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Leadership in agricultural machinery circles: experimental evidence from Tajikistan*

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Leadership is critical for the viability of rural groups. The way in which leadership is legitimised can mediate leader and group member behaviour in the face of social dilemmas. Yet there has been scant research on leader-follower dynamics in naturally occurring groups. Highlighting the case of agricultural machinery circles in Tajikistan, the effect of leading by example on investments to a collective good is studied in a framed field experiment. To increase realism, and contrary to standard economic experiments, this investment is a voucher allowing the group to make a real-world machinery purchase at reduced costs. Two treatments manipulate leaders' legitimisation. Elected leaders achieve 30 per cent higher contributions to the collective investment against a baseline version without a leader. Contributions remain, on average, relatively stable over the course of the game. The results are discussed with reference to the debate on external intervention in agricultural producer organisations.

Key words: field experiment, public goods game, leading by example, voting, producer organisations, rural development.

1. Introduction

The shift from collectivised agriculture towards individual farming has paved the way for steep increases in agricultural productivity and food production in most post-socialist countries (Rozelle and Swinnen 2004). As agriculture became more individualised, farm sizes decreased considerably (Lerman *et al.* 2004). This structural change has caused a shift in demand for rural services. Because family farms operate at smaller scale, farms face a 'make or buy' decision (Williamson 2002) for agricultural inputs like machinery services. Because rural markets often fail to supply essential services in post-socialist economies, agricultural service cooperatives have become an alternative to the market mechanism (Deininger 1995). These organisations allow farmers to vertically integrate to produce and procure inputs on their own. Despite these potential benefits, cooperative, farmer-based organisations are still uncommon in many post-Soviet economies (Lerman 2013). Decades of forced

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collectivisation have caused a legacy of low social capital and a reluctance to cooperate (Chloupkova *et al.* 2003; Fukuyama 2010, p. 18).

Leading entrepreneurs play a central role in transition processes (McMillan and Woodruff 2002). With respect to rural areas, leadership has been identified as a critical element for farmers' groups. There is widespread evidence that leadership strengthens group-formation processes and organisational viability (Thorp *et al.* 2005). This is particularly the case for cooperative organisations that encounter free-riding problems (Cook 1995). Where defection is a rational strategy, and where a threshold of initial investments is required, the experimental economics literature has shown that leadership can increase contributions to collective goods (Güth *et al.* 2007; Rivas and Sutter 2011; Jack and Recalde 2015). In contrast, leadership can also be a source of inefficiency and limit organisational change in cooperatives (Fulton 2001). Strong authoritarian leadership might be opposed to horizontal cooperation. Thus, governance in rural groups must be 'subject to achieving the fine balance between leadership and domination/exploitation' (Thorp *et al.* 2005, p. 912). Grossman and Baldassarri (2012) argue that the evolution and legitimacy of leadership can help achieve this balance and increase group cohesion, but there is still scant empirical evidence on how leadership legitimisation impacts decision-making within rural groups.

This paper presents experimental evidence on the investment decisions of farmers belonging to 19 machinery circles in rural Tajikistan, a former Soviet republic. These circles recently formed and made an initial machinery investment, which has been subsidised by a donor organisation. In a framed field experiment, which resembles a public goods game, five members of each circle can contribute to a *new* collective investment, a voucher that reduces the circle's costs for a future machinery acquisition. The fact that this investment has real value increases external validity. Because the way in which leadership emerges is critical for its legitimacy, first two mechanisms (varying in their degree of legitimisation) to install a leader are tested against a baseline version. Second, and to mimic the effect of the involvement of external donor agencies, a subsidy is temporarily introduced that changes the game structure and payoffs.

This paper contributes to the growing experimental literature in agricultural economics by providing evidence on the role of leading by example in naturally occurring groups. Because the circles might not have been formed without outside support and subsidies, results from the experiment and group information are linked to ongoing debates on the interference of donors and governments in producer organisations (Chirwa *et al.* 2005; Shiferaw *et al.* 2011; Francesconi and Wouterse 2015) and on whether subsidies support machinery investments (Huang *et al.* 2013).

The remainder of the paper is structured as follows: after background on machinery circles (Section 2), Section 3 reviews the critical role of leadership for cooperative groups. Section 4 details the experimental design and the study sample. Section 5 presents results from the experiment. A final section discusses the results and concludes the paper.

2. Agricultural machinery circles in Tajikistan

Disadvantaged by a long, terrible civil war after the breakup of the Soviet Union and retained early attempts at reform, Tajikistan witnessed a significant shift towards individual farming only over the last decade (Hofman and Visser 2014). Today, individual and family farms coexist with collective farms in a dual structure (Hierman and Nekbakhtshoev 2018; Müller and Rommel 2018). Collective farms are large enough to use agricultural machinery efficiently, but small, family farms have a cost disadvantage. Because family farms underutilise machinery, it can only be used efficiently if it is shared among several farms. The resulting coordination problem could be solved by a market for service providers in which farms could buy services instead of making them (Williamson 2002), but input markets are only poorly developed in rural Central Asia (Akramov and Shreedhar 2012). Reinforced by an abundance of labour, the availability and use of agricultural machinery in rural Tajikistan diminished drastically after independence (Lerman and Sedik 2008).

Cooperatives have been advocated as a solution when the market fails to supply services and goods, acting as a hybrid between markets and hierarchies (Ménard 2004). By means of integration and joint investments, cooperatives allow farmers to exploit economies of scale. In machinery circles, farmers invest collectively in agricultural machinery, organise and allocate machinery services among the involved farms and, in some instances, offer services to nonmembers. Machinery circles benefit participating farmers through lower costs, greater efficiency, access to new technology, and a greater pool of knowledge and resources (Harris and Fulton 2000). But peak demand during sowing and harvesting periods can create conflicts. In addition, the carelessness of some members has to be covered by the entire group in the form of higher maintenance and repair costs, creating a social dilemma.

Despite the potential benefits, service cooperatives are still an exception in post-socialist rural areas (Lerman 2013), where horizontal cooperation among farms and collective investments are less frequently observed than in most Western countries (Bijman *et al.* 2012). This scarceness has been attributed to low levels of social capital in countries where the state interfered in all areas of production and cooperation (Chloupkova *et al.* 2003; Fukuyama 2010). Particularly in agriculture, where farmers were forced for decades to work collectively under state rule, the terms 'cooperation' and 'cooperative' have negative connotations for farmers (Gardner and Lerman 2006).

Development agencies and non-governmental organisations (NGOs) have undertaken several efforts to support the formation of producer organisations in post-socialist countries. One approach, implemented by the German Corporation for International Cooperation (GIZ), was the formation of machinery circles ('TAMS') in Tajikistan. In 2012 and 2013, approximately 50 circles were started, mostly in the lowland regions. The groups, which consist of mostly five but sometimes more farmers, were each formed around a single group leader; these leaders were expected to kick-start collective investments. This approach followed the effort to build upon existing forms of leadership for collective action (Ostrom 2009), incorporating the important role of local Tajikistani leaders (*rais*) for addressing collective action problems such as irrigation systems (Hill 2013). Compared to Western-style machinery cooperatives, the organisational structure of these circles is rather informal, but individually established statutes for each entity should regulate contributions, usage and transactions. Machinery investments were financially supported by GIZ in the form of up to 30 per cent interest subsidies on the initial two investments (investments by individual farmers were not eligible). The subsidies required a minimum of 20 per cent equity capital from each circle; the difference was financed by local bank loans. After three years, all of the loans had been repaid on time.

It remains unclear whether a form of collective ownership emerged in these organisations. The role of leadership is pivotal in confronting this question. Did the support scheme serve only as a vehicle for the individual interests of some (e.g. the leaders), or does leadership encourage more collective investments and growth in the future? It is also an open question how leadership is legitimised in these groups and how legitimisation affects the decisions of nonleaders.

3. Leadership

Cooperative organisations often suffer from agency and control problems. They also face social dilemmas (Cook 1995; Baldassarri 2015). Leadership can have positive effects on the success and performance of farmer groups to overcome these problems (Kaganzi *et al.* 2009; Baldassarri 2015). On the other hand, leadership might be the source of organisational failure. Leaders can obstruct organisational change if there is insufficient monitoring and asymmetric information (Fulton 2001).

The evolution of leadership is considered a process exposing differences between individuals to solve group coordination problems (King *et al.* 2009), particularly in contexts where it is rational for individuals to defect (Glowacki and Rueden 2015). To understand the mechanisms and dynamics of leader-follower processes in collective action situations, laboratory economic experiments have extensively investigated decision-making in groups (see Moxnes and van der Heijden 2003, for one of the first studies). The framing of leadership varies largely across studies, including situations in which leaders can command group members' contributions (Van Vugt *et al.* 2004; Gatiso and Vollan 2017), suggest (Sahin *et al.* 2015) or reallocate decisions (van der Heijden *et al*. 2009; Hamman *et al*. 2011), and sanction and exclude group insiders or outsiders (Güth *et al*. 2007; Grossman and Baldassarri 2012). Leadership in many group processes is substantially different from these rather authoritarian types. Often coercion is not an option, and leaders must convince others by good example to conduct the desired actions. This type of leadership is contrary to authority because it presupposes the voluntariness of followership and hence has been coined 'leading by example' (Hermalin 1998). In a theoretical model, Hermalin shows that a leader, by demonstrating a good example, can cause rational agents to behave prosocially in situations where free riding is tempting. The formation of a group mirrors these dynamics because it requires some (the leaders) to convince others (the followers) by good example to engage in the group process and contribute to collective investments.

Despite game-theoretic predictions, leading by example, implemented as sequential play, can increase average contributions in voluntary contribution mechanism public goods games (Rivas and Sutter 2011). Several factors may variate this effect. For example, there is no evidence of an effect arising from differences between fixed or rotating leadership roles (Güth *et al*. 2007). More importantly for this study, it has been shown that the way in which leaders are installed has important behavioural consequences. Exogenously installed leaders have only a small or no effect vis-à-vis no leadership. Endogenously evolving leadership prompts contributions to public goods (Rivas and Sutter 2011), particularly in groups that successfully installed a leader through voting (Güth *et al*. 2007; Chiang and Hsu 2017). It has been argued that the mechanism by which leaders are selected causes a legitimacy effect (Grossman and Baldassarri 2012).

Because context is stripped away in laboratory experiments (Harrison and List 2004), and the subject pool is not representative enough to allow conclusions about decision-making in natural environments (Henrich *et al*. 2010), experiments on leadership have been recently conducted in specific field settings. Some notable examples are Gangadharan *et al*. (2016), who use a suggestion by a leader instead of an actual first move; Jack and Recalde (2015) and Müller *et al*. (2018), who both conduct (threshold) public goods games with leading by example, but also exogenously install leaders; and Baldassarri and Grossman (2011), who conduct a leadership-sanctioning treatment with elections of monitors.

4. Experimental design

To test the effect of leading by example and subsidies on investment decisions in machinery circles, the public goods game was adapted. In a paper-and-pencil experiment, members of 19 machinery circles were repeatedly asked to make an investment decision (with partner matching). In groups of five, farmers had to decide anonymously between allocating money to a private account, which was paid directly after the experiment, or investing in a new machinery purchase (i.e. allocating money to a group account). In each of a total of 15 rounds, individual farmers (players) were endowed with 20 Tajikistani somoni (TJS, approximately 3 USD) and could choose from this endowment any integer allocation between the private account and the group account.

To reduce artificiality and increase external validity (Levitt and List 2007), the experimental task and the commodity were more tangible than a pure monetary payoff, just as a real-world investment would be. Most standard public goods games misrepresent real investment decisions by paying individual and public accounts directly. In reality, invested money is usually 'gone'. It is bound in the investment and used to generate future income streams. To account for this lag in the experimental design, all money that was allocated to the group account over the course of the game was automatically invested into a voucher for each machinery circle. Groups received this voucher directly after the game. It was redeemable at the machinery trader that supplied the machines for the initial investments at the time of group formation. The voucher could only be used to buy new machinery. To redeem the voucher, each circle had to provide written consent, signed by all members who participated in the game. An anonymised sample voucher can be found in the appendix (Figure S4).

In the first ten rounds, every group received a subsidy on group investments to capture the effects of external monetary incentives for group investments (as in the GIZ scheme). The subsidy paid a 50 per cent bonus to investments in the group account but not to private accounts.

The game shares features of a public goods game but also has some important differences. In laboratory or artefactual public goods games (Harrison and List 2004), a multiplication factor usually mirrors the additional value of an investment into a public good. Here, there is no multiplication factor, because the voucher is part of a real investment that generates future income streams (or reduced costs) beyond what farmers could achieve individually. The subsidy factually multiplies contributions, but it is introduced to mirror external monetary incentives for groups and is thus different from the standard multiplication factor.

Unlike the public goods game, in which the social return is usually equally distributed to all members of the group, in this game, the true benefits of new machinery to participating farmers are not known but are assumed to be positive for all members. Similar to other public or club good field experiments (e.g. Carlsson *et al.* 2015), group members can be expected to benefit unequally from new machinery, depending, for instance, on farm size or agricultural practices. The game situation allows every member to make investments according to his or her utility, which is unobserved by the researcher.

It is individually rational to defect in the anonymous game situation because group members can easily free ride on contributions made by others. The potential for free riding mimics contributions in the investigated circles, which often lack clear rules and sanctioning mechanisms. For example, in the investigated circles, contributions to cover investment, maintenance and operating costs often vary and are not driven by relative usage. The game also mimics indirectly social dilemmas in machinery circles, where new members can free ride on previous investments, like in other cooperatives (Cook 1995). The carelessness of some farmers when using the machinery can create repair costs, which must be covered by the group (Harris and Fulton 2000). Yet, following empirical evidence on behaviour in social dilemmas (e.g. Jack and Recalde 2015) and the collective group experience in the field, reciprocity and conditional cooperation are presumably much better predictors of behaviour in the game than assumptions of pure rationality.

Every session targeted one machinery circle and followed a standard protocol. Players were asked to take a seat on chairs, which were separated to limit communication. After a brief welcome, the experimental game was explained verbally based on a standard protocol. The explanation included rules on options to choose in the game, information on how groups would receive and could redeem their voucher, three examples, and short rounds of questions and answers to ensure comprehension. Every player received an identification number and a folder that included sheets of paper for decisions in the game. The experimental decisions were made as follows: at the beginning of every round, players were asked 'how much to contribute from 20 TJS to the TAMS account' (i.e. the voucher); the remainder would be allocated to private accounts. After all decisions were made, folders were collected and the moderator publicly announced the individual contributions, the group investment and the additional 50 per cent subsidy on the group investment in each round by recording this information on a whiteboard that was visible to all. On the whiteboard, each player had an individual player number from 1 to 5. This number did not correspond to the identification number (a sample picture of how results were recorded on the whiteboard can be found in the appendix: Figure S5). The experimental protocol ensured that decisions were made privately and anonymously. The whiteboard allowed players to learn about the history of play of their peers.

To capture time dynamics of the real subsidy in the GIZ scheme, a first variation of the game was introduced for all groups. After the tenth round, players were informed (without prior notice) that the subsidy would be withdrawn for the last five rounds. The resulting version of the game (no leadership for all 15 rounds, withdrawal of the subsidy for rounds 11–15) is the *baseline* version of the game. Consequently, and including the subsidy, a total voucher value of 2,000 TJS ($\approx$ 300 USD) was at stake for each group, which matched approximately the cheapest machinery available at the machinery trader (a mower).

4.1 Leadership treatments and hypotheses

Following the baseline version of the game, two endogenous leading-by-example treatments were introduced for a fixed proportion of groups in a between-subjects (between-groups) design. Before round six, players in both leadership treatments were informed that they had the option to install an anonymous leader from the group for the remaining ten rounds of the game.[1] The implications of leadership were explained to the groups (one player decides first, his or her investment decision is reported publicly on the whiteboard, and the following four players decide). The two leading-by-example treatments differed in the process by which the leader obtained the role of investing before others. In a first treatment, henceforth referred to as *bidding*, all five group members could bid for leadership. Every player in the bidding treatment received an additional 40 TJS to the private account. Everyone could bid any amount out of this additional sum to become leader by writing it on a separate sheet of paper; the player with the highest bid was selected as the leader.

In the second leading-by-example treatment, henceforth referred to as *voting*, group members could elect a single leader by simple majority vote, with one vote per member, after round five. The vote was expressed by writing the preferred player number on a prepared sheet of paper. In case of a draw (which never ocurred), one leader would have been selected randomly. Note that players could base their decisions to become or vote for a leader in both treatments on the observed history of play of the first five rounds.

One can expect an increase in contributions when leading by example is introduced in round six compared to contributions in the baseline treatment (Güth *et al.* 2007; Rivas and Sutter 2011). Following Hermalin (1998), the other group members can form a belief based on the leader's decision. Because there is a potential legitimacy effect in the voting treatment, contributions are assumed to be higher compared to the bidding treatment for two reasons. First, players who invested more in the first five rounds are more likely to become elected. They might then reciprocate the voting result and maintain their higher investments or contribute even more. Second, the legitimacy effect might as well motivate followers to contribute more by mirroring lead decisions. It is also plausible that leaders in the bidding treatment paid money to become a leader because they want to prompt group contributions through higher lead investments. Because of the lower leader legitimacy, followers are assumed to contribute less in the bidding treatment compared to the voting treatment.

Removing the subsidy for the last five rounds is likely to cause a reduction in contributions across treatments because individual incentives to contribute decrease.

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[1] One alternative to further increase realism would have been to reveal the leader's identity by installing real-world leaders (Jack and Recalde 2015). The mechanism applied in this study allowed real-world leaders to become leaders in the game while maintaining players' privacy.

Table 1 Sequence of play by different versions of the game

All groups	Rounds 1-5 50% subsidy	Rounds 6-10 50% subsidy	Rounds 11-15 No subsidy
BASELINE (Four groups of five, n = 20)	No leadership (simultaneous play)	No leadership (simultaneous play)	
BIDDING version (Eight groups of five, n = 40)		BIDDING (sequential play)	
VOTING version (Seven groups of five, n = 35)		VOTING (sequential play)	

Contextual variables can impact investment decisions, too. Group members who do not regularly use the circle's machinery (or who only served to meet the minimum of five members for group formation and financial support) are expected to contribute less.

4.2 Sample and questionnaire

Stratified by region, 20 circles were randomly selected from among the 50 existing machinery circles. The leaders of the selected groups were informed about the planned study and asked to inform the remaining group members about the possibility of participating. One of the selected groups decided not to participate. The remaining 19 groups participated in separate sessions in October 2015 and were randomly assigned to treatments. Based on the distribution of treatments, one sequence (only baseline, voting or bidding) was drawn for each group without replacement. Because of the within-variation of the leading-by-example treatments, only four groups were assigned to the only-baseline version (Table 1).

Though some groups have more than five members, the design only included five players for reasons of comparability (groups were informed up front and decided which members could participate). Of the 95 players, five were women. Participation was voluntary, and players were informed that they could leave at any time (which no one did; there was no show-up fee). Field assistants were trained to respond to questions and assist players who were illiterate. After the game and before payments, players were asked to fill out a questionnaire on their socioeconomic backgrounds, roles and positions in the group, financial contributions, and perceived ownership, which was complemented by a small group questionnaire. To capture time preferences, which could have affected investment decisions in the game, the individual questionnaire contained a nonincentivised time preference task (Andersen *et al.* 2008).[2] Questionnaires were available in Uzbek and Tajik. There was no deception.

[2] Participants were asked ten times whether they preferred a hypothetical payment of 100 TJS now over a varying, higher payment in one year. The higher amount was increased from 105 TJS to 150 TJS in steps of 5 TJS. The frequency of preferring the future payment over the immediate payment was used as a time preference measure.

5. Results

Table 2 presents summary statistics and explains key variables. Across all rounds and treatments, players contributed on average 10.82 TJS out of 20 TJS to the group account (i.e. contribution). This variable is used throughout the analysis as the dependent variable. Aggregate individual contributions over 15 rounds vary strongly from 41 TJS to 300 TJS. Voucher volumes differ considerably across groups as well, ranging from 674 TJS to 1,895 TJS (i.e. group voucher earned), close to the maximum amount of 2,000 TJS. The second part of Table 2 presents data from the questionnaires.

Figure 1 suggests an overall balance in average contributions across different versions of the game for the first five rounds. This balance remains between the bidding and the baseline treatment in round six. After groups installed a leader through election in the voting treatment, contributions increase in the following rounds; these increases are sustained until the final round.

Because the main variable of interest (contribution) is not normally distributed neither for the full sample nor within treatments (cf. Figures S1-S3 in the appendix), only nonparametric tests are used in what follows.

Separate Kruskal–Wallis H tests for the initial five rounds do not reject the null hypothesis of differences in the distribution of contributions between treatments (highest $X^2 = 1.89$, $P = 0.39$, $N = 75$ for round 3), indicating that contributions to the group account in the following rounds are not driven by the possibility of different experiences in the initial rounds.

Numerical comparisons between rounds five and six confirm the patterns in Figure 1. While contributions in the baseline and bidding treatments change only marginally, the installation of an elected leader in the voting treatment has a strong impact. Contributions in the voting treatment increase on average by 2.4 TJS (a 22 per cent increase) from round five to round six, a difference significant at the 1 per cent level (cf. Table S1 in the Appendix S1). This pattern is stable over time: contributions in the voting treatment are significantly higher for the last ten rounds (compared to both other treatments), while the differences between sequential play in the bidding treatment and simultaneous play in the baseline version are negligible (cf. Table S2 in the Appendix S1).

Removing the subsidy in rounds 11–15 reduces overall contributions from 11.14 TJS (SD = 4.97) in rounds six to ten to 10.65 TJS in the last five rounds (SD = 4.95, Friedman test $X^2 = 19.66$, $P = 0.020$). In the voting treatment, contributions in the last five rounds remain high compared to the first five rounds. Consequently, removing the subsidy has only a marginal negative effect on contributions.

5.1 Leaders' and followers' behaviours

Figures and statistical tests presented in Table 3 provide a series of explanations for the differences in contributions between the leadership

Table 2 Summary statistics

Variable Name	Description	N	Mean	SD	Min	Max
Game data						
Contribution	Individual contribution in TJS by round	1,425	10.82	4.81	0	20
Aggregate contributions	Aggregate individual contributions over 15 rounds	95	162.28	59.54	41	300
Group voucher earned	Discount earned by group (= all contributions to the group account, subsidised by 50% in the first ten rounds)	95	1,083.92	301.32	674	1,895
Belief that game leader is real-world leader	(= 1) if respondent thinks that real-world leader is the leader in the game (only followers)	60	0.58		0	1
How will others decide	Belief about average contribution by other group members before the first round	95	10.65	4.35	3	20
Individual questionnaire data						
Age	Age in years	95	48.21	11.40	23	78
Education	Years of total education (primary, secondary, tertiary)	94	12.12	2.44	5	18
Agricultural experience	Years of agricultural experience	95	19.49	11.46	2	45
Soviet farm member	(= 1) if previously employed on a Soviet-style farm	95	0.67		0	1
Real leader	(= 1) if real-world leader of the machinery circle	95	0.19		0	1
Farm size	Farm size in hectare per group member	93	21.88	34.99	0	145
Regular usage	(= 1) if respondent uses machine at least once per month	95	0.66		0	1
'One uses machinery more than others'	(= 1) if respondent states that one member uses the machinery more often than others	90	0.77		0	1
Contributed additional machinery	(= 1) if respondent contributed a machine to the pool	94	0.27		0	1
Time preferences	Individual frequency of preferred future payments (cf. footnote 2)	95	4.24	2.93	0	10
Credit taker	(= 1) if respondent acted as a creditor towards the bank for the initial investment	95	0.47		0	1
Group questionnaire data						
Total machinery in circle	Number of machines in the machinery pool	95	2.53	1.76	1	9
Regular machinery services to outsiders	(= 1) if machinery circle rents out more frequently than yearly to nonmembers	95	0.58		0	1
Next group investment timing	Ten-point scale on timing of next investment (10 = 'very soon')	95	6.58	1.94	2	9
Group members	Number of members	95	6.37	2.57	5	16
Initial group loan	(= 1) if the initial loan was a group loan	95	0.42		0	1
Initial individual loan	(= 1) if the initial loan was only granted to one member	95	0.53		0	1

Source: Author's calculations.

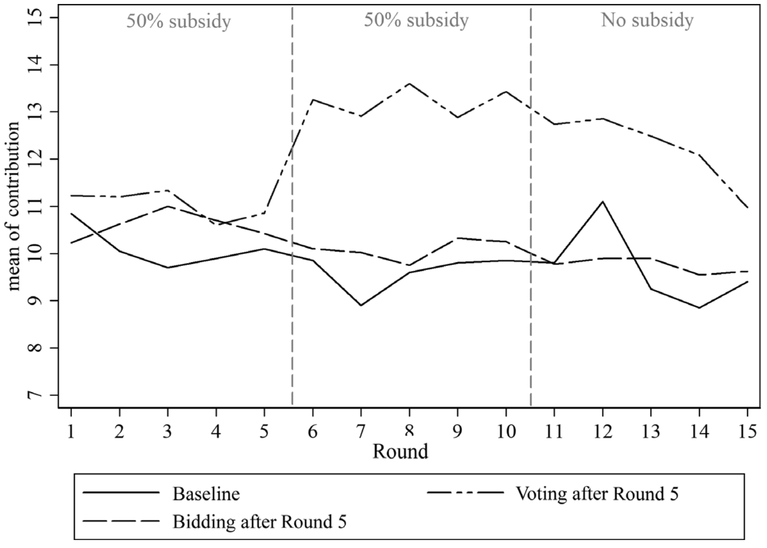

Figure 1 Average contributions over 15 rounds by treatments

treatments. Table 3 displays contributions in the first five rounds and contributions in rounds six to ten. It also distinguishes leaders and nonleaders (i.e. followers). The results illustrate that in the voting treatment, players install 'better' leaders (i.e. players who have contributed significantly more in the initial five rounds). The difference of more than 4 TJS to initial contributions by players who become leaders in the bidding treatment is significantly different from 0 at the 5 per cent level (bottom left of Table 3). Note that there is no such difference between players who do not become leaders in the first five rounds ($P = 0.57$).

Leaders in the bidding treatment increase their contributions by only 0.5 TJS, on average, after leading by example is introduced. In contrast, leaders in the voting treatment (who have already contributed more) increase their

Table 3 Contributions by game stage, leadership type and leadership role

	Players who become leaders after round 5		Test	Nonleaders		Test
	Rounds 1-5	Rounds 6-10	Friedman test	Rounds 1-5	Rounds 6-10	Friedman test
BIDDING	10.75 TJS (4.54, 40)	11.28TJS (4.84, 40)	$\chi^2 = 9.77$ $P = 0.37$	10.56 TJS (4.60, 160)	9.79 TJS (5.03, 160)	$\chi^2 = 11.78$ $P = 0.23$
VOTING	14.87 TJS (3.37, 35)	16.97 TJS (2.96, 35)	$\chi^2 = 25.37$ $P = 0.00$	10.09 TJS (3.35, 140)	12.28 TJS (3.88, 140)	$\chi^2 = 53.78$ $P = 0.00$
Mixed-effects model†	$z = 2.29$ $P = 0.02$	$z = 3.08$ $P = 0.00$		$z = -0.57$ $P = 0.57$	$z = 2.44$ $P = 0.02$	

†Test statistic values refer to the coefficient of VOTING in a linear mixed-effects model with only one independent variable; standard deviation and number of observations in parentheses.

contributions by 2.1 TJS on average (left part of Table 3). This also affects followers' decisions. There is a moderate but statistically nonsignificant decrease in followers' contributions in the bidding treatment. Voting causes followers not to free ride on the higher leader's contributions but to contribute on average 2.2 TJS more each round. In other words, the bidding treatment selects leaders who then fail to lead, while voting selects better leaders and increases both leaders' and followers' contributions. In five out of seven cases, voting selects the real-world leader of the group as the leader in the game, whereas in the bidding treatment, only four out of eight leaders in the game are the real-world leaders of their respective machinery circles.

To obtain more detailed results about the effect of history of play, Table 4 presents dynamic regression models on leaders' and followers' decisions. In the empirical analysis of dynamic effects over multiple rounds, it must be acknowledged that contributions are nested within individuals, who are nested within groups. Therefore, linear multilevel mixed-effects models, which include random intercepts for groups and players, are employed (Rabe-Hesketh and Skrondal 2008). All models use group contributions from the previous round as a lagged explanatory variable (full models can be found in Table S3 of the Appendix S1).

Model 1 in Table 4 uses all leaders' contributions in the bidding and voting treatments in rounds 6–15 as the dependent variable. It confirms that leaders in the voting treatment contribute more than leaders in the bidding treatment (3.02 TJS). Leaders base their contribution decisions on previous play, where higher group contributions in the previous round increase leaders' contributions, a pattern known from other public goods and coordination games. Model 2 uses a subsample of all followers' contributions in the bidding and voting treatments in rounds 6–15. Because leaders' contributions are higher in the voting treatment (cf. Table 3), the model uses as an additional control variable the interaction between voting and leader contributions. The coefficients show that followers generally contribute more in the voting treatment compared to the bidding treatment. Followers in both leadership treatments reciprocate higher leader contributions, even though this effect is limited (a 1 TJS increase in the leader's contribution only adds 0.22 TJS more on average to followers' contributions). This reciprocal behaviour is not different between the voting and bidding treatment (see the small and nonsignificant coefficient of the interaction term in Models 2 and 3, but recall that leaders contribute more in the voting treatment). Overall, this implies that leaders have an important role because they can prompt moderately higher contributions through good example (positive reciprocity) in both treatments. Independent of this positive leadership effect, the voting mechanism itself increases followers' contributions compared to the bidding treatment. Again, there is a positive effect of previous group contributions on current investment decisions by followers (0.05 TJS). Followers also reduce their contributions for the last five rounds in which the subsidy is removed (−0.42 TJS).

Table 4 Mixed-effects models to explain leaders' and followers' behaviours in the leadership treatments

	(1) Leaders' contributions	(2) Followers' contributions	(3) Followers' contributions
VOTING	3.02*** (1.02)	2.47** (1.22)	2.37* (1.41)
No subsidy	−0.81 (0.50)	−0.42* (0.22)	−0.42* (0.22)
Leaders' contribution		0.22** (0.09)	0.22** (0.09)
VOTING x Leaders' contribution		−0.12 (0.10)	−0.13 (0.10)
Group contribution previous round ($n - 1$)	0.16*** (0.02)	0.05** (0.02)	0.05** (0.02)
Game leader is real leader			0.55 (0.90)
Belief that game leader is real-world leader			1.29* (0.67)
Constant	3.53*** (0.85)	5.13*** (1.37)	4.02*** (1.37)
N	150	600	600
Log lik.	−372.10	−1473.31	−1471.56
Wald χ^2	262.87	39.95	54.58

Robust standard errors in parentheses; *$P < 0.10$, **$P < 0.05$, ***$P < 0.01$

Though leaders are anonymous, beliefs about the identity of the leader might drive contributions. Therefore, Model 3 in Table 4 adds a dummy variable that becomes 1 if the leader in the game is the actual leader of the machinery circle, and 0 otherwise, and a dummy variable that becomes 1 if players stated the belief the real-world leader was also the leader in the game, and 0 otherwise. Model 3 shows no effect on followers' contributions if the real-world leader and the game leader are the same person. However, if followers believe the game leader is the real-world leader, they contribute more (1.29 TJS, significant at the 10 per cent level).

5.2 Individual and group heterogeneity

Two regression models adjust for heterogeneity at the individual and group levels (Table 5). Model 1 is an ordinary least squares (OLS) regression with first-round contributions as the dependent variable. Model 2 is a linear multilevel mixed-effects model including all players' contributions over all rounds (full models can be found in Table S4 of the Appendix S1).[3] The previous findings remain unaffected. Age and machinery services to outsiders at the group level additionally affect contributions positively (significant at the 10 per cent level).

The positive effect of approximately 2 TJS higher contributions per round in the voting treatment is robust when individual and group covariates are added (cf. coefficient for VOTING in Model 2 of Table 5). Eight machinery circles have more than five members in reality. Their contributions, on

[3] An OLS regression was also run using the sum of a player's contributions over 15 rounds as the dependent variable ('aggregate contributions' in Table 2).

Table 5 Regression models to explore socioeconomic and group heterogeneity in investments decisions

	(1) Contribution OLS first round	(2) Contribution Mixed-effects panel
VOTING		1.79*** (0.31)
BIDDING		−0.28 (0.42)
No subsidy		−0.49 (0.37)
Age	0.08 (0.05)	0.04 (0.03)
Education	−0.06 (0.19)	0.07 (0.14)
Real leader	3.78*** (1.27)	2.54*** (0.79)
Contributed additional machinery	−2.91** (1.05)	−1.23** (0.57)
Farm size logged	0.09 (0.39)	−0.01 (0.25)
Regular usage	−0.44 (0.96)	−0.36 (0.82)
Time preferences	0.20 (0.17)	0.08 (0.09)
'One uses machinery more than others'	−2.52*** (0.69)	−3.65*** (1.01)
Total machinery in circle	−0.67** (0.27)	−0.67*** (0.23)
Next group investment close	0.19 (0.18)	0.38** (0.18)
Regular machinery services to outsiders	0.07 (0.68)	0.95 (0.84)
Constant	9.45** (3.92)	9.15*** (2.21)
N	85	1,275
χ^2		161.58
Adjusted R^2	0.13	

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

average, are not different from five member groups over 15 rounds (Wilcoxon Mann–Whitney U test, $z = 0.316$, $P = 0.7521$). Some of these covariates also affect contributions. Real-world leaders of the machinery circles (real leader), who might benefit most from the voucher, contribute significantly more over the course of the game (roughly 40 TJS over 15 rounds on average). If someone contributed a separate machine to the circle, he or she contributes significantly less than others. Notably, farm size and the individual frequency of machinery usage have no effect.[4] This could imply that neither variable adequately represents the true benefit individual farmers obtain from machinery services, or more likely, that group members in the game do not substantially base their contributions on individual gains (which could point to the role of outward orientation and positive other-regarding preferences). The coefficient for the results from the time preference task in the questionnaire has the expected sign (a lower individual discount rate positively affects contributions) but is statistically not significantly different from 0. As a proxy for individual trust, the number of members stemming from the own family has been tested as a covariate. There was no significant effect on contributions. If the respondent states that one person in the circle uses the machinery significantly more than others, contributions decrease

[4] As an additional robustness test, household wealth was used as an explanatory variable by the first two components of a principal component analysis of household assets. Treatment effects and coefficients of the other covariates remain unaffected.

significantly across all models (approximately −55 TJS over 15 rounds). There is also the indication of a saturation effect because more machines in the circle negatively affect contributions. The proximity of a new investment as stated by the group also positively affects contributions.

Further analysis also reveals a pattern of conditional cooperation (Fischbacher *et al*. 2001). Before the first round, players were asked to note the expected average contribution by others (i.e. 'How will others decide?'). There is a significant positive association between this expectation and first-round contributions (Spearman's $P = 0.73$, $P = 0.00$), but because the coefficient is significantly smaller than 1, it also shows a 'self-serving bias' (Chaudhuri 2011, p. 52).

6. Discussion

Previous studies have shown that leadership can have heterogeneous effects in farmers' cooperatives (Grossman and Baldassarri 2012). Findings from 19 investigated machinery circles confirm this result by showing that a leadership effect is conditional on the way in which leaders are installed.[5] Elected leaders and followers contribute more on average than players in a self-made-leader treatment. Here, it could be argued that the bidding mechanism creates an additional endowment effect because all followers in the bidding treatment receive 40 TJS more to their private accounts. Yet stake sizes in social dilemma games have not been found to significantly affect contributions in a specific direction.

Disentangling the leadership effect further, it is unimportant whether actual leaders or nonleaders obtain a leadership role, and it is only decisive how they become leaders, which could be used as an argument for rotating leadership through regular elections of managers/leaders in Tajikistani machinery circles, which are an important prerequisite towards more democratically controlled cooperative structures (Dunn 1988).

Average contributions remained relatively stable over the course of the game, which has been observed as well in laboratory experiments on leading by example (Güth *et al*. 2007; Rivas and Sutter 2011). Compared to both other versions, voting could increase average contributions by roughly 30 per cent ($\approx$ 3TJS, 15 per cent of the endowment per round), and bidding had no effect. This is overall a somewhat smaller magnitude compared to other experimental studies in this field, where leading by example sometimes increases contributions by up to 50 per cent or more (Levati *et al*. 2007). The comparatively low-magnitude effect might be driven by the fact that contributions in the baseline version were already high. Repeating this study

[5] A further study with more investigated groups could also vary the sequence of the leadership treatments, where some groups start with and some without leaders. Cross-checking with measures assessing the external validity of such games could help to further increase realism.

in the laboratory could help to find out whether this laboratory–field difference remains. In addition, individual risk preferences and trust could be elicited by separate experimental tasks to explain further variations in contributions.

In the experiment, farmers could earn a considerable amount of money by not contributing (up to 340 TJS, approximately 50 USD to the private account, though it was beyond the control of the experiment to know whether any of the private accounts were later also used for group machinery investments). In the last stage of the game, without the subsidy, incentives to defect were high. Despite these strong incentives, participants contributed on average more than half of their endowment to the group account, and the three highest-contributing groups achieved vouchers equivalent to 1,452 TJS, 1,542 TJS and 1,895 TJS (the last in the bidding treatment). The positive effects of legitimised leadership and a relatively high and constant prevalence of cooperative behaviour in the simultaneous version are signs that circles may be able to overcome the collective action problems inherent to those organisations.

The successful production of rural services is important in Tajikistan, which is land-locked, constrained by a lack of agricultural land, and experiencing rapid population growth. Machinery circles can improve the supply of rural services by offering services to group members and nonmembers, as some of the investigated groups already do. Tajikistan is still witnessing larger collective farm structures as remnants of the Soviet system, and many farmers are reluctant to start individual farming. Better access to inputs, like (more efficient) machinery services, would reduce the costs to leave collective farms. If farmers in Tajikistan could select their preferred type of farming dependent on more market-oriented prices for inputs and outputs (Hierman and Nekbakhtshoev 2018; Müller and Rommel 2018), efficient and optimal farm structures could evolve more easily (Lerman *et al*. 2004).

This paper indicates that rural groups can address collective action problems when leaders are legitimised through elections. Considering the external validity of the leader-election effect, one must consider the possibility of selection bias. Farmers in the existing machinery circles might have self-selected into the subsidy program because they are different from other farmers in Tajikistan. They might be in favour of democracy and free elections (although regular elections of leaders in machinery circles have not been observed in the field during this study). In consequence, further group support schemes would have to focus more on capacity building during processes of group formation. Only a new study could examine the claim of a selection bias directly by repeating this study design, particularly the leader-election treatment in other social dilemma settings (e.g. irrigation) and with farmers who are not organised in farmers' groups or associations.

Results from the experiment are also relevant for a growing body of literature on the role of financial and technical assistance for the development of farmers' groups (Francesconi and Wouterse 2015) and community-driven projects (Fearon *et al.* 2009; Navarra and Vallino 2015) and the question whether machinery subsidies in general induce more investments (Huang *et al.* 2013). The initial financial subsidy through which the machinery circles were formed was intended as a seed fund for further investments under collective property and as a stepping-stone towards the development of formal cooperative organisations. Some of the investigated circles seem dominated by one person, which resulted in lower contributions by others. There is even one group member who was stated not to have any agricultural land. It is likely that the subsidy in these groups was just a windfall gain for one or more farmers without further group investments. In other groups, the initial real subsidy triggered high contributions years later during the time of the study. Some of the presented models suggest that contributions decreased moderately after the subsidy has been dropped in the game, particularly in the voting treatment, but did not go below initial contributions in the first rounds. It remains unclear whether this reduction is due to final-round effects. Only further observations of the groups (or more repetitions in an additional experiment) can shed light on how those groups behave in the long term.

The generally high contributions in the game can be viewed as an indication of group cohesion and possible future investments under collective ownership. The survey data of the machinery circles also show that many groups have a growing machinery pool. Given the fact that structural change only happens at a slow pace and that rural service markets are only poorly established in Tajikistan, some of the groups would not have been formed without the initial subsidy. It is also a positive sign for cooperative principles that leader elections prompt investments in an otherwise authoritarian environment. Despite past failure, one should not give up easily on thinking about new ways to organise support for the formation of service cooperatives in other transition economies that lack efficient markets for rural services. This study highlights the role of contextual factors, such as the legitimacy of local leaders, to successfully support producer groups.

Conflict of interest

The author declares no potential conflicts of interest with respect to research or authorship of this article.

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Data availability statement

The data that support the findings of this study are available in the supplementary material of this article.

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Supporting Information

Additional Supporting Information may be found in the online version of this article:

Figure S1 Kernel density estimates of contribution for BASELINE version.

Figure S2 Kernel density estimates of contribution for the BIDDING version.

Figure S3 Kernel density estimates of contribution for the VOTING version.

Figure S4 Photography of one sample voucher (anonymized).
Figure S5 Whiteboard used during the game.
Table S1 Differences in contributions between rounds five and six.
Table S2 Results by treatments and hypotheses for rounds 6 to 15.
Table S3 Dynamic models (full models of Table 4 in manuscript).
Table S4 Heterogeneity (full models of Table 5 in manuscript).
Data S1 Data and code for replication of findings.