upstream along the Yurumanguí River, where gold extraction takes place. Table 3 summarizes some characteristics of our participants: a bit over half are women; the average age is about 36; and almost everyone does some voluntary community activities on a regular basis. Their education levels are quite low, with almost half below completion of primary. SSGM is the main economic activity for almost all and almost all use pumps as tools in their daily actual SSGM (13% use other machines as well, such as small dredges). Average income in a good week is ~US$69, in a bad week ~US$8 (US$1 = COP$3400). As gold mining has quite uncertain productivity, a miner's income can be very erratic.

Concerning their involvement in governance of these communities, 18.5 percent of our participants reported high or very high participation in the governing body of the Community Council. That can in principle be an indicator of "real-life" formal leadership roles. Yet it is limited measure as, in these communities, leadership goes beyond formal Council participation status. Teachers and elders, for example, often play non-formal leadership roles in the community (and we recall that, per Hermalin, 1998, leaders can be effective without holding formal authority). We highlight that only 25 percent of the emergent leaders in our games are high-frequency participants in the Council and that this fraction is not statistically differentiable from the share for non-leaders in our games.

5. Results

5.1. Robust baselines in policy-induced collective action

Fig. 1 and Table 4 show impacts of our collective incentives, and communication, by comparing outcomes – total pumps, by round – for both no-treatment rounds (1 & 8) and treatment rounds. With-

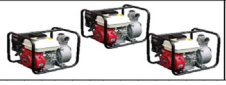
[10] Our field work revealed that the highest number of pumps that families would use for mining was 3. Higher intensity involves using heavier machines, like dredges or backhoes, which with a few exceptions are forbidden in Yurumangui. Thus, the number of pumps is in fact a fair indicator of the intensity of small-scale mining, at least within this region. For a maximum of 3 pumps per participant within the game, with groups of 5 the maximum pumps per group was 15. Along these lines, we used both 5 and 10 as thresholds, since targets that are multiples of 5 allow equal sharing of the burdens of collective compliance. Within efficient compliance, every group member can use an identical 1 or 2 pumps.

[11] For linear payoffs, an efficient Nash equilibrium in a threshold-public-goods game is any vector of individual contributions that: sums to the contribution threshold (efficiency constraint); and does not involve any individual contributing more than her benefits from the public good (rationality constraint -- as in Croson & Marks, 2000).

[12] This might affect decisions if previous interactions affect choices, especially in first rounds. Yet the initial rounds not only were close to uncooperative Nash but also had essentially the same results as the last (also no policy) round.

[13] The participants were aware that conversations were recorded much as they were aware that we were recording all their choices in the experiment in order to analyze the data (albeit never to reveal any individuals' choices to others). If participants adjusted choices because of their visibility to the experimenter, for instance if leaders acted for more equity because they felt some external pressure to do so, then our inequity results could be lower bounds on reality.

Table 1
Payoffs table.

My decision (number of pumps) Mark with an X		Earnings from mining	Collective reward	Total earnings
0	0	$1	+$7	$8
1		$3	+$7	$10
2		$5	+$7	$12
3		$7	+$7	$14

Notes: "Earnings from mining" are those from extracting, without any external payment, and rise at $2 per pump; "Collective reward" is the individual payment for each miner if the group complies with the target; so "Total earnings" sums those two categories if community comply with the target.

Table 2
Treatments and number of participants.

	Ordering of target (aggregate pumps)	
	THR-10-05	THR-05-10
Communication	50 people (10 groups)	50 people (10 groups)
No communication	50 people (10 groups)	50 people (10 groups)

Notes: "THR-10–05" refers to the treatment with a threshold (or target or limit) of 10 pumps for the first three treatment rounds (Rounds 2–4), followed by a limit of 5 pumps (for Rounds 5–7); then the "THR-05-10" treatment simply reverses the order of those targets, with 5 before 10.

out targets and incentives, individuals' choices average close to the maximum of three pumps (i.e., Rounds 1 & 8 are close to the symmetric non-cooperative Nash Equilibrium[14]). In Figure 1[15], we see that total pumps fall significantly with treatments, on average to close to the policy targets for most treatments. Communication helps, in particular when smaller targets are introduced first. All of this confirms robustness for non-communication behaviors and for communication's effects.

Even without communication, and a less stringent target of 10, the collective target lowers pumps (12.5 to 9.17, on average, below the target despite some failures within an 80% rate of compliance). The more stringent target of 5 makes things more complicated, with compliance now under 40%. Yet even with a majority of groups failing to get collective rewards, mean total pumps falls to 6.5. This highlights tradeoffs in target stringency (confirming core results from Rodríguez et al., 2019). Both failures without policy and policy impacts without communication are robust across contexts. Also in line with Rodríguez et al. (2019), groups starting with a tougher target have a much lower initial success rate (10%) – plus that undermines performance later, when facing an easier target.

Table 4's last two rows present the Communication treatment for both the orderings of the targets. While communication does raise success for less stringent initial targets (90% > 80%), its impact is greater for the more stringent target, for which successes jump to almost 60% from under 40%, a big rise (although this did not eliminate a 'stringency tradeoff' between success rate and pumps).

Communication also has positive equity impacts, on average. Table 5 shows how often the pumps choices look like a part of a symmetric-efficient equilibrium, i.e., one which hits the target exactly as all group members choose the same thing (2 for less stringency (10), 1 for more stringency (5)). We also see how many folks appear to have given up on that and, instead, just chosen three pumps. Though compliance can be reached with different combinations of decisions, and is an equilibrium for various asymmetric outcomes, Table 5 shows that communication increases the share of people choosing the symmetric option, which increases equity (for target 10 (dotted line) or 5 (solid line)).

5.2. Leaders' impacts

5.2.1. Communications leaders

Leaders can support collective solutions by establishing goals, motivating and building consensus, monitoring, resolving conflicts, and deciding payments distributions and sanctions (Calvert, 1992; Glowacki & von Rueden, 2015; von Rueden et al., 2014). To identify who may be playing those potential roles – except for formal sanctioning – we examine communications within our groups. Our "communications leaders" need not currently be formal leaders in these communities. Instead, leaders arise endogenously within our games, i.e., we study those individuals who effectively lead discussions, so that other group members follow. We acknowledge that any study of leadership is conditioned on how it has emerged. Here that is not by random assignment, raising relevance for some contexts but not others. In sum, we comment upon groups where leaders arise endogenously.

From notes taken by group facilitators, and recordings of discussions, we identify two situations: i) leaders emerge to suggest what to do; ii) "failed communication"/"no leader", i.e., either nobody tried to take a lead or "consensus failed", which includes efforts by individuals to lead discussions that effectively are

[14] Our appendix present average individual pump in Rounds 1 & 8: by treatments (Table A1), which do not differ in these rounds except by chance; and by factors that might influence baseline behaviors (Table A2). Controlling for all socioeconomic characteristics, treatment groups do not differ. We note women chose higher pumps in the baseline.

[15] In the Appendix (Fig. A1, Fig. A2, Fig. A3, Fig. A4), in order to display the diversity of dynamics, we also include figures for each of these groups.

Table 3
Socio-demographic characteristics of participants (N = 200).

Variable	Mean	Standard deviation	Min	Max
Age (years)	35.7	15.4	17	87
Women (%)	55.5			
Participation in voluntary activities (%)	90.9			
Income in a good week (US$)	68.8	83.6	3.0	606.1
Income in a bad week (US$)	8.3	21.6	0	181.8
Current high participation in governing body of the council (%)	18.5			
Education level (%)				
None	13.6			
Incomplete primary	30.6			
Complete primary	8.0			
Incomplete secondary	29.7			
Complete secondary	16.1			
Technical or college	2.0			
Artisanal miners (%)	96.5			
Mechanized miners (%)	3.5			
SSGM primary income (%)	86.4			
Use of pumps in real mining (%)	87.0			
Use of other machines (%)	13.0			

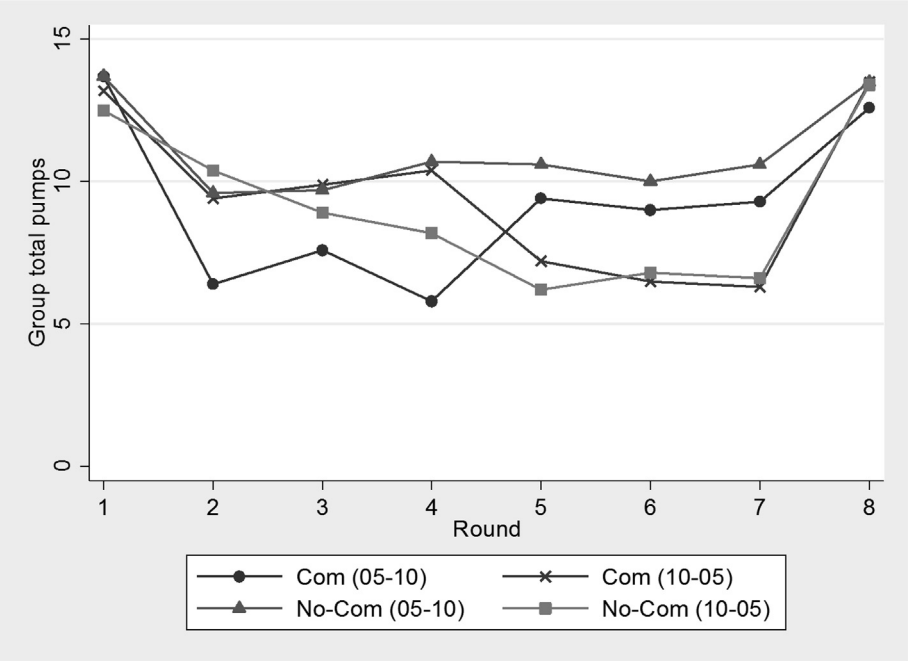


Fig. 1. Mean group totals per treatment. Notes: "Group total pumps" (Y axis) = the average of these groups' aggregate pumps, by round; And regarding treatments: "Com (05–10)" = a communication treatment with a limit of 5 pumps for the first three treatment rounds (Rounds 2–4), followed by a limit of 10 pumps (for Rounds 5–7); while "Com (10–05)" then also has communications and simply reversed the order of those targets; and "No-Com (05–10)" has the initial ordering of the targets but does not allow communications; and finally "No-Com (10–05)" has the reversed ordering of targets, again without communications.

ignored. Out of the 20 groups randomly assigned to allow for communication, in 15 groups leaders emerged to try to clarify and suggest.[16] Further, for some of those 15 groups, two leaders emerged (we see 23 leaders in the 15 groups). For all others, communications failed.[17]

Some leaders always promoted either a symmetric (efficient) strategy or an asymmetric strategy. Yet others tried some of each, varying across rounds. Table 6 conveys the evolutions of strategies through time for some groups. Groups with two leaders more frequently moved toward symmetry and we see that most conversations driven by two leaders reached consensus in favor of symmetry.

The quotes below are examples of the conversations that we used to code if the strategy suggested by leaders was symmetric (equitable) or asymmetric (inequitable) or if communication had failed. We coded as equitable all cases in which the suggestions made by the discussion leaders were to reach compliance using a symmetric strategy (i.e., 1 or 2 pumps for each, depending on the target):

[16] Is this high relative to expectations? Komai et al. (2007) suggest that having a leader helps but they focus upon information asymmetries. We do not consider this question but just report back on leaders' impacts.

[17] In some groups, people tried to lead but their statements did not help the group to coordinate. One attempted leader was the only man in the group but the women were quiet, so communication failed, and his suggestions were ignored. In another case, the group just split up. In another case, one participant simply insisted on always choosing 3 pumps.

Table 4
Average group totals and success rate by treatment & stage.

	Baseline	First stage (rounds 2–4)		Second stage (rounds 5–7)	
	Mean pumps	Mean pumps	Success rate	Mean pumps	Success rate
No Communication	12.5	9.17	80%	6.5	36.7%
THR-10-05	(1.82)	(1.81)	(0.4)	(2.13)	(0.48)
No Communication	13.7	10	10%	10.4	43.3%
THR-05-10	(1.11)	(3.16)	(0.3)	(2.38)	(0.5)
Communication	13.2	9.9	90%	6.7	56.7%
THR-10-05	(1.55)	(1.3)	(0.3)	(2.93)	(0.5)
Communication	13.7	6.6	60%	9.2	93.3%
THR-05-10	(0.91)	(2.72)	(0.49)	(1.53)	(0.25)

Notes: "THR-10-05" refers to the treatment with a threshold (or target or limit) of 10 pumps for the first three treatment rounds (Rounds 2–4), followed by a limit of 5 pumps (for Rounds 5–7); then the "THR-05-10" treatment simply reverses the order of those targets, with 5 before 10.
"Mean pumps" = average of group's aggregate pumps, with standard deviations in parentheses. "Success rate" = % of rounds in which the group complies with the target, earning collective reward.

Table 5
Strategy chosen per treatment & round.

	No-Com (10-05)		No-Com (05-10)		Com (10-05)		Com (05-10)	
	1st stage	2nd stage	1st stage	2nd stage	1st stage	2nd stage	1st stage	2nd stage
0 pumps	13%	20%	6%	5%	6%	12%	13%	9%
1 pumps	22%	47%	29%	21%	17%	63%	59%	10%
2 pumps	35%	14%	24%	33%	49%	5%	11%	67%
3 pumps	31%	19%	41%	40%	27%	20%	17%	13%

Notes: In dotted lines, the percentage of participants that chose a symmetric action if threshold = 10. In solid lines (boxes), the percentage of participants that chose a symmetric action if threshold = 10.

"If there are 5 pumps, we have to mark 1 each. If 10 pumps are allowed, we mark 2 each. Then we get the $20.000" (this is the additional reward of ~US$7 - Group COM0510-10, round5).
"We get the additional gain with the 5 pumps, but if we use more we do not have the additional profit that the government gives. As we are 5 (people), we can choose each one, one. Ready? Is it an agreement? It is simply an activity where the less pumps we take, the government will pay us for that because less environmental damage we cause. Ready?"(Group COM1005-9, round2)
"We are five people, so if each marks one then, how many pumps will we have? We will get five" (Group COM0510-3, round3)

We coded as unequitable all the cases in which the suggestions made by discussion leaders were to choose a different number of pumps (though in most cases still allowing for group compliance):

"This time we cannot go over 10. Come on guys, let's do our best (...) you choose 0, I choose 3, you 2, you 2 again, and you 2. Ready? I am 3, I count, he is 0 (sic)" (Group COM1005-4, round5).
"It consists in the same, but now, let's do the sum by choosing 1, 0, 2, 1 and 1. You mark 0 here, you mark 1, you mark 1, you mark 1, and I mark 2. Okay?" (Group COM1005-9, round4)
"Three people mark 1, one person 2 and one person 0 ... we cannot go over 5" (COM0510-1, round2)

Finally, we coded as "failed communication" (no leader or failed consensus) the cases in which there was no clear leader or when efforts to lead were not specific or, more generally, effective:

"We all have to put lower numbers" (Group COM0510-2, round 3).

"I hope you have taken your decisions thinking about the whole group" (Group COM1005-4, round 2)

"I made that decision and I'm going to stick with it" (Group COM1005-5, round 4)

Our field facilitators recorded participant identification numbers for all statements (confirmable in our recordings). Table 7 shows differences in sociodemographic characteristics and games profits for leaders versus non-leaders. Leaders are younger, more educated, and with larger incomes than non-leaders. We did not find differences in their genders or participation in community activities.

5.2.2. Leaders & efficiency

Table 8 and 9 are regressions for group outcomes that leaders might affect: total pumps (Table 8), which affects compliance; and the group's standard deviation of its individuals' pumps (Table 9), a proxy for equity. Table 8's initial columns summarize some prior results, in considering all our treatments. Its final four columns consider only communication, to examine the impacts of leaders.

Table 6
Dynamics in strategies proposed by leaders (number of groups).

Round	Equal Strategy			Unequal strategies		
	If one leader	If two leaders	Total	If one leader	If two leaders	Total
2	5	4	9	1	4	5
3	5	4	9	1	4	5
4	2	4	6	4	4	8
5	3	5	8	4	3	7
6	3	5	8	4	3	7
7	3	5	8	4	3	7

Notes: "Equal Strategy" = leader(s) suggest that everybody make the same decision on pump's use; while in contrast "Unequal Strategies" = leader(s) suggested different actions for each participant.
Also, "If one leader" indicates that a single leader emerged in the group to suggests actions to group members; while "if two leaders" indicates that, instead, two leaders emerged from within the group.

Table 7
Differences among leaders and no leaders (only communication groups).

	Leader (N = 23)	No leader (N = 77)
Age (years)	30.34*	35.53
Gender (% women)	69.56	62.34
Participation in voluntary activities (%)	91.30	92.21
Income in a good week (US$)	102.01**	52.92
Income in a bad week (US$)	11.19	5.85
Current high participation in governing body of the council (%)	26.09	15.58
Education (%)		
None	4.34	12.98
Incomplete primary	26.08	38.96
Complete primary	8.69	6.49
Incomplete secondary	26.09	31.17
Complete secondary	21.74	9.09
Technical or college	13.04***	0.0
Profit (US$)		
Round 2	9.52	9.38
Round 3	9.17	9.01
Round 4	10.73	10.03
Round 5	10.30**	8.44
Round 6	11.0***	8.56
Round 7	11.39**	9.67

Notes: *** p < 0.01, ** p < 0.05, * p < 0.1 for comparison of means.

In terms of prior results, Table 8 confirms that: targets have impact; the hard target first does worse; and communication has impact, more for harder targets. Again, those basically confirm robustness of our baselines before comparing leaders across contexts and versus literature on communication. We control for proportions within these groups, both of women and people with very low levels of education: education always matters; yet gender does not when communications were allowed.

In terms of leaders' impacts, column (3) shows that, on the whole, they reduce total pumps. Indeed, we find either type of strategy that was suggested by a leader – equal or unequal, in column (5) – served to reduce the groups' total number of pumps. Interestingly, that pumps coefficient is larger when leaders suggested unequal strategies, although this difference is not statistically significant.

Column (4) considers the number of leaders who arose endogenously within a group's discussions. As noted above, either one or two leaders sometimes emerged, each for about half of these groups. Table 8 shows that if anything, having two leaders seemed to help to control the number of pumps. However, the difference is not statistically significant – although we would, finally, highlight that column (6) indicates that a greater reduction for two leaders holds true for either type of strategy.

5.2.3. Leaders & equity

Table 7 not only has leaders' relative characteristics, it also shows their relatively high earnings. Leaders earned more from the games, in particular during second-treatment stages (Rounds 5–7), consistent with single leaders switching from equal to unequal strategies after Round 4 (Table 6 and, in terms of details, returning us to some of the specifics quoted above in coding for inequity).

Table 9 further explores leaders' equity effects using an OLS regression, clustered by group, with robust standard errors for one equity metric: the within-group standard deviation of pumps chosen. The sole significant result in the first two columns, where we consider all of our treatments, is that communication appears to reduce the standard deviation, which would imply improving equity. However, in order to see any such effect that is statistically significant, we need further details.

The third column considers only communications data and the average effect of emergent leaders. Simply having a leader does not, by itself, statistically significantly raise equity in this analysis. However, when we use the variable number of leaders instead of the binary variable for presence, within column (4), we confirm the suggestion above within Table 6: groups with two leaders – instead of one – may well have more equitable distribution. Yet, here, still this is not significant.

Table 9's column (5), however, shows that the details of what effective leaders suggest do matter. Specifically, when leaders suggest equal strategies (generally efficient symmetric Nash strategy), groups' standard deviations fall – though suggesting unequal strategies has no significant impact.

Combining the effects of more leaders and detailed suggestions, the largest effect is in column (6). When two leaders suggest an equal strategy, that reduces the pumps standard deviation even more. When one leader alone suggests an equal strategy, though, in our limited data that is not significant. Interestingly, however, groups appear to be resilient to unequal suggestions, even with two leaders.

6. Discussion

Despite efforts to formalize small-scale mining, in many places around the world, it is dominated by open access although often influenced by local governance institutions (e.g. Hilson et al., 2017; Johnson, 2019; Peluso, 2018; Hook, 2019). When monitoring on mining frontiers is costly for any government, its influence can be limited. It may turn to strategies complemented by strong local governance, working with local institutions as much as possible and adapting to local institutional arrangements when introducing top-down incentives (Van Bockstale, 2014; Siegel & Veiga, 2009).

Yet local actors differ in power, including abilities to capture rents or control environmental and social impacts. SSGM is far

Table 8
Explaining Groups' Total Pumps.

OLS	All Groups		Only Communications Groups			
	(1)	(2)	(3)	(4)	(5)	(6)
1 if limit = 10	−3.475***	−3.305***	−2.298***	−2.259***	−2.292***	−2.308***
	(0.580)	(0.489)	(0.542)	(0.542)	(0.549)	(0.555)
1 if limit = 5	−6.677***	−6.419***	−5.388***	−5.447***	−5.395***	−5.491***
	(0.515)	(0.495)	(0.913)	(0.892)	(0.970)	(0.978)
1 if limit = 10 first	−0.269	−0.181	0.143	0.0456	−0.0351	−0.0648
	(0.481)	(0.455)	(0.541)	(0.530)	(0.606)	(0.632)
1 if limit = 5 first	3.614**	2.995**	0.314	0.509	0.436	0.565
	(1.355)	(1.310)	(0.827)	(0.808)	(0.855)	(0.909)
1 if communication	0.0190	−0.409				
	(0.655)	(0.528)				
Communication = 1 * Limit = 5_first	−3.319***	−2.434*				
	(1.163)	(1.207)				
Round 8	−0.0250	−0.0250	−0.400	−0.400	−0.400	−0.400
	(0.311)	(0.312)	(0.530)	(0.532)	(0.532)	(0.536)
Share: women in the group		1.832**	0.654	0.839	0.812	0.951
		(0.775)	(0.582)	(0.618)	(0.675)	(0.695)
Share: education < primary		2.029**	1.950**	2.224**	1.944*	2.241**
		(0.889)	(0.926)	(0.940)	(0.982)	(0.981)
1 if any leader in group			−2.367***			
			(0.587)			
1 if one leader in group				−2.057***		
				(0.510)		
1 if two leaders in group				−2.575***		
				(0.621)		
1 if leader suggests equal strategy					−2.089***	
					(0.718)	
1 if leader suggests unequal strategy					−2.346***	
					(0.635)	
1 if one leader * equal strategy						−1.772**
						(0.801)
1 if two leaders * equal strategy						−2.215***
						(0.690)
1 if one leader * unequal strategy						−1.924***
						(0.586)
1 if two leaders * unequal strategy						−2.641***
						(0.755)
Constant	13.40***	11.82***	12.66***	12.70***	13.15***	13.29***
	(0.640)	(0.735)	(0.933)	(0.865)	(0.981)	(1.032)
Observations	320	320	160	160	160	160
R-squared	0.556	0.599	0.709	0.712	0.702	0.706

Notes: Robust standard errors (clustered by groups) in parentheses.*** p < 0.01, ** p < 0.05, * p < 0.1.

from homogeneous. There can be mutually beneficial forms of sharing but arrangements can be unequal (Verbrugge & Besmanos, 2016), e.g., some small-scale mining are under the control of rent-seeking chiefs and landlords who charge exorbitant fees (Hilson et al., 2017). Broadly, some groups reap more benefit from resource uses or related programs (Somerville et al., 2010; Adhikari, 2005). Thus, distributional issues must be considered in policy approaches which combine state and local strengths by using external policy to induce local collective action.

For our lab-in-field experimental results on distributional and efficiency impacts of leaders when communities respond to external incentives, first we confirmed consistency with prior literatures. Collective incentives face free-riding challenges to collective action. As in Rodríguez et al. (2019), we find that collective incentives nonetheless can improve efficiency: "graduated stringency" of a policy can be useful in inducing compliance, as starting easier facilitates learning and coordination. When we allowed for communication, we then confirmed results in the literature that it facilitates efficiency, while showing a greater impact when a group is facing a harder coordination problem.

Moving to our focus, our leaders affected not only efficiency in responses to policy but also equity. Communication improved equity, on average. However, communications leaders play key roles in the distribution of the costs of that compliance: communication does not raise equity uniformly; and leaders are at least part of the reason why. While some leaders suggested symmetric (equitable) solutions all of the time, others suggested asymmetric (inequitable) solutions all the time, and still others varied. Groups with a single leader are more prone to suggest unequal strategies over time, while groups with two leaders tend to move to symmetry. While any leader suggestion facilitated efficient coordination (reducing environmental damages), if leaders suggested efficient symmetric Nash strategies we showed that this lowered the standard deviations of payoffs within the group, i.e., raised equity. Thus, as in Kosfeld and Rustagi (2015) although we did not use any punishments, we find that leaders matter a lot, within collective action – with idiosyncratic yet powerful roles.

Other authors have explored the role of communication by unpacking some underlying elements. Lopez and Villamayor-Tomas (2017), in a common-pool resources game, classify state-

Table 9
Explaining within-group standard deviation of pumps.

OLS	All Groups		Only Communications Groups			
	(1)	(2)	(3)	(4)	(5)	(6)
1 if limit = 10	0.317***	0.326***	0.233	0.254	0.174	0.232
	(0.109)	(0.105)	(0.246)	(0.235)	(0.222)	(0.220)
1 if limit = 10	0.370***	0.377***	0.363*	0.331	0.490**	0.441**
	(0.124)	(0.125)	(0.198)	(0.203)	(0.176)	(0.178)
1 if limit = 10 first	0.183	0.181	0.286	0.233	0.311**	0.213
	(0.116)	(0.118)	(0.189)	(0.168)	(0.134)	(0.128)
1 if limit = 5 first	−0.265	−0.265	−0.351	−0.245	−0.398	−0.239
	(0.230)	(0.246)	(0.312)	(0.260)	(0.275)	(0.256)
1 if communication	−0.217	−0.232				
	(0.145)	(0.142)				
Communication = 1 * Limit5_first	0.106	0.114				
	(0.179)	(0.165)				
Round 8	0.0268	0.0268	0.0915	0.0915	0.0915	0.0915
	(0.0826)	(0.0829)	(0.141)	(0.141)	(0.141)	(0.142)
Share: women in the group		−0.0276	−0.486	−0.385	−0.364	−0.249
		(0.192)	(0.297)	(0.319)	(0.258)	(0.244)
Share: education < primary		0.126	0.104	0.253	0.0679	0.214
		(0.187)	(0.331)	(0.319)	(0.313)	(0.309)
1 if any leader			−0.265			
			(0.237)			
1 if one leader in group				−0.0967		
				(0.242)		
1 if two leaders in group				−0.379		
				(0.256)		
1 if leader suggests equal strategy					−0.582**	
					(0.217)	
1 if leader suggests unequal strategy					0.0366	
					(0.220)	
1 if one leader * equal strategy						−0.355
						(0.235)
1 if two leaders * equal strategy						−0.738***
						(0.206)
1 if one leader * unequal strategy						0.0408
						(0.231)
1 if two leaders * unequal strategy						0.0349
						(0.233)
Constant	0.511***	0.464***	0.980	1.003	0.750	0.588
	(0.138)	(0.155)	(0.576)	(0.589)	(0.462)	(0.454)
Observations	320	320	160	160	160	160
R-squared	0.124	0.128	0.125	0.165	0.321	0.359

Notes: Robust standard errors (clustered by groups) in parentheses. *** p < 0.01, ** p < 0.05, * p < 0.1.

ments as one of 'informational', 'disapproval', or 'group solidarity' – as well as whether they refer to the "field context". If so, then 'informational' statements have a negative effect on cooperation, they find, while 'disapproval' and 'group solidarity' have positive effects. As a distinct example, conveying the breadth of interest in leadership and communications (Hermalin, 1998 is not environmental), Crockett, Smith, and Wilson (2009) explore communication steps that lead towards specialization in production, as well as resulting exchange and competitive equilibrium: first, discovering that trade is feasible; second, finding a partner with whom trading is beneficial to both; and, finally, building a relationship with increasing specialization over time. While our focus on endogenous leaders is on equity, such that we coded statements by whether what the leaders had suggested was equitable, surely extensions that code content along other dimensions could reveal additional useful patterns. One might also further explore why group members followed some leaders but not others. It may link with followers' perceptions of leaders' in terms of motivations, understanding, or information.

For our context, a remote mining frontier in Colombia, discussing results with the community has revealed that they see some inequity in payoffs as acceptable, or at least normal, given leaders' efforts. Leaders can incur costs others do not and those may be seen to be worthy of compensation. Yurumanguí has a long tradition of collective action, where leaders play central roles, even putting their lives at risk to prevent incursions based on illicit economies, including mining invasions by outsiders (Velez & Lobo, 2019; Lobo et al., 2020). This community trusts their actual leaders a lot. Members perceive them to be closer than formal agencies that are seen as distant and incapable of responding. It may be worth noting, though, that the Community Council is governed by a group, not a single leader, perhaps linking to our result regarding more equitable outcomes for the groups in which the 'influence power' was shared between two instead of just a single emergent leader.

Although we do not assert broad external validity for our specific results, we did replicate within Yurumanguí the results without communication from mining communities with less social capital

(Rodríguez et al., 2019). Regarding communication, that it sometimes increases inequity in a setting with high social capital may be a lower bound on increases in inequity that we might see elsewhere. We also saw variations in how attempted leadership aligned with the interests of the group (Lobo & Vélez, 2020), affecting the acceptance of suggestions about how to distribute compliance costs. These dimensions of collective action seem worthy of broader consideration and further research.

In sum, collective rewards have potential to improve environmental performance of small-scale miners by creating incentives for local agreements and cooperation among miners. Nevertheless, their outcomes depend on groups' abilities to build internal agreements and monitoring strategies. In all this, equity matters *per se* and as part of sustained efficient coordination to raise total welfare. Yet equity impacts depend upon specific features of participants and communities. Distributional outcomes from efficient collective incentives are not obvious, even if a community has strong past history and the ability to coordinate efficiently. Local leaders' suggestions affect those outcomes.

As one practical implication, our results suggest that balancing power within collective decisions can matter. Promoting the participation of – and thus likely the outcomes for – women, the poor, and other disadvantaged groups can affect equity and future research could explore interventions along these lines, including examination of when inequities can be shifted or instead are persistent. Additional lines of further inquiries could consider how variations in some group characteristics, such as group education, gender and income shares, may be part of persistent (un-) equal outcomes. Most generally, it could only add to try similar explorations within different types of communities.

CRediT authorship contribution statement

Luz A. Rodriguez: Conceptualization, Methodology, Investigation, Data curation, Formal analysis, Writing - original draft, Funding acquisition. **María Alejandra Velez:** Conceptualization, Methodology, Investigation, Writing - review & editing. **Alexander Pfaff:** Conceptualization, Methodology, Writing - review & editing, Funding acquisition.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A

Table A1
Baseline mean individual number of pumps (choices were 0, 1, 2, 3).

	No-Com (10-05)	No-Com (05-10)	Com (10-05)	Com (05-10)
Baseline decision (round = 1)	2.5 (0.73)	2.74 (0.49)	2.64 (0.69)	2.74 (0.49)
After policy decision (round = 8)	2.68 (0.59)	2.7 (0.55)	2.7 (0.55)	2.52 (0.81)

Notes: "Group total pumps" (Y axis) = the average of these groups' aggregate pumps, by round.

And regarding treatments: "Com (05-10)" = a communication treatment with a limit of 5 pumps for the first three treatment rounds (Rounds 2–4), followed by a limit of 10 pumps (for Rounds 5–7); while "Com (10-05)" then also has communications and simply reversed the order of those targets; and "No-Com (05-10)" has the initial ordering of the targets but does not allow communications; and finally "No-Com (10-05)" has the reversed ordering of targets, again without communications.

Table A2
Baseline individual number of pumps – OLS regression.

	(1)	(2)
No-Com (05-10)	0.240*	0.162
	(0.123)	(0.134)
Com (10-05)	−0.120	−0.271
	(0.224)	(0.225)
Com (05-10)	0.0378	−0.0364
	(0.165)	(0.164)
Age		0.00198
		(0.00296)
Gender (1 if women)		0.246**
		(0.0962)
Less than primary education		0.0958
		(0.103)
1 if mining primary activity		0.0197
		(0.110)
1 if voluntary work		−0.0538
		(0.128)
Constant	2.356***	2.194***
	(0.171)	(0.256)
Observations	200	199
R-squared	0.036	0.091

Notes: Robust standard errors in parentheses – Controls per session.
*** p < 0.01, ** p < 0.05, * p < 0.1.

See

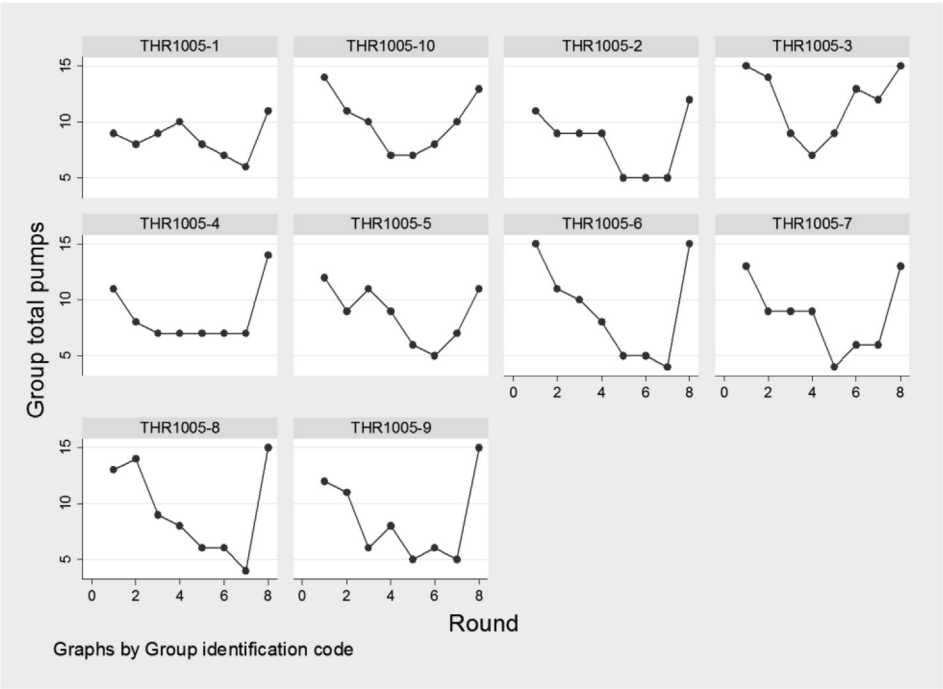

Fig. A1. No Communication (with aggregate targets of 10 and then 05).

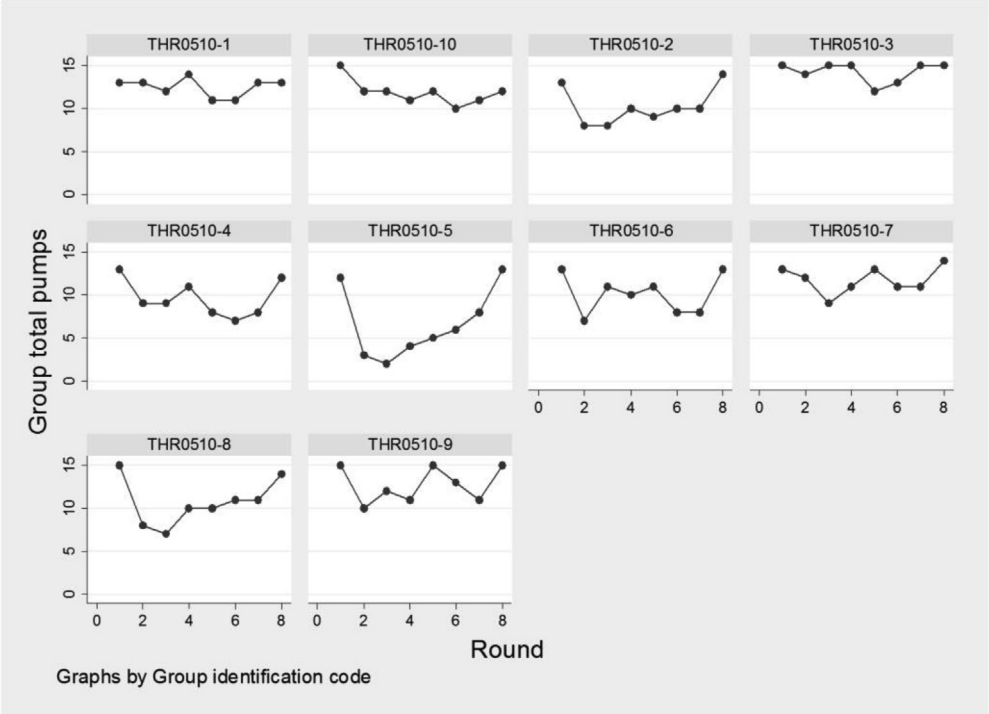

Fig. A2. No Communication (with aggregate targets of 05 and then 15).

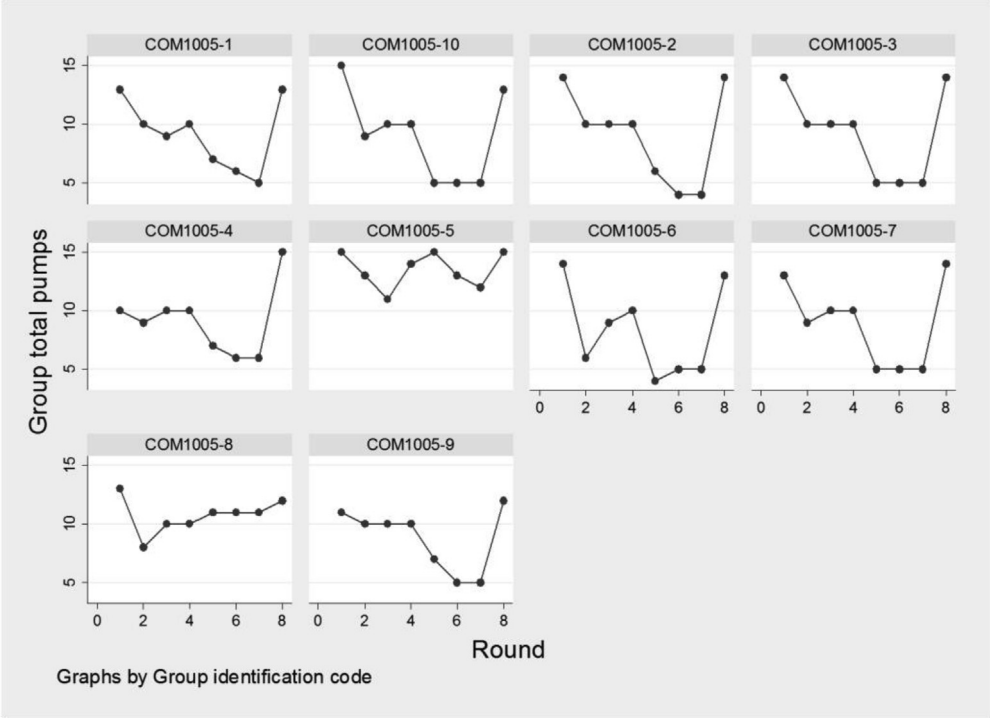

Fig. A3. Communication (with aggregate targets of 10 and then 05).

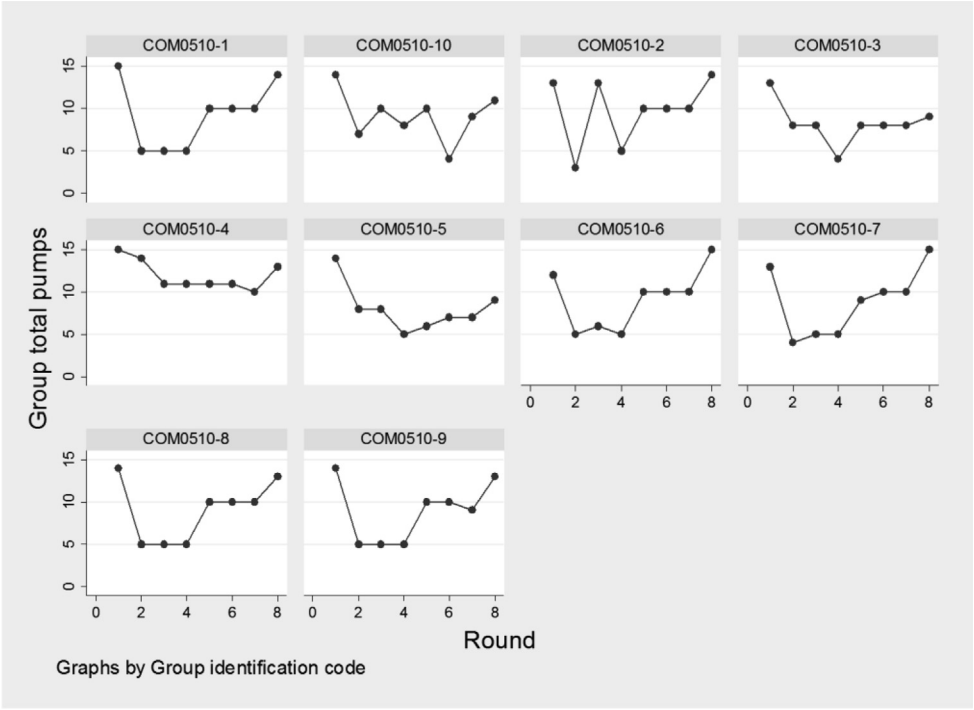

Fig. A4. Communication (with aggregate targets of 05 and then 10).

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