



Water scarcity and support for costly institutions in public goods: Experimental evidence from Cambodia

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ABSTRACT

Voluntary contributions to public goods are vulnerable to free riding. A potential solution is the implementation of a costly institutional arrangement that deters free riding behavior. In this paper, we analyze to what extent resource users are willing to bear those costs and vote in favor of costly institutions. We carried out lab-in-the-field experiments with Cambodian farmers in the Kampong Chhnang province. In the first experiment, the subjects played public goods games, with an option to vote for a costly institution with a minimum contribution level. In the second experiment, subjects voted between a costless weak enforcement mechanism and a costly strict enforcement mechanism. We find broad support for both costly institutions, and even more so if players had been exposed to resource scarcity in the past. This finding suggests that even though effects of climate change tend to exacerbate scarcity, it may also trigger institutional responses that can ameliorate those climate impacts.

1. Introduction

Resource governance depends largely on cooperation among resource users to organize collective activities (Janssen et al., 2015; Ostrom, 1990; Schill et al., 2016). In many situations, cooperation involves provision of local public goods. For example, farmers have to jointly contribute effort to maintain a shared irrigation system, which is a public good (Ostrom and Gardner, 1993). The provision of public goods, however, is difficult to achieve because doing so is costly for individuals, but its benefits can be enjoyed by everyone, even if one does not contribute anything. This situation creates tension between individual and collective interests—the so-called social dilemma, which is a central issue in the management of local and global natural resources (Ostrom et al., 1999). Overcoming social dilemmas can be challenging, especially in the wake of climate change (Bisaro and Hinkel, 2016). Climate change may alter biophysical conditions of the resource and thus affect the incentive structure of resource appropriation, potentially eroding cooperative arrangements (Nhim et al., 2019; Schlüter et al., 2016). The institutional setting plays an important role in mediating individual and group interests to mitigate risks and impacts of climate change (Agrawal, 2008). A key requirement for successful resource

governance—be it formal or informal—is compliance with rules, regulations or norms (Bastakoti and Shivakoti, 2012; Shreedhar et al., 2019; Tavoni et al., 2012). Without effective enforcement of rules and norms, a self-interested individual has no incentive to follow the prescribed rules and norms because doing so is costly to the individual. A voluntary mechanism to sustain cooperation thus may be at risk due to free riding. This raises the obvious questions, under which conditions users choose to implement appropriate institutional arrangements to safeguard cooperation and how it relates to the cost of institutions (Dannenberg and Gallier, 2020).

Using lab-in-the-field experiments, this paper aims to understand to what extent resource users are supporting costly institutions if they are designed to discourage free riding when contributing to public goods. Further, we aim to explain what mediating factors affect the probability of subjects supporting such costly institutions. We carried out two experiments, where users can vote between a costly institution – designed to deter free riding – and a costless alternative that opens the door for free riding. First, we consider a mandatory minimum level of contribution to the public good. Such a setting deters free riding, but may also crowd out more generous contributions by providing a clear focal point of contribution. Second, we announce a non-mandatory minimum level

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of contribution, but users risk to be detected and fined if they underprovide. The choice here is to vote between a setting in which detection is probabilistic and a setting in which all free-riders are detected.

The contribution of our paper to the literature is twofold. First, we analyze which factors affect the support for costly institutions among users and how it correlates with observables from the field. In particular, we are interested whether experienced scarcity in the field affects the probability to vote for institutions.

Second, we consider explicitly institutional costs and its impact on welfare. A challenge is that in a standard setup users make contribution decisions after learning the voting outcome, which may reveal information about the intentions or cooperative attitude of other players. We obtain a clean measure for welfare by using the strategy-elicitation method, which implies that users decide on each context before learning which one will be relevant.

We find that a significant share of the subjects supports costly institutions. Prior experience with resource scarcity increases the likelihood of subjects voting for a costly institution. In particular, we find that the more frequent the subjects were previously exposed to water scarcity, the more likely they are supporting costly institutions. We also find that the average contribution in the setting of costly institutions is higher than in the costless institutions, suggesting that the costly institutions do indeed deter free riding without crowding out more generous contributions. While minimum contributions as well as strict enforcement increase average contributions, only the minimum contribution is welfare-enhancing. The increase in cooperation in the costly strict enforcement mechanism is not enough to compensate the institutional cost.

The remainder of this paper is structured as follows. [Section 2](#) briefly describes the context and water management in Cambodia. [Section 3](#) reviews related literature on endogenous institution in public goods experiment. [Section 4](#) describes experimental design and procedures. [Section 5](#) presents main experimental results, and [section 6](#) concludes.

2. Water governance in Cambodia

The governance of local water resources in Cambodia, in particular irrigation water, relies heavily on informal arrangements. Cooperation among farmers in sharing the water and maintaining the irrigation infrastructure thus plays a vital role in facilitating an efficient and fair use of water. However, weak enforcement of rules and social norms that govern water use are obstacles which result in frequent conflicts over water sharing and poor maintenance of water infrastructure (Chea, 2010; Sam and Pech, 2015). In response to these challenges, Cambodia has been transforming water governance from a centralized system where the state plays a central role in making decisions related to water sharing, water infrastructure maintenance, and rule enforcements, to a more decentralized system where local communities have more power in making these decisions (Mak, 2017). This transformation results in a complex, nested system of water governance with multiple actors involved in decision making such as farmers, farmer organizations, the so-called 'Farmer Water User Communities' (FWUC), local governments, and the state. In many cases, both the state and communities are involved in the management process which creates a situation where informal arrangements such as social norms and formal written rules can be misaligned and result in conflicts and inefficiency.

As part of the decentralization process, more recently the government has made an effort to test whether the community, through a FWUC, can take over the responsibility to manage the irrigation system. This kind of organization is a by-law institution that is formed through a participatory process. Such an institution is indeed a form of formal institution, i.e. a decentralized water governance body, that is voted for by farmers. The arrangement is that the farmer members pay the irrigation service fee and in turn this organization is responsible for keeping the irrigation infrastructure in good quality, ensuring provision of irrigation to their members, and enforcing the written rules. To what extent

it is supported by the community of larger population of Cambodian farmers, however, remains a priori unclear. In Cambodia, out of 2525 irrigation schemes across the nation, only 6.3% have a FWUC that is mandated to self-govern the irrigation system (Mak, 2017). If such an institution is proven to be effective and supported by farmers, there is therefore great potential to increase its number and roles across the country. However, one of the main challenges facing FWUC is that its committees find it difficult to sanction farmers who do not comply with rules in terms of both water allocation and payment of the irrigation service fee (Mak, 2017). Currently, the centralized enforcement of rules conducted by its committee in a FWUC remain weak, leaving free-riders to exploit the farmers who comply with the rule. As such, it remains an open question whether farmers would support a stricter enforcement mechanism, even if it is costly.

Water governance in Cambodia is facing further challenges such as increasing water scarcity due to growing demand of water for agriculture and climate change (Mak, 2017; Sam and Pech, 2015). Climate change is expected to worsen water scarcity (Haddeland et al., 2014; Schewe et al., 2014) and increase water's variability in time and space (Jaeger et al., 2017). In Cambodia, climate change impacts are already evident, with changes in rainfall patterns and increased climatic events such as floods and droughts being observed in many areas (Diepart, 2015), posing extra challenges on food security of Cambodian farmers who depend strongly on water resources for farming.

In the face of such institutional and environmental uncertainties, Cambodia clearly needs an institution that can enhance cooperation and mitigate free riding, especially in the context of climate change (Chem et al., 2010). Understanding whether a decentralized institution such as FWUC and a stricter centralized enforcement would be supported by the community of water users and whether the institution may enhance cooperation and welfare, is therefore a key policy question for the design and implementation of water institutions in Cambodia.

3. Endogenous institutions and public goods experiments

Institutions can be categorized in a variety of ways, but it is useful to distinguish formal and informal institutions (North, 1991). In the context of local resource governance, an informal institution is one in which resource users enforce the rule by themselves, e.g. through peer pressure and informal sanctions, while in a formal institution the rule or regulation is enforced exogenously or centrally by a third party (Yeboah-Assiamah et al., 2017). Our study features two types of institutions: informal and formal. The informal one is voluntary and monetarily costless, while the formal one has restrictions and is costly.

When it comes to institutional choice in public goods experiments, existing literature has mainly focused on how endogenously chosen and exogenously imposed institutions affect cooperation positively or negatively (Dal Bo et al., 2010; Gallier, 2020; Kamei et al., 2015; Kocher et al., 2016; Kroll et al., 2007; Markussen et al., 2014; Martinsson and Persson, 2019; Sutter et al., 2010; Sutter and Weck-Hannemann, 2003; Tyran and Feld, 2006; Volland et al., 2017). Only more recently the literature explores what determines the choice of institutions in public goods experiments (Dannenberg and Gallier, 2020). The institutional choice is usually made by the subjects through repeated voting (Sutter et al., 2010; Sutter and Weck-Hannemann, 2003, 2004) or voting once (Kocher et al., 2016), in which the voting outcome is determined by the majority vote (Kroll et al., 2007). In many cases, the contribution decision is made through the direct-response method (Gallier, 2020), while in some cases the strategy method is used (Volland et al., 2017).

Previous studies feature various institutional settings. For some, the focus is on minimum contribution mechanisms in public goods games, where players can vote between a standard public goods game, which resembles an environment without formal institution, and a public goods game with a minimum contribution level, which resembles an institution that is governed by a tax system (Kocher et al., 2016; Martinsson and Persson, 2019). Sutter and Weck-Hannemann (2003) and

(Sutter and Weck-Hannemann, 2004) allow subjects to vote repeatedly whether to implement a binding minimum contribution level in non-linear public goods games. They find that about 80% of groups voted for the institution, but the average contribution is not significantly different between groups that support the institution and groups that do not (Sutter and Weck-Hannemann, 2003). However, asymmetric minimum contribution levels, i.e., group members face different minimum contributions, tend to undermine contributions by those who are disadvantaged. Also, individuals that vote for such an institution contribute significantly more in the public goods game than those that do not vote for the institution (Sutter and Weck-Hannemann, 2004). Kocher et al. (2016) also study the effects of different levels of minimum contribution on cooperation in a linear one-shot public goods game. In their study players can vote between a standard public goods game and a public goods game with low minimum contribution (10% of the endowment) or high minimum contribution (35% of the endowment), both of which are above the Nash equilibrium, but below the social optimum. The institution that is implemented is determined by a random vote, and the contribution decision is made via a strategy elicitation method. Martinsson and Persson (2019) have a similar experimental design, but with a minimum contribution of 25% of the endowment. They find that 81% of the subjects supported the institution with minimum contribution level and that cooperation is higher in this institution in comparison to the environment without formal institution. In these studies, the implementation of the institution does not pose additional monetary costs to the subjects.

Another strand of literature focuses on endogenous choice of sanctioning institutions in public goods games. In these games, players can vote between a standard public goods game and a public goods game with peer or centralized punishment mechanisms. Feld and Tyran (2002) allow players to vote between a standard public goods game and a public goods game with centralized punishment. Using a strategy method, each player makes a contribution decision for each possible voting outcome, which is determined by the majority rule. Punishment is non-deterrent, i.e., free riding incentives remains, even if punishment is executed when the player contributes less than the full endowment. They find that half of the subjects voted for the game with punishment institution. Also, the contribution rate is significantly higher in the game with punishment than in the standard game without punishment, but the payoff is only slightly higher. A similar experiment was conducted by Tyran and Feld (2006), but adding a new feature in which punishment is deterrent, i.e. there is no free riding incentive. They find that more players prefer the institution with deterrent punishment (75%), as compared to the one with non-deterrent punishment (50%). Overall, the contributions and payoffs are higher in the institution with both conditions of punishments than in the standard game (Tyran and Feld, 2006). In a similar setup, Volland et al. (2017) find that 42% of players voted for the institution with non-deterrent punishment. Whereas the average contribution is higher in the game with punishment than in the standard game, the payoffs in both institutional settings do not differ. In a similar experiment, but with the direct-response method, Gallier (2020) find that 73% of players voted for the public goods game with non-deterrent punishment.

Costs of institutions tend to affect institutional choices and cooperation. For instance, Sutter et al. (2010) let subjects vote between a standard public goods game and a public goods game with costly reward or peer punishment. They find that 62% of groups voted in favor of the standard public goods game over the alternatives when the reward or punishment is expensive. However, when it is relatively cheap to reward or punish, the standard game becomes much less popular. i.e., receiving only 15% of votes. The contribution rate is always lower in the standard game than in the game with reward or punishment regardless of voting (Sutter et al., 2010). Dannenberg et al. (2019) let subjects repeatedly vote between a standard public goods game and a public goods game with the option to exclude another member. They find that up to 96% of groups vote for the exclusion institution when the institutional cost is

absent. When the institutional cost is introduced, however, only 52% vote for the institution. Markussen et al. (2014) also let subjects choose between a standard public goods game and the public goods game with a formal or informal punishment scheme. They find that both informal and formal punishment institutions are preferred to the standard public goods game without punishment. Further, the formal punishment institution is the most popular option, especially when it is cheap and deterrent (Markussen et al., 2014). These findings are in line with Kamei et al. (2015).

So far, existing literature on endogenous choice of institution has mainly focused on how various institutional settings such as different levels of minimum contribution or sanctioning strength affect cooperation. The determinants of institutional choices such as those related to personal experience or contextual factors, however, are largely unexplored. Some studies have explored the role of personal characteristics, such as cooperativeness (Ertan et al., 2009), cognitive ability (Dal Bo et al., 2010) or cooperation types (Volland et al., 2017). After all, most of the studies are based on lab experiments which limits the possibility of exploring the role of personal experiences outside the lab. Such contextual factors are indeed important (Ostrom, 2000, 2009) and can only be tested in the field. Our study analyzes which factors determine the endogenous choice of institutions by including not only variables about individual preferences such as cooperative traits, risk, and trust, but also contextual variables such as wealth and prior experience related to resource conditions.

Previous studies suggest that resource scarcity could have positive or negative effects on cooperation. On the one hand, resource scarcity increases competition and leads to a faster rate of resource depletion (Grossman and Mendoza, 2003). In addition, past experience about resource scarcity can increase the appropriation rate and thus undermine collective action (Blanco et al., 2015; Pfaff et al., 2015). On the other hand, resource scarcity may increase cooperation. For example, concerns for resource scarcity can decrease extraction rate (Osés-Eraso and Viladrich-Grau, 2007), either because the scarcity is caused by human and/or nature (Osés-Eraso et al., 2008). If the resource users are faced with higher resource uncertainty, they may reduce their harvest rate, as they are concerned about the future decline of the resource (Finkbeiner et al., 2018). To what extent users' experience about scarcity could impact the support of costly institution, however, has not been studied yet, and this is the focus of this paper.

4. Experimental design and procedures

In our experiment on endogenous institutions, subjects play one-shot public goods games with an option to vote for a preferred institution. We use one-shot games to avoid confounding our results with learning effects. Each game consists of two stages: an institutional choice stage and a voluntary contribution stage. In the first stage, subjects simultaneously and independently vote for one of two available institutions. In the second stage, each subject interacts in a public goods game with two other random partners. Contributions are made via the strategy method which has been used to elicit contributions to different institutions that are subject to a referendum among the players (Tyran and Feld, 2006; Volland et al., 2017). First, subjects simultaneously and independently vote for one of two available institutions. Second, and before knowing the voting outcome, participants make a contribution choice for each institutional setting. This setup has the advantage that each subject's choices in all possible outcomes of the voting are known, including those that will not actually materialize (Tyran and Feld, 2006). The institution that is implemented is determined by the majority of votes in the group they play the public goods game in. By letting people first choose the institution, we get a clear measure on which setting is preferred by the individual. The use of a strategy elicitation allows us to determine whether people behave differently in their preferred institution compared to an institution that is imposed upon them by their peers. To establish a baseline of contribution levels we run beforehand a linear

public good game and elicit conditional contributions based on [Fischbacher et al. \(2001\)](#). Further, we elicit risk aversion. All instructions are provided in the appendix.

4.1. Experiment 1: a voluntary system versus a costly tax system

In the first experiment, the choice is between a standard public goods game, which resembles an environment without formal institution, and a public goods game with a minimum contribution level, which resembles an institution that is governed by a tax system. In the standard public goods game, each subject is endowed with six bills of 1000KHR,¹ and may contribute any amount between 0 and 6 bills to the public good. The marginal per capita return from the public good is 0.5 ($\alpha = 0.5$). A rational self-interested player would never contribute to the public good since $\alpha < 1$. The Nash contribution is thus zero. However, since $an > 1$, where $n = 3$ is the group size, it is socially optimal to contribute the entire endowment. This creates a social dilemma situation in our public goods game. Denoting g the amount invested in the public good, the payoff of subject i in the regime of the standard public goods game is given by

$$\pi_i = E - g_i + \alpha(g_i + g_{-i}) \quad (1)$$

where E is the endowment, g_i the contribution of subject i to the public good and g_{-i} is the contribution by the other two players.

For the public goods game with a minimum contribution level, hereafter referred to as a tax system, the subjects were endowed with 6 bills of KHR and each player has to invest at least 3 bills to the public good. The implementation of the tax system incurs a cost of 1000 KHR per group member. By setting the minimum contribution to 3 we ensure that the gain through the mandatory contribution is high enough to offset the institutional costs.² Using half the endowment as minimum contribution plays into the observed tendency to contribute around 50% of the endowment ([Ledyard, 1995](#); [Fehr and Urs, 2003](#); [Burton-Chellew et al., 2013](#)). Since $\alpha < 1$ and the minimum contribution is 3 bills, the Nash contribution is 3 bills. Like for the standard public goods game, the socially optimal contribution is thus 6 bills, as $an > 1$. Denoting m the cost of institution ($m = 1$), the payoff of subject i in the regime of the public goods game with a minimum contribution is given by

$$\pi_i = E - g_i + \alpha(g_i + g_{-i}) - m \quad (2)$$

with $g \geq 3$.

The Nash equilibrium and socially optimal contributions and the

Table 1

Nash and social optimum contributions and corresponding payoffs in voluntary and tax systems.

	Contribution	Payoff
Voluntary system		
Nash	0.0	6.0
Social optimum	6.0	9.0
Tax system		
Nash	3.0	6.5
Social optimum	6.0	8.0

¹ KHR stands for Khmer Riels and 1.00 USD is about 4000 KHR.

² The experiments that are closest to ours are [Kocher et al., 2016](#) and [Marinsson and Persson \(2019\)](#) who both use an endowment of 20 with varying minimum contribution levels. However, their design is a computerized experiment programmed in z-tree. Given the high illiteracy rates among our participants, we conducted our experiments with envelopes and cash. Following [Rustagi et al. \(2010\)](#) – who conducted a linear public goods game in Ethiopia – we chose for an endowment of six bills.

corresponding payoff are given in [Table 1](#). While the Nash contribution in the voluntary system is zero, the Nash contribution in the tax system is 3. The payoff for the Nash contribution is slightly lower in the voluntary system than in the tax system, but the payoff for the social optimum contribution is higher due to institutional cost in the tax system.

4.2. Experiment 2: a weak enforcement versus a strict enforcement system

In the second experiment, the choice is between a weak enforcement and a strict enforcement mechanism. In this setting, there is a rule that each group member must contribute at least 3 bills to the public good. The subjects are free to decide whether to follow the rule or not. However, breaking the rule would get sanctioned with a probability of 0.5 ($p = 0.5$).³ In our setup, if caught and sanctioned, the subject loses half of his payoff (penalty $\gamma = 0.5$).⁴ The expected payoff of subject i who violates the rule in the regime of weak enforcement mechanism is given by

$$\mathbb{E}(\pi_i) = p[E - g_i + \alpha(g_i + g_{-i})] + (1 - p)\gamma[E - g_i + \alpha(g_i + g_{-i})] \quad (2)$$

The payoff of a rule-complying individual is the same as in the standard public goods game (Eq. (1)).

Under the strict enforcement regime, each subject must pay an institutional cost m so every rule breaker is caught and gets sanctioned. In our setup, the cost of operating detection and sanctioning of rule breakers is $m = 1$. The payoff of subject i who breaks the rule in the strict enforcement regime is given by

$$\pi_i = \gamma[E - g_i + \alpha(g_i + g_{-i})] - m \quad (3)$$

The payoff of a rule-complying individual is given by Eq. (2). The Nash equilibrium and social optimum contributions and the corresponding payoff are given in [Table 2](#). From the table, we observe that overall the payoff of the game that features a weak enforcement mechanism is slightly higher than that of the game that features a strict enforcement mechanism, due to the institutional cost incurred in the latter. In both games, the Nash contribution is to follow the rule and contribute 3 bills.

Before the public goods games with both costly institutional settings, we also run a Gneezy-Potter risk-elicitation game ([Gneezy and Potters, 1997](#)),⁵ to characterize the risk preferences of participants, followed by a standard public goods game and a public goods game with strategy

Table 2

Nash and social optimum contributions and corresponding payoffs in weak and strict enforcement mechanisms.

	Contribution	Payoff
Weak enforcement		
Nash	3.0	7.5
Social optimum	6.0	9.0
Strict enforcement		
Nash	3.0	6.5
Social optimum	6.0	8.0

³ We set the probability to get caught at 50% to facilitate understanding by the participants and because we do not have reliable numbers of the likelihood to get caught in similar real life settings in Cambodia.

⁴ Again, the main reason to set the penalty at 50% of the payoff is to facilitate understanding and computation by the participants. Further, losing 50% of your payoff can be considered high enough to have a deterring effect. While the size of the punishment can have an impact on contribution, we are mainly interested in the institutional choice. Thus, having a punishment that is high enough to have a deterring effect is sufficient.

⁵ We use a Gneezy-Potter risk elicitation game since it is easy to understand for the participants and is straight forward to implement in a field setting with a sample pool where illiteracy is high.

elicitation, to study cooperative types. After the games, we also conducted structured interviews with each participant. We asked question along five different topics: (i) community trust, support, and collective action, (ii) scarcity, (iii) shocks, (iv) institutional settings experienced, and (v) demographics. Details on the survey and exact methods of eliciting risk and social preferences are given in [Schuch et al. \(2021\)](#). The study was reviewed by the Social Sciences Ethic Committee of Wageningen University and registered as a pre-analysis plan; see [Richter et al. \(2020\)](#).

4.3. Implementation

Our study sample consists of rural Cambodian farmers from 21 villages in the Kampong Chhnang province ([Fig. 1](#)). We focus on three communes, namely Kouk Banteay (8 out of 8 villages), Taing Krasaing (we randomly drew 6 out of 12 villages), and Tuol Khpous (7 out of 7 villages). While farming is prevalent in all these communes, fishing dependency and access to irrigation water differs. Thus, only some farmers have the option to use fishing as a secondary income. Fishing dependency is relatively high in Kouk Banteay, and low in Tuol Khpous and Taing Krasaing. Further, Kouk Banteay has more access to water than the other two as it has more canal systems.

The participants were recruited via village chiefs. We informed village chiefs about the criteria for recruitment. We required that the participants should be (i) 18 years or older, (ii) only one person per household (preferably the household head or spouse), (iii) healthy as the experiments would take around 3 h, and (iv) from all social spheres within the village. Thus, while our selection of villages was random, the recruitment of participants was dependent on availability of participants. We believe that our sample captures the most essential parts of Cambodian society in this area with a slight overrepresentation of females (see [Table 3](#)). The overrepresentation of females is mainly driven

Table 3

Descriptive statistics of relevant variables.

Variable	Obs.	Mean	Std. Dev.	Min.	Max.
Socioeconomics					
Gender (male = 1)	281	0.37	0.48	0.00	1.00
Age	282	46.20	13.22	18.00	80.00
Schooling years	282	4.05	3.48	0.00	16.00
Number of household members	282	4.76	1.70	1.00	11.00
Individual preferences					
Risk aversion	282	3.18	1.00	0.00	6.00
Trust	282	7.33	2.35	0.00	10.00
Wealth					
Owning a motorboat	282	0.09	0.28	0.00	1.00
Owning farmland for growing other crops	282	0.22	0.42	0.00	1.00
Owning paddy land close to water source	282	0.46	0.50	0.00	1.00
Receiving income from remittance	282	0.32	0.47	0.00	1.00
Experience about scarcity					
Frequency of water scarcity experienced	282	0.95	2.93	0.00	20.00
Having enough water for irrigation	282	0.62	0.49	0.00	1.00
Having experienced catch decline	282	0.19	0.39	0.00	1.00
Having experienced stock collapse	282	0.12	0.33	0.00	1.00
Having experienced income shock	282	0.57	0.50	0.00	1.00

by availability since farming required males to attend the fields. At the beginning of each session the village chiefs where there to greet people and ensure that everything was running smoothly before they left for

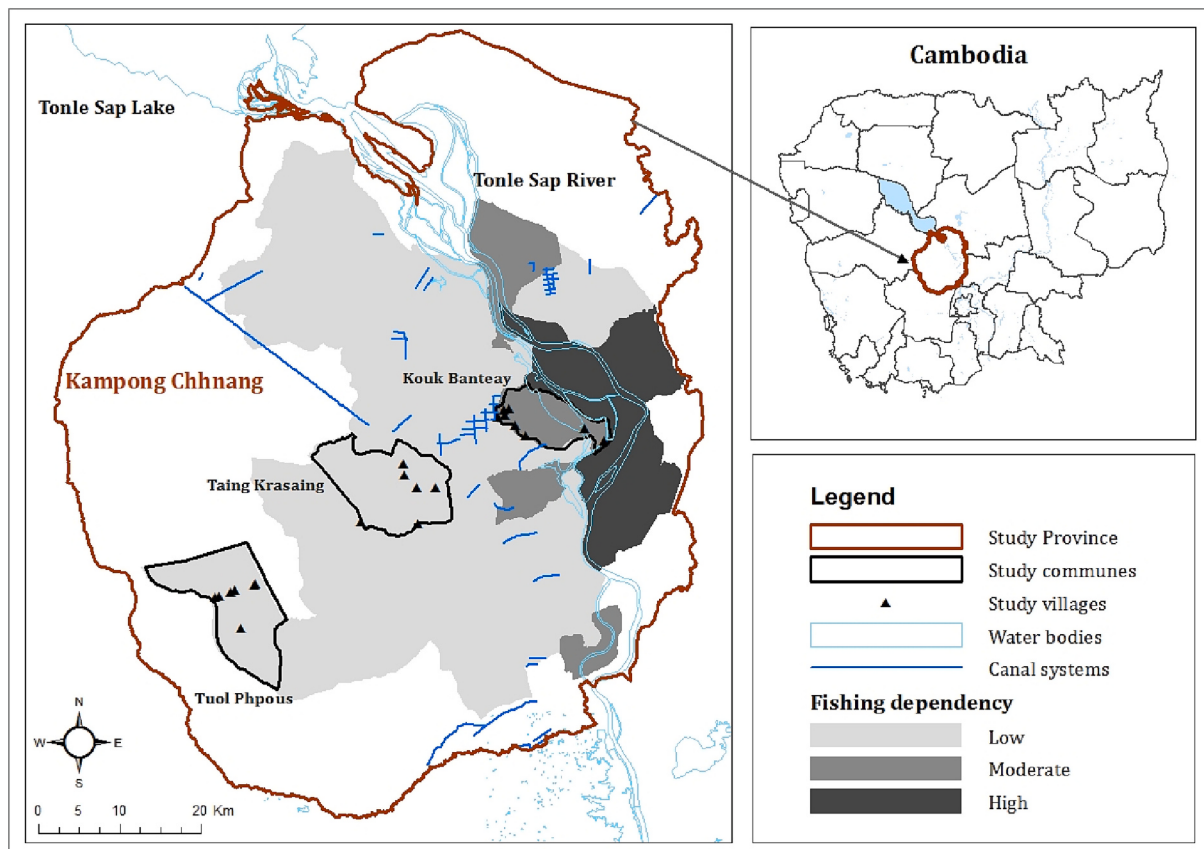


Fig. 1. Map of the study area in Kampong Chhnang province, Cambodia.

their respective work. This way we could ensure that the village chiefs did not influence the decision-making.

All instructions were given verbally using posters and examples to ensure understanding in a population with high illiteracy rates. The exact instructions of the experiments and the materials used are given in Appendix 2. Participants were encouraged to ask questions during the instructions which were then discussed in the group. We also included two comprehension questions for everyone. Out of the 302 participants 231 answered both questions correct. Given the social context we refrained from excluding individuals that answered the questions wrong, but rather used this as an opportunity to clarify the experimental tasks. We do control for answering control questions correctly in the regression analysis.

For each of the games the individuals were assigned randomly to new groups. There was no feedback given between the experiments. To account for the time investment, we pay each participant a show-up fee of 4000 KHR and another 6000 KHR if they stay till the end in addition to the money earned in one of the games. At the end of a session one of the games was chosen randomly for each participant to avoid confounding effects between the games. The average payout is 17,000 KHR which corresponds to \$4.25 and provides a sufficient incentive to participate given the average daily wage in the region of \$4.50.

We started with the risk elicitation followed by a one-shot linear public goods game and a conditional public goods game, before conducting the two experiments. We did not randomize the order of the experiments, because experiment 1 was conceptually closer to the baseline public goods game. This has eased understanding among our participants, though we cannot rule out that order effects are confounding our results. However, in the instruction we made it clear to the subjects that they should treat both experiments separately and that their decisions and the resulted payoffs in one experiment do not affect those in another experiment. Further, they were also told that their partners are random and different from one experiment to another.

In all experiments the participants were asked to divide their endowment of 6000 KHR between a group fund (a green envelope) and a private fund (a white envelope). The only difference was in the tax treatment. Here, the participants were given only 3000 KHR to divide between the private and the public fund while already 3000 KHR were in the public fund envelope. This way we made it salient that 3000 KHR are going towards the public fund (the mandatory tax) and the participants only had a distributional choice regarding the other 3000 KHR. In the punishment treatments there is only the rule to contribute 3000 but the participants have a choice whether they want to follow this rule, thus we provide them with 6000 KHR.

5. Results

5.1. Data description

We have 302 participants in our experiments, though 20 participants did have to leave right after the experiment without answering the survey questions. Thus, when analyzing survey data we only have 282 observations. Our sample has more female (63%) than male (37%) participants. The average age is about 46 years, and no one is below 18 years old. Most of them have very low education (average schooling years of 4). On average, a household has about 5 members. Furthermore, most of the subjects are farmers as primary occupation.

We find that in the baseline linear public goods game average contribution is 3.11 (52% of the endowment). This is higher than what is often found in lab experiments carried out with Western university students. For example, [Zelmer \(2003\)](#) reported an average contribution of 37.2% in a meta study on public goods experiments. However, our contribution levels are in line with what has been reported in other studies carried out in Asia. [Jarungrattanapong and Boonmanunt \(2020\)](#) reported an average contribution of 56.8% of the endowment in Thailand, which is similar to that found in our study. [Carpenter et al.](#)

(2004) reported an average contribution of 67.2% of the endowment in an urban slum context in Thailand. To measure cooperative traits, we asked participants to play a conditional public goods game to understand their prosocial preferences. In the game, subjects were endowed with 6 bills of 1000 KHR and asked to make seven decision rounds on how much to contribute to the public good, knowing what the partner contributes. Using the hierarchical cluster analysis ([Fallucchi et al., 2018](#)), the subjects can be divided into five groups in terms of their prosocial preferences ([Table 3](#)); see also [Schuch et al. \(2021\)](#). Low, medium, and high unconditional cooperators are those who made low (mean of 1.77), moderate (mean of 2.54), and high (mean of 4.44) contributions respectively regardless of what the partner contributed. Conditional cooperators are the ones who try to match the contribution of partners (mean of 3.16). Finally, we have some subjects (79 out of 282) whose contribution level seems to be irregular, referred to as “other behavioral type”. In terms of individual preferences, we measured risk aversion on a scale 0 to 6, with zero being not at all risk averse and 6 being highly risk averse. In our study sample, overall, the subjects are fairly risk averse.

In our survey we measured trust by asking them how many out of 10 villagers would voluntarily join a collective project in the village if invited. The average trust level is around 7.0. We also measured wealth of each household. First, we asked whether the household owns a motorboat since fishing is an important source of income in the study area. We find that 9% of them own a motorboat, which implies that those individuals can be considered wealthier than those who do not. Further, 22% of the respondents own farmland for growing other crops rather than rice. When it comes to assets related to rice farming, which is the most important livelihood option in the area, 46% of them own paddy land close to an irrigable water source, which is within the distance of 100 m. Remittance from migration is another important source of income, and in our study sample 32% of them did receive remittance in the past year.

Finally, we also elaborate on household experience about water scarcity. Firstly, we asked how many times the household experienced irrigation water scarcity in the past 5 years. Since level of scarcity may differ within and between villages depending on access to water in the system, “household experience” of water scarcity is probably the most appropriate way to measure water scarcity. The average frequency of water scarcity experienced in the past 5 years is 0.95. Further, 62% of the respondents did not have enough water for irrigation in the past year. With regard to those who have fishing experience, 19% have experienced catch decline in the past year, and 12% reported that they experienced stock collapse. Lastly, 57% of the respondents also reported that they experienced an income shock in the past year.

5.2. Voting and contribution in costly institutions

5.2.1. Voting on costly institutions

Our study features two experiments: each with two institutional settings. In the first experiment, the choice of institution is between a costless voluntary system where there is no rule prescribing how much each group member has to contribute to the public good, and a costly tax system where each group member has to contribute at least half of the endowment to the public good. In the second experiment, the institutional choice is between a costless weak enforcement mechanism and a costly strict enforcement mechanism. Under the weak enforcement mechanism, rule breakers (those who contribute less than half of the endowment) have a 50% chance to escape from punishment. Under the strict enforcement mechanism, however, every rule breaker is punished.

Results of voting between a voluntary system and a tax system show that a significant share of subjects (62.25%) voted for the tax system, and 63.55% of the groups ended up having this institution implemented. Similarly, the majority of the subjects (61.59%) voted for a strict enforcement mechanism, and 62.50% of the groups ended up having the strict enforcement mechanism implemented. If we look at voting

behavior across institutions, we observe that 23.84% of the subjects voted for both costless institutions, i.e., the voluntary system and the weak enforcement mechanism, and up to 47.68% voted for both costly institutions: the tax system and the strict enforcement mechanism. 14.57% of them voted for the costly tax system and the weak enforcement mechanism, while the rest (13.91%) voted for the voluntary system and the costly strict enforcement mechanism.

5.2.2. Contributions in costly institutions

Here, we want to understand cooperative behavior of subjects in terms of their contribution to the public good in both experiments (Fig. 3). Overall, only a very small proportion of subjects contribute nothing to the public good. Also, contributing the minimum requirement (3 bills) – implemented or not – to the public good is the most popular option across institutions. The most frequently observed contribution level in the standard voluntary contribution setting is 3, which is half of the endowment. This effect is well documented in the literature and our subject pool is no exception.

Overall, the contribution level in the costly institutions is significantly higher (based on Wilcoxon signed-rank tests) than that in the costless institutions (Fig. 2). In the first experiment, the contribution level is significantly higher ($z = 11.502, p = 0.0001$) under the tax system (mean 4.02) as compared to the voluntary system (mean 2.92). In this experiment, the percentage of players contributing the social optimum level (6 bills) is higher in the tax system (about 10%) than in the voluntary system (about 3%). In the second experiment, the contribution level is significantly higher ($z = 4.433, p = 0.0001$) under the strict enforcement mechanism (mean 3.66) than under the weak enforcement mechanism (mean 3.44).

While we observe increased contributions in the presence of costly institutions, it is not clear where these increases come from. Thus, we plot individual contributions by institutional system (Fig. 3). We indicated whether the institutional system led to higher contributions (crowding in) or lower contributions (crowding out) compared to the weaker institutional counterfactual. Looking at the tax system we see that the majority of participants increase their contributions even if they already contributed three or more bills in the voluntary contribution system. Thus, by and large the three bill tax does not seem to crowd out more generous contributions. In the case of weak versus strict enforcement the picture is less clear. While we do see that some individuals contribute more, there is also crowding out. The most often observed

pattern here is that contributions remain the same across institutional design if they were at least three bills.

5.3. Individual payoff of each institution

Fig. 4 shows individual payoff conditional on the institutional regime. It is worth to recall that the contribution decision in our game is based on the strategy method, meaning that each subject decides on the contribution in each game, without having known the voting outcome. Therefore, we are able to compare the payoff levels between the two institutional regimes. As for the first institutional setting (Fig. 4a), we observe higher payoffs under the tax system than in the voluntary system, suggesting that there is a welfare improvement in the costly institution, as compared to the costless institution. In contrast, we see lower payoffs under the strict enforcement mechanism, as compared to the weak enforcement mechanism (Fig. 4b). The reason is simply that the cost of the strict enforcement mechanism does not outweigh the benefit in terms of higher cooperation.

5.4. Determinants of institutional choice

Logistic regressions were run to understand effects of prior experience about scarcity, wealth, and individual characteristics on the likelihood of subjects voting for a costly tax system (Table 4). In the first model, we observe that having experienced scarcity impacts subjects' voting behavior. In particular, the more exposed to water scarcity people have been in the past, the more likely they are to vote for the tax system. This result holds true even when we control for village effects (model 2). If we distinguish between those who engage in fishing (model 3) and those who do not (model 4), the positive effect of exposure to water scarcity on the support of the tax system disappears among those who do not engage in fishing. It is worth to note that those who engaging in fishing also do farming, and when we asked participants in the survey to identify their primary occupation, 52 out of 63 who engage in fishing responded that rice farming is their primary occupation, and only one of them considered himself as a fisher. It seems to point to the fact that fishing is a complementary activity as a livelihood strategy. Further, 44 out of 63 who engage in fishing (70%) also cultivate dry season rice, which is a relative water-consuming farming system, suggesting that water scarcity is highly relevant for those who also engage in fishing. We also look at other variables that describe household experience of

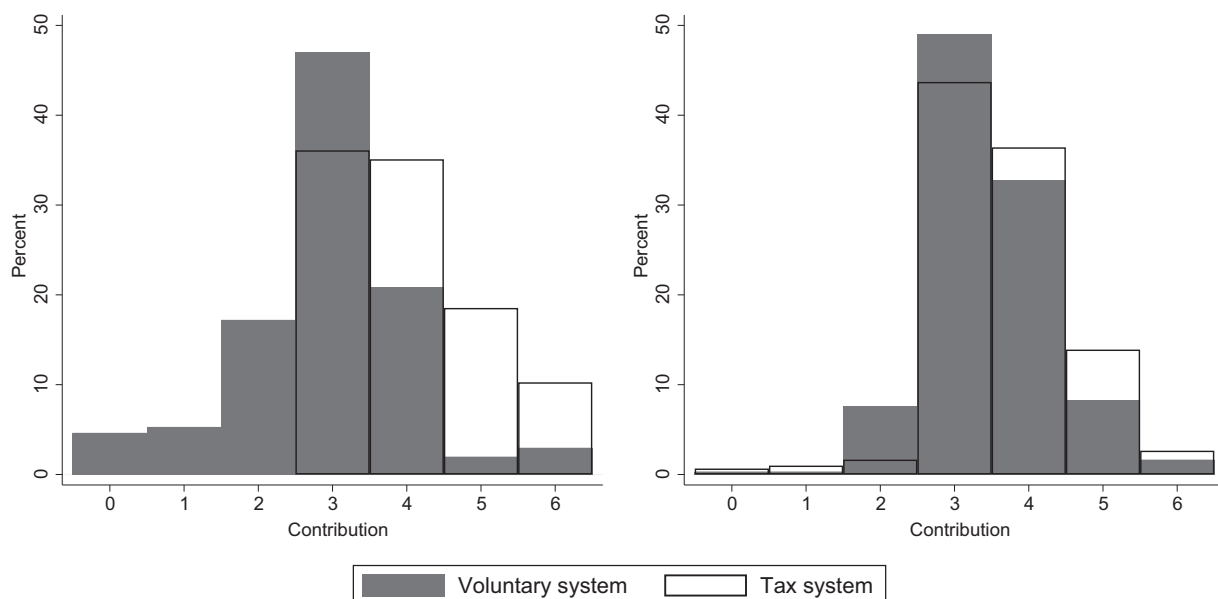


Fig. 2. Distribution of contribution levels between costless and costly institutions ($N = 302$).

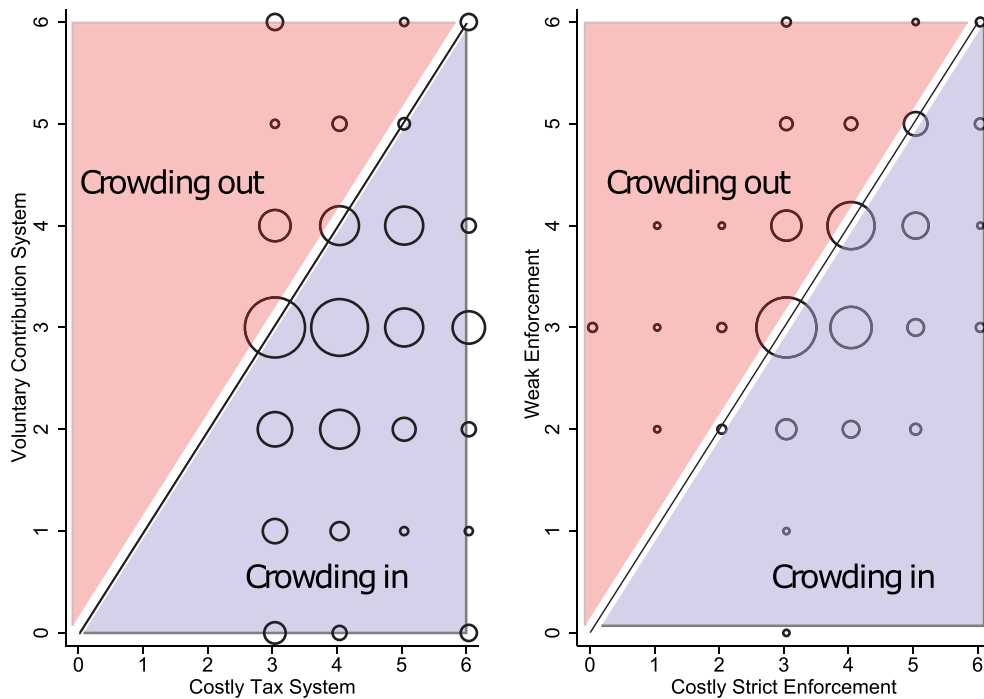


Fig. 3. Comparison of contributions by institutional system (N = 302). Size of bubble represents the frequency of this combination.

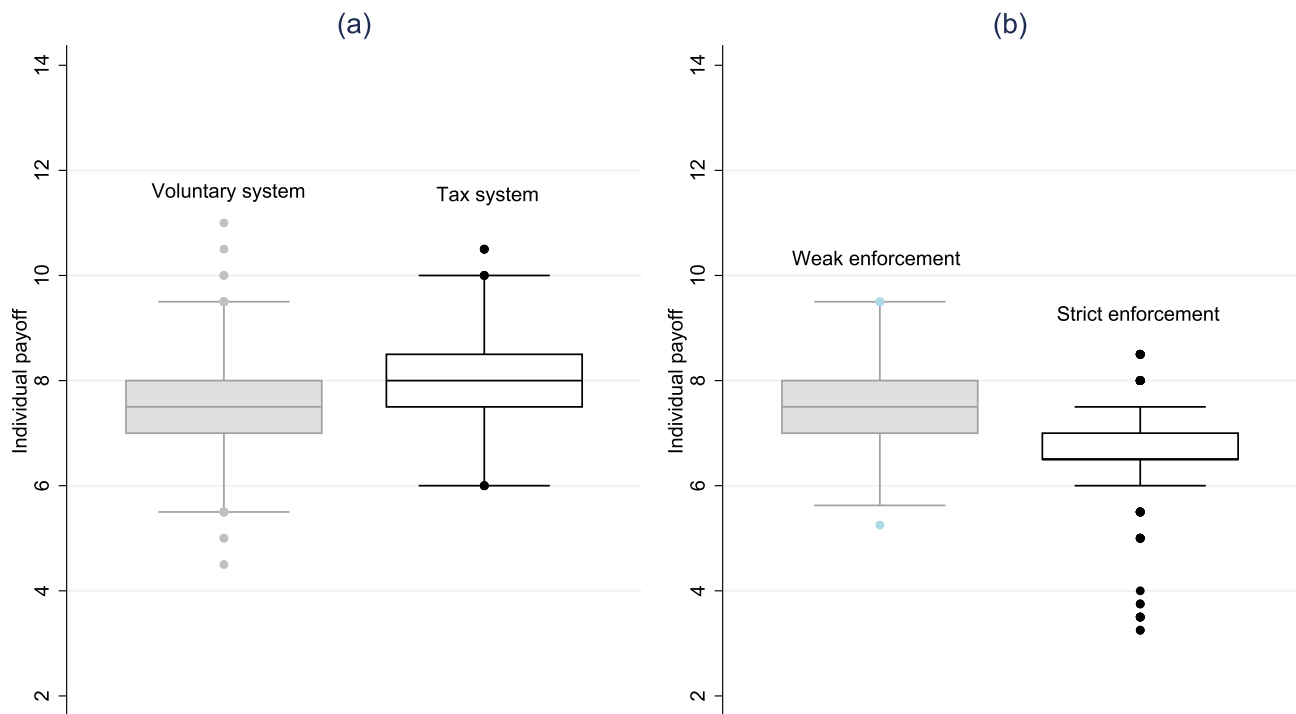


Fig. 4. Boxplot showing individual payoffs for the different institutional settings. The horizontal line inside the rectangle represents the median payoff and the ones either side of the rectangle show lower and upper quartiles. Circle markers are outliers (N = 302).

scarcity such as whether the household has had enough water for irrigation, experienced catch decline, and fish stock collapse, but we do not find any significant effects on their voting behavior. In addition, we also observe that household experience of income shocks in the past years does not impact voting behavior either.

Wealth, however, can have different effects on voting behavior, depending on whether it is related to rice farming or not. For instance, the subjects who own paddy land close to irrigable water sources are less

likely to vote for the tax system. The reason could be that this group has a higher capacity to cope with water scarcity as well as more control over water access, finding it less important to have such an institution. We find that those who receive off-farm income from remittances are more likely to vote for the tax system. We also included other variables related to wealth such as whether the households own a motorboat or whether they own farmland for growing other crops rather than rice, but we find no significant effects. In terms of individual preferences such as

Table 4

Effects of experience about scarcity, wealth, and individual preferences on subject's voting for the tax system.

Dep. Var.: Voting for tax system (1/0)	Pooled		Fishing	Non-fishing
	(1)	(2)	(3)	(4)
Experience about scarcity				
Frequency of water scarcity experienced	0.0993* (0.0563)	0.115** (0.0580)	0.883*** (0.325)	0.0552 (0.0577)
Having enough water for irrigation	0.596 (0.365)	0.710* (0.413)	1.500 (2.016)	0.689 (0.425)
Having experienced catch decline	-0.516 (0.579)	-1.112* (0.673)	-1.941 (3.365)	
Having experienced stock collapse	0.605 (0.903)	0.896 (0.903)	0.642 (1.793)	
Having experienced income shock	-0.0999 (0.221)	0.0103 (0.331)	3.063 (2.174)	-0.267 (0.278)
Wealth				
Owning a motorboat	-0.0282 (0.855)	0.538 (0.995)	-0.508 (1.933)	
Owning farmland for growing other crops	0.622 (0.447)	0.303 (0.472)	-0.186 (2.717)	0.832* (0.490)
Owning paddy land close to water source	-0.849*** (0.298)	-0.939** (0.376)	-2.851 (1.832)	-0.801** (0.333)
Receiving income from remittance	0.649** (0.323)	0.401 (0.359)	4.180* (2.346)	0.582 (0.407)
Individual preferences				
Risk aversion	0.0509 (0.157)	0.136 (0.179)	0.0375 (1.398)	0.0604 (0.168)
Trust	0.0163 (0.0601)	0.0479 (0.0725)	0.246 (0.231)	0.0138 (0.0679)
Constant	-1.072 (0.848)	-0.936 (1.537)	-15.99* (8.490)	-0.797 (0.866)
Commune fixed effects	✓		✓	✓
Village fixed effects		✓		
Cooperative traits	✓	✓	✓	✓
Socio-demographics	✓	✓	✓	✓
Answering control questions correctly	✓	✓	✓	✓
Observations	281	267	63	218
Pseudo R ²	0.156	0.222	0.436	0.159

Standard errors in parentheses, clustered at village level.

* $p < .10$, ** $p < .05$, *** $p < .01$.

risk and trust level, we do not find any significant effects on their voting behavior. We also control for village effects, as indicated in the second model, but we find no major differences.

Similarly, we run logistic regressions to understand the effects of prior experience about scarcity, wealth, and individual preferences on the probability that the subjects vote for the strict enforcement mechanism (Table 5). Overall, we find that more exposure to water scarcity increases the likelihood of subjects' voting for the strict enforcement mechanism. Again, this effect is more present among those who are also fishing. Other variables related to experience about scarcity, such as whether the household has had enough water for irrigation and experienced catch decline and fish stock collapse, have no significant effects on the voting behavior. Whether the household experienced income shock in the past year does not impact voting behavior either.

We do find that wealth affects voting behavior. While the subjects who own a motorboat are less likely to vote for the strict enforcement mechanism, those who own farmland for growing other crops rather than rice are more likely to vote for the strict enforcement mechanism.

Table 5

Effects of experience about scarcity, wealth, and individual preferences on subject's voting for a strict enforcement.

Dep. Var.: Voting for strict enforcement (1/0)	Pooled		Fishing	Non-fishing
	(1)	(2)	(3)	(4)
Experience about scarcity				
Frequency of water scarcity experienced	0.147** (0.0738)	0.164** (0.0694)	0.337 (0.225)	0.105 (0.0739)
Having enough water for irrigation	0.312 (0.359)	0.599 (0.418)	0.520 (1.770)	0.266 (0.359)
Having experienced catch decline	0.344 (0.614)	-0.0431 (0.658)	0.0400 (1.377)	
Having experienced stock collapse	0.360 (0.694)	0.661 (0.775)	1.408 (1.374)	
Having experienced income shock	0.0162 (0.228)	0.0909 (0.311)	-0.548 (1.028)	0.0855 (0.265)
Wealth				
Owning a motorboat	-1.836** (0.875)	-1.390* (0.755)	-2.148** (1.028)	
Owning farmland for growing other crops	0.893* (0.521)	0.543 (0.397)	-2.281* (1.202)	1.092* (0.629)
Owning paddy land close to water source	-0.221 (0.377)	-0.00594 (0.378)	-3.509*** (1.014)	-0.0333 (0.430)
Receiving income from remittance	0.378 (0.308)	0.392 (0.348)	-1.293 (0.822)	0.448 (0.387)
Individual preferences				
Risk aversion	0.0116 (0.198)	0.164 (0.182)	2.598*** (0.924)	-0.0628 (0.224)
Trust	0.0630 (0.0733)	0.0897 (0.0747)	0.155 (0.180)	0.0419 (0.0802)
Constant	-1.209 (1.098)	-2.705* (1.435)	-4.521 (4.788)	-1.168 (1.313)
Commune fixed effects	✓		✓	✓
Village fixed effects		✓		
Cooperative traits	✓	✓	✓	✓
Socio-demographics	✓	✓	✓	✓
Answering control questions correctly	✓	✓	✓	✓
Observations	281	264	63	218
Pseudo R ²	0.116	0.202	0.453	0.145

Standard errors in parentheses, clustered at village level.

* $p < .10$, ** $p < .05$, *** $p < .01$.

Overall, other variables related to wealth such as whether households own paddy land close to water source and whether they receive income from remittance have no significant effects on the likelihood of subjects voting for the strict enforcement mechanism. However, among fishers the effects of wealth are largely negative. Finally, if we look at the effects of individual preferences such as risk aversion and trust on the voting behavior, we observe that risk averse fishers are more likely to vote for the strict enforcement mechanism.

So far, as depicted in the logistic regressions in Tables 4 & 5, we observe a relationship between household experience about scarcity, measured as the frequency of water scarcity experienced in the past 5 years, and the probability of voting for a tax system and for a strict enforcement mechanism. We further explore the probability of voting conditional on having experienced scarcity, plotting the marginal effects (Fig. 5), based on model 1 in Table 4&5. We used commune fixed effects and robust standard errors clustered at the village level.

Overall, the marginal effects show that the probability of voting for

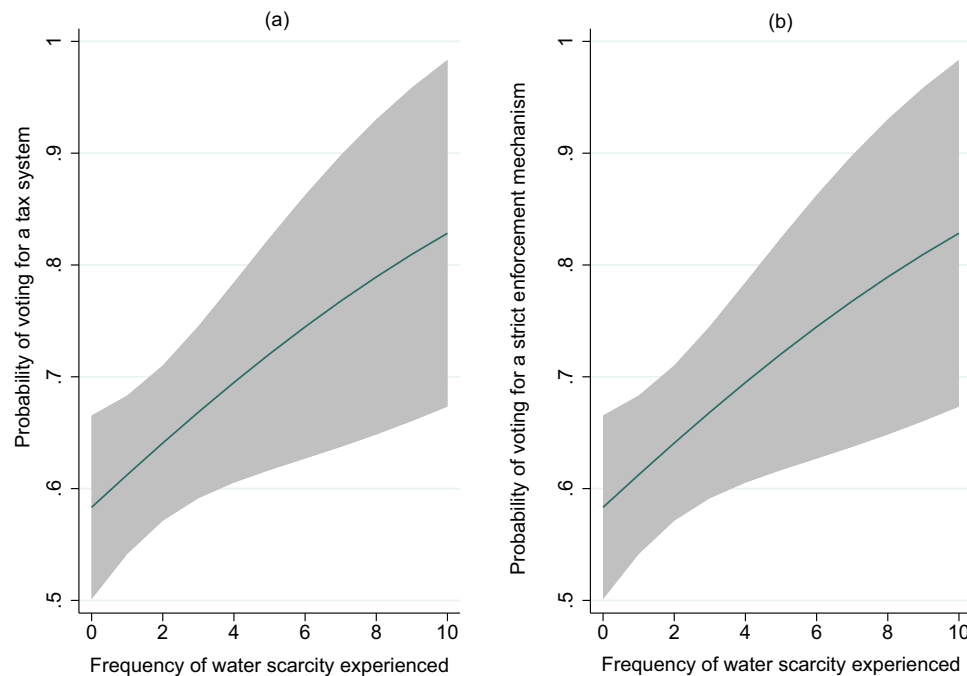


Fig. 5. Marginal effects of household experience about water scarcity in the past 5 years on the probability of voting for (a) tax system and (b) strict enforcement mechanism.

the implementation of costly institutions increases with experience about scarcity. If farmers have experienced water scarcity at least once in the past five years, the probability of voting for both costly institutions is approximately 0.6 (Fig. 5). In the field setting, water scarcity varies within and between villages, depending on how far a farming plot is from accessible water sources, e.g., a canal. Further, the frequency of water scarcity experienced also depends on the number of cropping cycles per year. In the study setting, farmers grow up to three crops of rice per year.

We also analyze if contributions depend on whether the subjects vote for a specific institutional setting. Table S1 & S2 (Appendix 1) shows that contributions to the public fund do not depend on whether the subjects have voted for the institution. Further, we analyze how the cooperative traits interact with the institutional regimes. Not unexpected, we find that low unconditional cooperators contribute significantly less in all institutional regimes than high unconditional cooperators (Table S1 & S2). We also looked at the difference in contributions between the two institutions in both experiments that could be voted for (models 3 & 6) to see whether certain cooperative types contribute more (or less) under the tax and strict enforcement regimes, but we do not observe this effect.

6. Discussions and conclusion

The provision of public goods can be fragile if it is based on voluntary contributions by users, as some users may be tempted to underprovide or free ride. We explore with artefactual field experiments under which conditions users vote for costly institutions that set rules that govern the contribution to public goods. Our results show that a significant share of subjects vote for costly institutions even if they are not necessarily efficient. We find broad support for both a minimum contribution level (a tax system) and also stricter enforcement if it increases the chances of detection for those who underprovide. These findings are in line with other experimental work which find that users choose to implement an institutional setting, even if costly, compared to the voluntary contribution mechanism (Dannenberg et al., 2019; Kamei et al., 2015; Markusen et al., 2014; Sutter et al., 2010).

Accordingly, we also observe that the average contribution is higher

when institutions are in place, suggesting that they do indeed improve cooperation. In the minimum contribution regime, where each subject has to contribute at least half of the endowment to the public good, the majority of them still contributes more than the minimum requirement, suggesting that the tax regime does not crowd out the voluntary contribution beyond the required minimum level. An interesting avenue for further research would be to vary the minimum contribution level to account for crowding out effects and the natural tendency to contribute half the endowment. When it comes to the sanctioning institutions, the average contribution in the strict enforcement mechanism is higher than that in the weak enforcement mechanism.

Furthermore, we also analyze effects of individual preferences, wealth, and experienced scarcity on the probability of subjects voting for the costly institutions. In both the tax system and the strict enforcement mechanism, we find that greater exposure to water scarcity in the past increases the likelihood of the subjects voting for the institutions. We also consider effects of risk preference and trust on voting behavior, but we do not find any significant effects. We find that wealth has different impacts on the likelihood of subjects supporting the costly institutions, depending on whether the wealth is related to on-farm or off-farm livelihood options. The subjects who possess wealth that can be accumulated through off-farm activities such as fishing and remittance are less likely to support the costly institutions, as compared to those who own wealth that is related directly to farming. The reason could be because those who can earn off-farm income (which can serve as a buffering capacity in the face of scarcity and shock) depend less on farming, and thus find that the support of institution is less important.

Previous studies have shown that the informal institution which is enforced through social norms may collapse in the wake of scarcity, e.g. due to climate change (Nhim et al., 2019; Richter et al., 2013). While our experiments are artefactual, the institutional settings that are featured in our games resemble the type of institution available in the field settings of the study area. Our findings demonstrate that the alternative institution such as the formal institution could be supported, even if they are not welfare-enhancing. This finding suggests that fairness, rather than efficiency, could be an important element when it comes to supporting institutions (Kosfeld et al., 2009). This result is in line with early findings in the classic ultimatum game and lab experiments (Güth et al., 1982;

Hoffman and Spitzer, 1982). However, it has been shown that fairness is perceived to be less important if the money is 'earned', rather than gained as a windfall profit – which may also partially explain why individuals tend to favor costly institutions in our experiment (Cherry et al., 2002). Future research could explore further how support for institutions depend not only on outcomes, but also on processes leading to outcomes. We do find that individuals are more inclined to vote for such institutions when they were exposed to resource scarcity in the past. For future research it would be interesting to test whether this result depends on whether experienced scarcity is perceived as a matter of bad luck or bad decision making that could have been mitigated by adaptive actions. Finally, voting against an institution may reflect (i) lack of political will (there is no will to cooperate, though there would be need for an enforcement mechanism) or (ii) perceived redundancy of such mechanism (there is will to cooperate, but no need for enforcement mechanism). Typically, both factors depend on village-specific social norms and environmental factors. Visiting only 21 villages did not allow us to credibly link village-level attributes to voting behavior, and we rather carried out an individual analysis with village-level fixed effects. Looking closer at variation between villages would be a fruitful and exciting avenue for further research. Afterall, voting and cooperating are individual decisions, but they takes place in a social context that is evolving in response to shocks and scarcity, too.

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.

Data availability

Data will be made available on request.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.ecolecon.2023.107932>.

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