Reward, Punishment and Children's Cooperation Preference

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Abstract: Based on a large-scale field experiment of public goods games from over 1600 students aged 7-17, this paper investigates the effects of different institutions, including endogenous reward, endogenous punishment, exogenous reward, and exogenous punishment, on children's cooperation preference. First, we found that exogenous mechanisms are more effective than endogenous ones, indicating that the endogenous premium does not exist in children; Punishment is more effective than reward under an exogenous context. Then, we asked children about their preference for reward/punishment and found that reward is more popular. Supporters of institutions contribute more than opponents. Thirdly, we introduced uncertainty into reward/punishment and found that mechanisms with a 50% probability of enactment could also significantly improve children's cooperation, but the effects are inferior to certain ones. Finally, a significant positive correlation was found between children's contribution and their beliefs about the contribution of other group members. However, the free riders could take advantage of the institutional effect on cooperation promotion to select the dominant strategy. Compared with previous studies, this paper systematically analyzes the role of incentive institutions in improving children's cooperation and thus provides policy implications.

Key words: Public goods games; reward; punishment; cooperation; children
JEL codes: C93 C71 J13

1. Introduction

Cooperation based on genetically unrelated individuals is a universal feature in human societies (Fehr and Fischbacher, 2003). In recent years, there has been increasing literature focusing on cooperation among children (Alencar et al., 2008; Angerer et al., 2016; Cardenas et al., 2014; Sutter and Untertrifaller, 2020; Sutter et al., 2019). Similar to adults, children also provide cooperation in the face of social dilemmas, which deviates from the hypothesis of *Homo economicus* (Harbaugh and Krause, 2000). Also, children may learn to free-ride over game periods (Alencar et al., 2008). However, little research has introduced incentive mechanisms, such as punishments and rewards, in cooperation experiments among children (e.g., Lergetporer et al., 2014) to further explore how to maintain cooperation at an early age, even if it has been widely discussed among adults (Balliet et al., 2011; Chaudhuri, 2011; Fehr and Gachter, 2000; Sefton et al., 2007).

To investigate the cooperation of children under institutions is of great significance. Theoretically, studies of children's social preferences help to test the applicability of existing models of social preferences formed on adults such as inequality aversion (Fehr and Schmidt, 1999), reciprocity (Rabin, 1993), and so on (Fehr et al., 2013). Also, we could better understand adults by understanding children (List et al., 2021). Practically, experiments on children are conducive to finding appropriate policies to guide child preference development and skills formation. At the same time, the development of social preferences on behalf of non-cognitive abilities is crucial to children's human capital accumulation and future performance in the labor market (Heckman et al., 2006). As proposed by House et al. (2013), "Further work should explore specific cultural beliefs and institutions that influence cooperative behavior and how their acquisition and application shape children's behavior across development (pp.14590)". This paper is devoted to exploring the impacts of different institutions on children's cooperation.

To this end, we designed four public goods games with the interactions of "reward-punishment" and "endogenous-exogenous" settings in a large-scale field experiment, namely endogenous reward, endogenous punishment, exogenous reward, exogenous punishment. A total of 1,602 primary and secondary school students aged 7-17 in China participated in this experiment. Under the conditions of exogenous reward and exogenous punishment, the payoff will be deducted by a third party if any subject's contribution does not reach a certain threshold. Besides, we introduce uncertainty that the reward or punishment is implemented with a 50% probability. Under the endogenous conditions, we introduce a voting setting to measure children's preference for reward and punishment, and strategically ask their decisions when the institutions are implemented.

We are committed to answering the following four questions based on the above design. First, what are the impacts of the four institutions on the level of children's cooperation? Are punishments generally work better than rewards? Few studies have revealed the answers, even though there has been abundant evidence on adult experiments (Andreoni et al., 2003; Choi and Ahn, 2013; Rand et al., 2009; Sefton et al., 2007; Wang et al., 2020). In addition, does the exogenous system work better than the endogenous system? Among adult subjects, the phenomenon of *endogenous premium* that an endogenous system is superior to an exogenous system prevails (Dal Bo et al., 2010); however, no evidence has proven its existence among children.

The second objective is to investigate children's preference toward reward and punishment. Is the institution that most children prefer more effective? The literature among adults suggests that effective institutions are not necessarily selected (Tyran and Feld, 2006; Vollan et al., 2017). Nevertheless, there is no evidence of child experiments on this issue to the best of our knowledge. To analyze this question, in the endogenous context, children are asked whether they support reward or punishment. Moreover, as interpreted by Tyran and Feld (2006) and Vollan et al. (2017), we would further distinguish between the heterogeneity of supporters and opponents.

Then came the question of how we can save the high institutional cost? Implementing laws with probability is considered the easiest way to allocate administrators' responsibilities and alleviate cost problems (Chen et al., 2014). Therefore, we introduce uncertainty that the reward or punishment is implemented with a 50% probability in the exogenous system. If children can still maintain a certain level of cooperation under uncertain conditions, this design may effectively save costs.

Finally, if the reward and punishment can facilitate children's cooperative behavior, what may be the underlying reasons? Existing literature points out that besides the direct institution effect (Dal Bo et al., 2010), it is also possible that the institution can function by changing the subjects' cooperative beliefs about other group members, which are significantly associated with their own contribution (Fischbacher and Gachter, 2010; Gachter and Renner, 2010; Kocher et al., 2015). To further understand the underlying mechanism, we would also examine the correlation between children's beliefs in others on children's cooperation.

The main findings of our paper are as follows. First, among the four institutions, the effect of exogenous punishment is the strongest, followed by an exogenous reward, while there are no significantly different effects between endogenous reward and endogenous punishment. This paper also reveals that *exogenous premium* exists in children instead of *endogenous premium*. In other words, the cooperation level of children in the exogenous system is higher than that of in the endogenous system. Second, although the punishment works better, children subjects prefer the reward. About 87.74% of the children support the reward rule, while only 35.58% support punishment. Thirdly, after introducing uncertainty into the exogenous system, children would also contribute to the public account when the reward or punishment is implemented with a 50% probability. As a consequence, this paper provides experimental evidence for cost-saving policy design. At last, we found that children's beliefs about group members' contributions are significantly positively correlated with their own contribution level.

We contribute to the literature in three aspects. First, we systematically studied the differentiated impacts of the reward and punishment institutions under both endogenous and exogenous contexts on the level of child cooperation, owing to our large-scale field experiment involving more than 1600 children. To the best of our knowledge, only a small amount of literature has investigated the impact of endogenous reward (Yang et al., 2018b) and endogenous punishment (Lergetporer et al., 2014) on child cooperation. Second, this paper reveals similarities and differences between children and adults confronted with various institutions, which helps us further understand the development of human cooperative behavior. Finally, this paper provides field experimental evidence for policymakers to adopt appropriate incentives to guide the development of children's social preferences.

The remaining structure of this paper is as follows. Section 2 proposes the research hypotheses, and then Section 3 introduces the experimental design and process. In Section 4, we present the experimental results. Section 5 makes further discussion before we make concluding remarks in Section 6.

2. Hypotheses

Abundant evidence from public goods games has shown that non-zero voluntary contribution is widespread, but the level of cooperation gradually decreases across repeated game periods

(Ledyard, 1995). The prevalence of free-riders and conditional cooperators below the average contribution is the main driving factor (Fischbacher et al., 2001). So, how can we design institutions to restrain free-riders and maintain long-term cooperation? Two kinds of common norm enforcement involve punishment and reward (Fehr and Gachter, 2000; Sefton et al., 2007). Experimental studies on adult subjects have demonstrated the effectiveness of reward and punishment on cooperation levels (Balliet et al., 2011; Chaudhuri, 2011; Fehr and Gachter, 2000; Tyran and Feld, 2006; Vyrastekova and van Soest, 2007; Yang et al., 2018a). However, only a few studies have introduced these institutions into child experiments (e.g., Bernhard et al., 2020; Gummerum and Chu, 2014; Yang et al., 2018b), and the systematic effects on children's cooperation remain to be studied.

Existing literature suggests that individuals would negatively evaluate free riders at the early age of 4 years and show expectations of implementing norms to enhance public resources (Yang et al., 2018b). Unlike adults, children's punishment is mainly based on the unfair result rather than intention (Gummerum and Chu, 2014). Moreover, compared with a third-party punishment, children are more likely to make a second-party punishment when directly involved in the allocation (Bernhard et al., 2020). The effect of punishment is significant, more than doubling the cooperation rate (Lergetporer et al., 2014). Although some literature has explored the role of punishment, there are scarce experiments on children have compared both reward and punishment mechanisms, while the experiments among adult subjects have discussed a lot over this question (Andreoni et al., 2003; Choi and Ahn, 2013; Rand et al., 2009; Sefton et al., 2007; Wang et al., 2020).

The incentive mechanisms can be further embedded into exogenous and endogenous contexts. Under the exogenous context, a third party executes the punishment or reward uniformly. Since it is difficult to reveal people's preference for the punishment/reward and how the right of choice can affect people's cooperation level under the exogenous system (Sutter et al., 2010), economists have further introduced a democratic decision process, including voting, namely the endogenous system. Dal Bo et al. (2010) find that the endogenous system may better deliver cooperative signals from collaborators, leaving people at a higher level of cooperation than under an exogenous system, where there is an *endogenous premium*. Vollan et al. (2017) further find that *endogenous premium* is heterogeneously generated among populations in college student samples, but not in workers with higher authority compliance.

To systematically investigate the effects of different institutions on children's cooperation, we design four treatment groups combining "reward-punishment" and "endogenous-exogenous" settings, namely endogenous reward, endogenous punishment, exogenous reward, and exogenous punishment. We are to examine the abovementioned two questions. The one is the differing effects among differing institutions, and the other is whether there is an *endogenous premium* among children. Previous adult experiment results help to predict the results. For example, Sefton et al. (2007) conducted a public goods experiment with group members randomly assigned to compare the different cooperation levels in different groups, including the benchmark group, the reward group, and the reward-punishment combination group. The results show that the punishment and reward-punishment combination mechanism can significantly improve the level of cooperation; the cooperation level of the reward group is higher at the beginning but gradually decreases over time, and finally even lower than that in the benchmark group. Therefore, the reward may be less effective than the punishment. As for whether there is an endogenous premium in the child samples, we speculate that their cooperation level should be closer to the results of worker subjects in Vollan et al. (2017) because students in the compulsory education stage also have the characteristics of authoritative obedience. Therefore, the following hypothesis is proposed to be tested:

Hypothesis 1*:* Children cooperate more under the punishment system, and there is no *endogenous premium*; that is, the exogenous system promotes cooperation more than the endogenous system.

Research with adults shows that effective institutions are not necessarily the ones people prefer. For example, imposing punishments in the public goods games could effectively improve the contribution, but such an institution is not necessarily adopted when participants have the right to choose (Tyran and Feld, 2006; Vollan et al., 2017). So, what institution do children prefer? As opposed to the punishment system under which participants may lose existing endowments, the reward means additional income. Evidence from neuroscience suggests that potential losses have a greater impact than potential gains when adolescents are confronted with gambling games in which gains coexist (Barkley-Levenson et al., 2013). So even if we assume that punishment is more effective for children, the reward may be more popular. The subsequent question is, what is the difference in the cooperation level between supporters and opponents of the institution? A literature review related to institutional choice by Dannenberg and Gallier (2019) reveals systematic differences between supporters and opponents. Subjects with a cooperative spirit and optimistic beliefs about others usually voted for an incentive institution. In addition, the level of cooperation between supporters of institutions is higher than that of opponents (Tyran and Feld, 2006; Vollan et al., 2017). We believe that there may be similarities between children's performance and the results of adult subjects. Here, we propose ***Hypothesis 2*** to be tested:

Hypothesis 2: Children prefer to reward rather than punishment, and the contribution of institutional supporters is higher than that of institutional opponents.

Even though the effectiveness of rewards and punishments has been examined extensively in the literature, one issue that cannot be ignored is that punishments or rewards are costly. First, punishment cannot significantly improve the overall social benefits because it costs a certain amount to implement punishment, and the punished person also loses some benefits (Fehr and Gachter, 2000). Regarding rewards, compared with a pure transfer, net positive rewards are used more frequently and have better effects (Vyrastekova and van Soest, 2007). The former does not raise overall social welfare, while the latter requires an additional external expenditure. Second, since the implementation of punishment needs to pay the cost, and the existence of punishment inevitably leads to the improvement of the level of cooperation, participants can choose the cost-saving non-punishment scheme, which brings about the second-order free-riding problem (Kiyonari and Barclay, 2008). Thirdly, in the multi-stage games, punishment may reduce the degree of cooperation of altruists, especially when retaliatory behavior or antisocial punishment exists (Denant-Boemont et al., 2007; Fehr and Rockenbach, 2003; Herrmann and Gächter, 2008; Nikiforakis, 2008; Nikiforakis and Engelmann, 2011). For punishment to be effective, the efficacy of punishment must be much higher than the cost of punishment (Nikiforakis and Normann, 2008). Finally, rewards for contributions above the mean and punishment for contributions below the mean imply continuous supervision (Dai et al., 2015). In fact, it is impossible for the government to punish everyone who violates social norms immediately, nor to commend everyone who complies with social norms due to the huge regulatory costs and loss of social benefits.

To alleviate the problem of costly reward and punishment and share the monitor's responsibility, probabilistic sanctions are considered the easiest way (Chen et al., 2014). Some studies have introduced uncertainty in reward and punishment mechanisms in public goods games. For example, Dai et al. (2015) introduced a probabilistic audit system in the public goods games. A certain probability of punishment would be taken into effect when the contribution level of the subject is lower than the group's average. The results showed that the participants who initially experienced systematic audit decreased their contribution value immediately after the audit was withdrawn, while the participants who initially experienced low frequency and irregular audit held a firm belief in cooperation and maintained a high level of cooperation after the audit was withdrawn. Yang et al. (2018c) introduced a lottery design in the public goods game. They found that with the emergence of lottery, the cooperators took a dominant position and finally almost reached the state of global cooperation. The higher the winning rate or lottery prize, the easier it is to cooperate. Jiao et al. (2020) prove that probabilistic punishment and reward can more effectively promote the evolution of cooperative behavior through simulation. There is an optimal execution probability that promotes cooperation and reduces cost maximization. Drawing on the design of Walker (2004), we introduce uncertainty into the exogenous system, that is, the reward or punishment would be implemented with a 50% probability. Thus, we propose the following ***hypotheses 3***.

Hypothesis 3: Uncertain institutions with a 50% probability of implementation could also improve children's cooperation level, but the effect is not as good as the certain institutions.

What is the underlying mechanism if punishment and reward can improve children's cooperation? Studies based on adults offer two possible explanations. One is that the institution itself, as a social norm, can promote people's cooperation (Dal Bó et al., 2010). Under an exogenous system, the improvement of cooperation level mainly comes from institutional factors. Under endogenous institutions, the promotion of cooperation includes institutional effect, information effect, selection effect, and democracy effect, among which institutional effect is still the most important promoting factor (Vollan et al., 2017). Another possibility is that institutions may change people's beliefs about their peers, whereas most people cooperate conditionally based on belief (Fischbacher et al., 2001). People's beliefs about others' contributions are significantly correlated with their own contribution (Fischbacher and Gächter, 2010; Gächter and Renner, 2010; Kocher et al., 2015), that is, if people expect their peers to contribute more under the institutions, they will also contribute more. Lergetporer et al. (2014) reached a similar conclusion in the prisoner's dilemma game with a third-party punishment involving 1120 children. We, therefore, propose the following ***hypothesis 4*** to be tested:

Hypothesis 4: Beliefs about other group members positively correlate with children’s own cooperation level.

3. Experimental Design and Procedure

3.1 Experimental Design

Our experiments consist of four one-shot[1] and anonymous linear public goods games with distinct incentive institutions, including endogenous reward, endogenous punishment, exogenous reward, and exogenous punishment. Table 1 shows the grouping of the experiment.

Table 1. Experimental Grouping

Groups	Group1	Group 2	Group3	Group 4	Total
Institution	Endogenous Reward	Endogenous Punishment	Exogenous Reward	Exogenous Punishment	1602
Game Rule For children	Addition Rule Voting Rule	Deduction Rule Voting Rule	Addition Rule	Deduction Rule	
Observations	367	430	357	448	

Irrespective of the treatments, participants are randomly partitioned into a group of N = 3 individuals. Each subject receives an initial endowment of 10 tokens, and they need to decide the contribution $g_i \in [0, 10]$ to the public account, remaining for private account. Other members would make the decision simultaneously. The marginal per capita return of the contribution is 0.5. Subject i's earnings π_i is as follows:

$$\pi_i = 10 - g_i + 0.5 \sum_{j=1}^{3} g_j$$

Where g_i is the amount individual i contribute to the public account, and j represents any other group member. Since $\pi_i = 10 - 0.5g_i + 0.5g_{-i}$, where g_{-i} means the total contribution of the other two members, subject i choosing full free riding ($g_i = 0$) would be the dominant strategy for rational self-interested individuals.

We call the public games " Magic Game " to evoke children's interest in the games, we call the public games "Magic Game." The experimenter tells subjects that they will play a magic game with another two classmates randomly selected by the computer, and they do not know the identity of each other. Everyone gets 10 game tokens at the beginning of the game and needs to decide the number of tokens sent to the magician. The magician will change every two coins into three and

1 We do not set up the multi-period public goods experiment mainly for the following two reasons. Firstly, the field experiment designs are complicated enough for the children in the manner of pen and paper, with the exogenous system treatment group introducing probability and belief in others, and the endogenous system introducing voting rule. Second, even in multi-stage public goods experiments, the first-round effect is often the focus of analysis, because it is not affected by the results of other rounds and could represent subjects' voluntary cooperation preference (Harbaugh & Krause, 2000).

then make a per capita distribution. Everyone's final earnings would be the sum of tokens left in hand and allocated by the magician.

Treatment 1: Public good game with endogenous reward (EndoReward)

Based on the above standard voluntary contribution public good game, the EndoReward treatment incorporates the *addition rule* and *voting rule*. The *addition rule* refers to that anyone who contributes all their tokens to the public account will gain extra two tokens. The *voting rule* stipulates that the *addition rule* would be put into effect only when two or three students in a group vote for it. The earnings of subject *i* under addition rule is as follows:

$$\begin{cases} \pi_i = 12 - g_i + 0.5\sum_{j=1}^{3} g_j \ , g_i = 10 \\ \pi_i = 10 - g_i + 0.5\sum_{j=1}^{3} g_j \ , g_i < 10 \end{cases}$$

To make it easy for the lower grades to figure up, g_i and g_j are even values within 10. In this game, all individuals *i* full riding, i.e., $g_i = 0$ is the Nash equilibrium. When individual *i* makes a full contribution, $\pi_i(\text{full}) = 7 + 0.5g_{-i}$. When individual *i*'s contribution is zero, $\pi_i(\text{zero}) = 10 + 0.5g_{-i}$. Since $\pi_i(\text{full})$ is less than $\pi_i(\text{zero})$, free riding is the dominant strategy, and the individual's final return π_i equals to 10. However, everyone fully contributing to the public account could maximize the groups' payoff $\sum g_j$. In this case, the individual's earning π_i equals to 17 when the reward takes effect.

Treatment group 2: public goods game with endogenous punishment (EndoPunish)

EndoPunish treatment contains *deduction rule* and *voting rule*. The *deduction rule* refers to that any individual contributing less than 10 points to the public account would be deducted by 2 tokens in their final return. The penalty ratio refers to Mild Law proposed by Tyran & Feld (2006). Similarly, the voting rules state that the *deduction rule* would only take effect if a majority of the three members uphold the punishment. When the *deduction rule* takes effect, the final earning function of subject *i* is as follows:

$$\begin{cases} \pi_i = 10 - g_i + 0.5\sum_{j=1}^{3} g_j \ , g_i = 10 \\ \pi_i = 8 - g_i + 0.5\sum_{j=1}^{3} g_j \ , g_i < 10 \end{cases}$$

When an individual contributes all 10 endowments, $\pi_i(\text{full}) = 5 + 0.5g_{-i}$. When an individual contributes zero, $\pi_i(\text{zero}) = 8 + 0.5g_{-i}$. Since $\pi_i(\text{full}) < \pi_i(\text{zero})$, the free-riding choice g_i=0 of all individual *i* is an inefficient Nash equilibrium when the endogenous punishment is in effect, and the individual payoff π_i equals to 8.

Under endogenous mechanisms, the subjects are first required to vote whether to implement the *deduction rule* or *addition rule.* Then, they need to decide the contribution to the public account. Since it is a one-shot game, the subjects could not get feedback on the voting results, that is, the subjects do not know whether incentive institution would be implemented when making the contribution decision. Here, we apply a strategic approach to avoid the select effect by asking participants about their contribution conditional on the circumstance of implementation and non-implementation of the rule, respectively.

Treatment 3: Public goods game with exogenous reward (ExoReward)

Unlike EndoReward where the implementation of the *addition rule* depends on the voting process, ExoReward means that a third party enforces the addition rule. The earning function of subject *i* was the same as that of EndoReward. In the case of exogenous rewards, individuals also have the motivation to free ride to maximize personal benefits, and g_i=0 for every member is the Nash equilibrium.

Treatment 4: Public goods game with exogenous punishment (ExoPunish)

Similarly, with exogenous punishment, the *deduction rule* is also enforced centrally by an external third party rather than by an internal vote of the group members. The earning function of subject *i* is the same as that of EndoPunish, and g_i=0 is the Nash equilibrium of the game.

Under exogenous mechanisms, we further incorporate the uncertainty where rewards and punishments are implemented with a 50% probability. At each implementation probability (100% vs. 50%), we asked students about their beliefs in others' contribution, namely, "How much do you think the other two classmates in your group will contribute" and "How much do you think the three members in another group would contribute."

Appendix 1 and Appendix 2 take the endogenous reward and exogenous reward, respectively, as examples to show the specific experimental content and the subjects' decision-making-related questions.

3.2 Experimental procedure

The experiment was conducted in 11 schools in three rural counties of Sichuan Province, China, from April to June 2019. The public goods games with rewards and punishments are a part of a project investigating children's economic preferences, including risk and time preferences. The experiment was approved and supported by the local education bureau and the principals of the sample schools. Taking class as the unit, we randomly selected one sample class from each school's second, fourth, sixth, and ninth grades. A total of 1602 primary and secondary school students aged 7-17 from 38 classes participated in the experiment.

The experiment is usually set in a relatively spacious place, such as a large conference room or lecture theatre, so that the subjects could be seated randomly at intervals. The experimenters are master students or research assistants from Beijing Normal University, all of whom have received training in behavioral and experimental economics. They are familiar with the experiment process and content after strict exercises for scenario simulation. The other experiment assistants are similarly well-trained. Thus, they could avoid influencing the choice of subjects by using inductive language.

All experiments were conducted in the manner of paper and pen, and the experiment content is presented in the form of neutral and cartoon games for easy understanding. Before the experiment, the students were instructed that they would earn candy, stationery, or money in the games. Students voluntarily participate, and the experimenter would emphasize the discipline requirements, such as “no interaction or communication is allowed.” Then, the experimenter introduces the content and procedure of the game in detail with slides and blackboard writing with many examples. To ensure their motivation and conscientiousness, subjects are told that we would randomly choose one of the games they participated in as their payoff. After introducing the game's rules, the subjects need to finish the control questions, and the experiment assistant would confirm the correct answers one by one before the experiment officially begins. If the subject has any questions, the assistant will make a private explanation immediately.

After the experiments, the subjects are required to fill in a student questionnaire, involving information about their demographic characteristics, personality, and interaction with parents. The experimenter would lead students to complete the questionnaire, and the assistant would answer questions. When the questionnaire is returned, the assistant will check the quality one by one to ensure integrity and logicality. Then, we pay the subjects after the end of the questionnaire. The average payoff of the subjects from treatment 1 to 4 was 15.10, 16.55, 14.77, and 13.14 tokens, respectively. Students could exchange these tokens for stationery and candy freely. To make the monetary incentive relatively the same for each grade, we vary the exchange ratio of tokens/RMB (yuan) for deferent grades, namely the second, fourth, sixth, ninth grade is 1:0.2, 1:0.2, 1:0.3, 1:0.4, considering the difference of average pocket money across grades.

In addition to students’ questionnaires, family questionnaires are collected through parents’ meetings, from which we acquire the basic family information such as family social-economic status, parents’ job and education, and the personal information and values of students’ main caregivers. We have overcome many difficulties in the process of data collecting. For example, many parents work outside the home and ask children’s grandparents who do not receive much education to answer the questionnaire. To capture as complete information as possible, we adopted various measures. First, the experimenter would show the questionnaire on the screen and help interpret the questions one-by-one. Besides, we arranged a one-to-one assistant for parents or grandparents with literacy difficulties who could speak the local dialect to help them. After parents filling in the questionnaire, the assistants would also check the questionnaire. Finally, for parents who could not show up or who fill in the questionnaire with poor quality, we went to the school for the second or third round, or conducted another telephone interviews.

4. Experimental results

4.1 Comparison of the effects of various punishment and reward mechanisms

First, we will investigate whether incentive mechanisms can promote children’s cooperation level and whether different settings would induce differing compliance. To do so, we compare children’s cooperation levels under exogenous reward, exogenous punishment, endogenous reward, and endogenous punishment. However, a prerequisite for drawing valid conclusions from a direct comparison of groups is to ensure the grouping balance, that is, there is no significant difference in demographic characteristics among the subjects in each group. We have tried our best to do so by first assigning each class into four groups at the grade level so that there are subjects of all ages in each group. Then, based on random grouping, the distance between the school and the county center would be considered to balance the economic development status of each group. The results of the grouping balance test are reported in Table 3. Compared with group 1, there is no significant difference in most demographic characteristic variables such as gender, left-behind child of other groups, except for boarding in Group2 and Group4, which are significantly higher than that in Group1. Consequently, although simple comparison results of mean differences between groups provide important information on the efficiency of different mechanisms, we should also use regression analysis to control as many confounding variables as possible.

Table 3 Balanced test

Variables	Group 1	Group 2	Mean diff. Group 1 vs. 2	Group 3	Mean diff. Group 1 vs. 3	Group 4	Mean diff. Group 1 vs. 4
Gender	0.48	0.48	0.00	0.51	0.03	0.47	-0.01
Age	11.40	11.31	-0.09	11.07	-0.33*	11.22	-0.18
Only Child	1.74	1.75	0.01	1.67	-0.07*	1.68	-0.06*
Board	1.30	1.39	0.09***	1.31	0.01	1.41	0.11***
Left-behind Child	0.62	0.67	0.05	0.62	0.00	0.62	0.00
Pocket money	7.47	9.67	-2.19*	7.13	-0.34	8.54	1.06

Note: T-test is used for testing the mean differences of each group. *, ** and ** represent significance levels of 10%, 5% and 1% respectively.

Figure 1 presents the primary results revealing the efficiency of reward and punishment on children's cooperation level. Among the four mechanisms, children show the highest compliance under exogenous punishment, with the mean contribution of 8.17/10, followed by an exogenous reward (7.77), endogenous punishment (7.26), and endogenous reward (7.13).

Comparing the mean contribution level between the exogenous and endogenous ones, we could conclude that the exogenous system is more effective than the endogenous system in promoting children's cooperation level, that is, there is no *endogenous premium* in children subjects. Conditional on punishment, children cooperate more under exogenous punishment (8.17) than endogenous punishment (7.26). In the meantime, conditional on reward, children contribute more under exogenous reward (7.77) than in endogenous one (7.13).

When the scope is transferred to the exogenous framework, it could seem that punishment is more effective than reward; however, within the endogenous framework, the difference between them is not significant (p= 0.646).

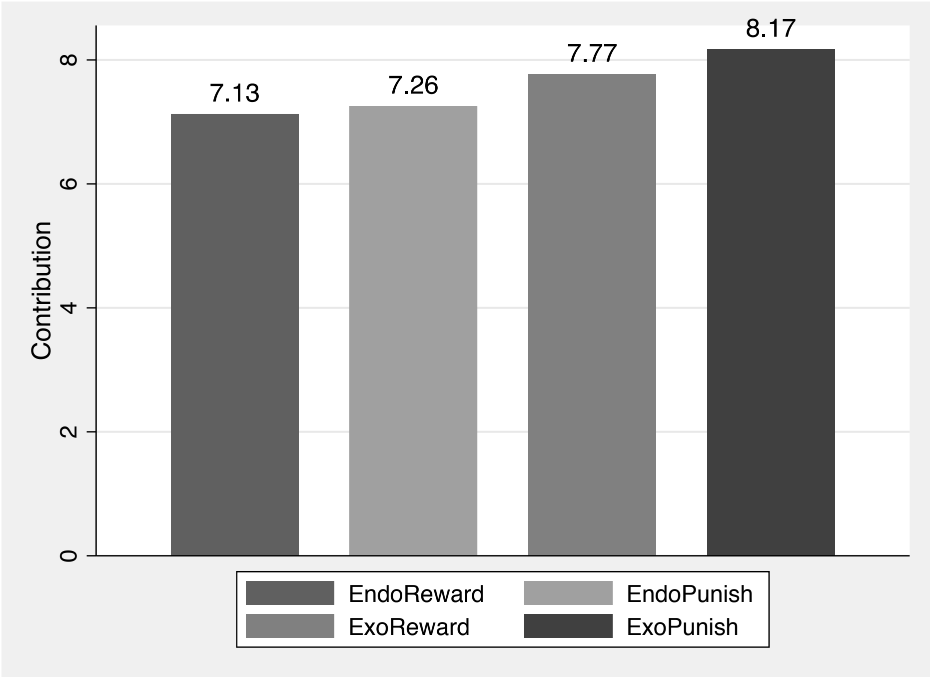

Fig. 1 Average contribution under various mechanisms

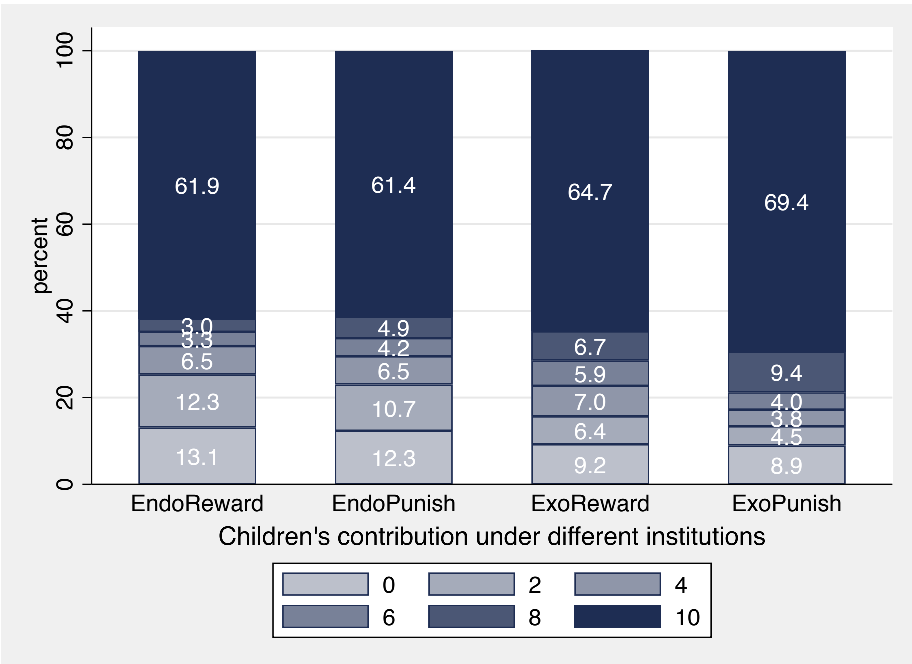

Fig. 2 Distribution of contribution under various mechanisms

Table 2 Mean differences among mechanisms

	Endogenous reward	Endogenous punishment	Exogenous reward
Endogenous punishment	0.128	-	
Exogenous reward	0.642^{**}	0.642^{**}	-
Exogenous punishment	1.046^{***}	1.046^{***}	0.404^{*}

Note: Wilcoxon rank-sum tests are used in the mean difference across treatments *,**and***represent the significance levels of 10%, 5% and 1% respectively.

Figure 2 shows the specific distribution of children's contribution under various systems, confirming the previous result that exogenous systems can restrain free-riding behavior and increase the proportion of cooperators more effectively than endogenous systems.

In the condition of *EndoReward*, the proportions of free-rider and low-level cooperators (contribute 2), which account for 13.1% and 12.3% respectively, are the highest among the four settings. Subsequently, the proportions decline monotonously under *EndoPunish* (12.3% and 10.7%), *ExoReward* (9.2% and 6.4%) and *ExoPunish* (8.9% and 4.5%). By contrast, the proportion of median-level cooperators (contribute 4 or 6) showed a trend of first increasing and succeeding decreasing, from 9.8% (=6.5%+3.3%) in *EndoReward* to 12.9% in *ExoReward* and then to 7.8% in *ExoPunish*. Additionally, the proportion of high-level cooperators (contribute 8 and 10) increased monotonously, from 64.9% (= 3.0%+61.9%) under *EndoReward* to 78.5% under *ExoPunish*.

The next question we are interested in is whether children's cooperation confronted with institutions shows the same as the adults'? We consider comparing the settings of punishments with those in Vollan et al. (2017). Their study provides comparability as they employed exogenous and endogenous punishments using both undergraduates and worker samples in China. As Table 4 shows, they found that subjects' mean contribution rate under *EndoPunish* and *ExoPunish* is 50% and 60%, respectively, where full cooperators accounted for 28% and 48% respectively; and free-riders accounted for 25% and 26% respectively. Considering the average contribution rates of 72.6% and 81.7% under *EndoPunish* and *ExoPunish* in our sample, we could consequently preliminarily conclude that the cooperation level of adult subjects is significantly lower than that of children subjects. By further distinguishing contribution by undergraduates from workers, it is found that the results of children in our paper are similar to workers in Vollan et al.'s (2017) but quite different from undergraduates. For example, in the *EndoPunish* and *ExoPunish*, 12% and 9% of children in this paper choose to free-ride, which is close to 13% and 13% of workers and far away from 37% and 40% of undergraduates.

Table 4 Comparison results of children with adult subjects under *EndoPunish* and *ExoPunish*

Contribution rate/Proportion	Vollan et al. (2017)			This paper
	All sample	Undergraduates	Workers	
Contribution in *EndoPunish*	50%	37%	63%	73%
Contribution in *ExoPunish*	60%	45%	74%	82%
Free riders in *EndoPunish*	25%	37%	13%	12%
Free riders in *ExoPunish*	26%	40%	13%	9%
Full cooperators in *EndoPunish*	47%	40%	55%	61%
Full cooperators in *ExoPunish*	48%	38%	64%	69%
Supporters for *EndoPunish*	42%	52%	32%	36%

Note: As some proportions are not reported in Vollan et al. (2017), we ask for the data from the authors for calculation.

Furthermore, we specify the empirical model (ordinary least squares, OLS) to estimate the effects of all settings on children's cooperation.

$$Contri_i = \beta_1 EndoPunish_i + \beta_2 ExoReward_i + \beta_3 ExoPunish_i + \boldsymbol{\gamma}' \boldsymbol{X}_i + \varepsilon_i \quad (1)$$

where, $Contri_i$ is the contribution to the public account of subject *i*, $EndoPunish_i$, $ExoReward_i$, and $ExoReward_i$ denotes the endogenous punishment, exogenous reward, and exogenous punishment. $\beta_1 \sim \beta_3$ are the estimated coefficients of the effects of various institutions. $\boldsymbol{X}_i$ is a vector of control variables, including children's individual characteristics such as gender, grade dummy variable, whether they are an only child, currently boarding in school, whether they are left behind, and other regional characteristics such as school distance. ε_i is the disturbance term.

Table 5 presents the regression results, with column (1) merely incorporating the dummy variables of the settings without controlling other variables and column (2) adding the above control variables. *EndoReward* was considered as the reference group in both regressions. Results in columns (1) and (2) show that compared with *EndoReward*, *EndoPunish* has no significant difference in promoting children's cooperation level, while *ExoReward* and *ExoPunish* render a statistically increase of coefficients. Exogenous punishment has the strongest effect on children's cooperation among all four settings. These results are consistent with previous simple comparison results.

However, two concerns still exist about the validity of using all samples, including the 2nd-grade students (nearly 7-8 years old). The first came that due to the complexity of the experimental design, whether the lower grades can fully understand the game's rules although they have passed the control tests. The other is, although the one-shot design can well eliminate the influence of the learning effect, it may contain cooperation caused by confusion or mistakes. To this end, we excluded the second-grade samples in the regression. The results reported in column (3), Table 5 show that compared with *EndoReward*, other settings still have larger and economically significant coefficients. However, the difference between EndoPunish and *EndoReward* is not statistically significant (p=0.169), nether the difference between *ExoReward* and *EndoReward* (p=0.106).

Based on the above analysis, we conclude the following results:

Results 1: Exogenous system is better than the endogenous system in improving children's cooperation level, that is, there is no *endogenous premium* for children. There is no significant difference between reward and punishment in the endogenous system, while in the exogenous system, the effect of exogenous punishment is greater than exogenous reward. Therefore, *hypothesis 1* is basically verified.

Table 5 The influence of different mechanisms on children's cooperation level (OLS)

Variables	All sample (1)	(2)	Excluding 2nd grade samples (3)
EndoPunish	0.128	0.193	0.499
	(0.278)	(0.291)	(0.362)
ExoReward	0.642^{**}	0.650^{**}	0.603
	(0.277)	(0.288)	(0.373)
ExoPunish	1.046^{***}	1.137^{***}	1.334^{***}
	(0.259)	(0.281)	(0.365)
Controls	No	Yes	Yes
Observations	1602	1531	1102
Adjusted-R^2	0.012	0.017	0.012
F-value	7.528	3.265	2.075

Note: Robust standard errors are in the parentheses, $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$.

4.2 Reward or punishment, which is more popular?

Previous results show that the effect of punishment is stronger than that of reward, and it is more significant under exogenous systems. However, does it mean that children prefer punishment? We introduce voting in endogenous systems to measure children's preference for rewards and punishments. The results showed that about 87.74% of children voted for endogenous reward, but only 35.58% supported endogenous punishment.

Furthermore, we measured the level of children's cooperation when an endogenous institution was decided to be implemented and then not by group voting. The results in Table 6 show that the enactment of endogenous reward facilitates the overall level of children's cooperation to 7.13, but the cooperation drop to 3.77 when the reward is not implemented, with a decrease rate of 47.09%.

Regarding the punishment, the decision not to implement the endogenous punishment leads to a decrease rate of 37.47% of the overall cooperation level (from 7.26 to 4.54).

Finally, we investigate the difference in cooperation level between supporters and opponents. Table 6 shows that the average contribution of supporters is higher than that of opponents, irrespective of the implementation of the endogenous system. For example, when endogenous rewards are implemented, the average contribution of reward supporters is 7.45, while that of reward opponents is 4.8, and the difference between them is significant at 1%. Additionally, there is also a significant difference in cooperation level between the supporters of the reward system and the punishment system (7.45 and 7.69), but a significant difference between the opponents (4.8 and 7.02).

These results are similar to Kocher and Matzat (2016) and Sutter et al. (2010), who used adult subjects, but there were differences in the magnitude of the influence. For example, in the "stranger" treatment group of Kocher and Matzat (2016), the proportions of supporting reward and punishment were 55.54% and 21.53% respectively. As a consequence, children in China expressed higher support for incentive institutions than foreign college students. Vollan et al. (2017) reported the cooperation results of adults in China under endogenous and exogenous punishment. Nearly 52% of college students and 32% of workers supported punishment, respectively. Thus, support for punishment among children in this paper was close to that among workers but lower than among college students.

Second, we found significant differences in the contributions of institutional supporters and opponents, and these results were largely similar to Tyran and Feld (2006) and Dannenberg et al. (2019) with adult subjects. Tyran and Feld (2006) found that institutional supporters contributed more than opponents in all mechanisms (endogenous institutional enactment or non-enactment). Moreover, institutional supporters will reduce their contribution when endogenous institutions do not take effect. Dannenberg et al. (2019) devised a system option for expelling members and found that subjects who voted for the exclusion system contributed more than subjects who voted against the exclusion system, but only when the exclusion system was implemented.

Based on the above analysis, we obtain the following results in support of hypothesis 2:

Results2: Compared with punishment, the reward is more popular. The cooperation level of institution supporters is higher than that of policy opponents regardless of whether the institution is implemented.

Table 6 Differences in contributions of policy supporters and opponents

	Endogenous punishment				Endogenous reward			
	Overall	Supporters (87.74%)	Opponents (12.26%)	Mean diff.	Overall	Supporters (35.58%)	Opponents (64.42%)	Mean diff.
EndoReward_100	7.13	7.45	4.8	2.65***				
EndoReward_0	3.77	4.02	1.95	2.07***				
EndoPunish_100					7.26	7.69	7.02	0.67*
EndoPunish_0					4.54	5.14	4.22	0.92**

Note: A Wilcoxon-signed ranks test is used for the mean difference between supporters and opponents in the system's (no) enactment. *, ** and *** represent the significance levels of 10%, 5% and 1% respectively.

5. Discussion

5.1 How to reduce the cost of system enactment?

Predictions In uncertain conditions, complete free-riding by everyone is the unique Nash equilibrium in dominant strategies. Consider an individual i who maximizes its payoff under exogenous reward to see why. If an individual contributes all of the initial endowment, the return with reward is $\pi_{ir}(\mathrm{full}_{100}) = 7 + 0.5\mathrm{g}_{-i}$ when the reward is implemented, while is $\pi_{ir}(\mathrm{full}_0) = 5 + 0.5\mathrm{g}_{-i}$ when the reward is not implemented, where g_{-i} denotes the contributions of the other group members to the public good. As a consequence, individual's expected return is $E[\pi_{ir}(full)] = 1/2[\pi_{ir}(\mathrm{full}_{100}) + \pi_{ir}(\mathrm{full}_0)] = 6 + 0.5\mathrm{g}_{-i}$. If someone contributes 0 to the public account, $E[\pi_{ir}(zero)]) = 10 + 0.5\mathrm{g}_{-i}$. As $E[\pi_{ir}(full)] < E[\pi_{ir}(zero)]$, free-riding is a dominant strategy for rational self-interested individuals.

In the condition of uncertain exogenous punishment, the Nash equilibrium is almost the same. If an individual contributes all of the endowment, the earning is $\pi_{ip}(\mathrm{full}_{100}) = \pi_{ip}(\mathrm{full}_0) = 5 + 0.5\mathrm{g}_{-i}$ irrespective of the enactment probability of the punishment. Individual's expected return is $E[\pi_{ip}(full)] = 5 + 0.5\mathrm{g}_{-i}$. However, if someone contributes 0 to the public account, the return will be $\pi_{ip}(\mathrm{zero}_{100}) = 8 + 0.5\mathrm{g}_{-i}$ if the punishment is implemented and $\pi_{ip}(\mathrm{zero}_0) = 10 + 0.5\mathrm{g}_{-i}$ if not. Consequently, an individual's expected return is $E[\pi_{ip}(zero)] = 1/2[\pi_{ip}(\mathrm{zero}_{100}) + \pi_{ip}(\mathrm{zero}_0)] = 9 + 0.5\mathrm{g}_{-i}$. As $E[\pi_{ip}(full)] < E[\pi_{ip}(zero)]$, g_i =0 is the inefficient Nash equilibrium of the game.

Results Figure 3 compares children's cooperation level between certain (with a 100% probability of enactment) and uncertain (with a 50% probability of enactment) rewards and punishments. The results show that children's mean cooperation is 6.31 and 6.85 when exogenous reward and exogenous punishment are implemented with a 50% probability. These results suggest that even if there is a 50% chance of incentive mechanisms, children will also contribute more than half of their endowments. Nevertheless, the cooperation level is significantly lower than the average value of 7.77 and 8.17 under the certain reward and the punishment, respectively. At the same time, at the level of a 50% probability of enactment, the average value of children's cooperation under exogenous punishment is still significantly higher than that under exogenous reward. This result uncovers that the deterrent effect of punishment is higher than the attraction of reward. It is quite different from Walker (2004), who finds that neither rewards nor punishments can significantly improve subjects' contribution, nor can they find significant differences between participants' cooperation under uncertain and certain mechanisms.

Fig. 4 more intuitively compares the distribution of children's cooperation under certain and uncertain mechanisms. When the reward and punishment mechanism is certainly implemented, the proportions of children contributing 0, 2, 4, 6, 8 are all less than 10%, while more than 60% of children have contributed all their endowments. By contrast, when there is a 50% chance of the reward and punishment implementation, less than 40% of them contribute all their endowments.

Results 3: The uncertainty of the enactment of reward or punishment can also improve children's cooperation level, but the effect is not as good as when the reward and punishment mechanism is certainly implemented. Under the condition of uncertain enactment, punishment plays a more effective role than reward in promoting children's cooperation level.

To sum up, *Hypothesis 3* is verified.

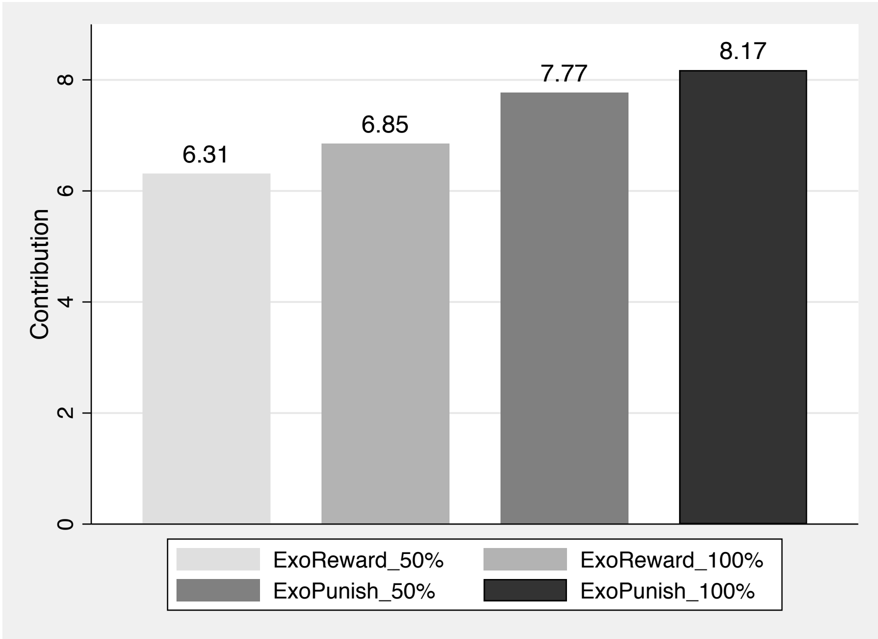

Fig. 3 Children's cooperation level under uncertain and certain exogenous mechanism

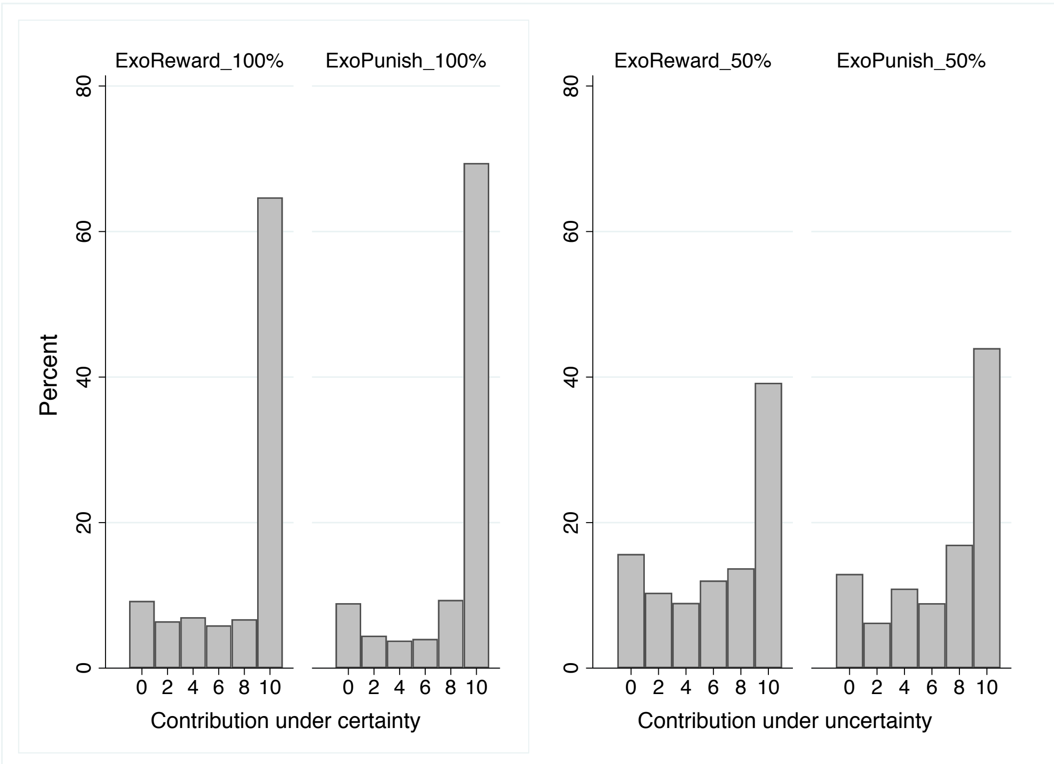

Fig. 4 Distribution of children's cooperation level under uncertain and certain exogenous mechanism

5.2 How does belief affect children's cooperation level?

In order to explore the influence of beliefs on children's cooperation level, we asked the subjects' beliefs about the contribution of the other two group members under the exogenous mechanisms. Figure 5 shows the distribution of children's beliefs.

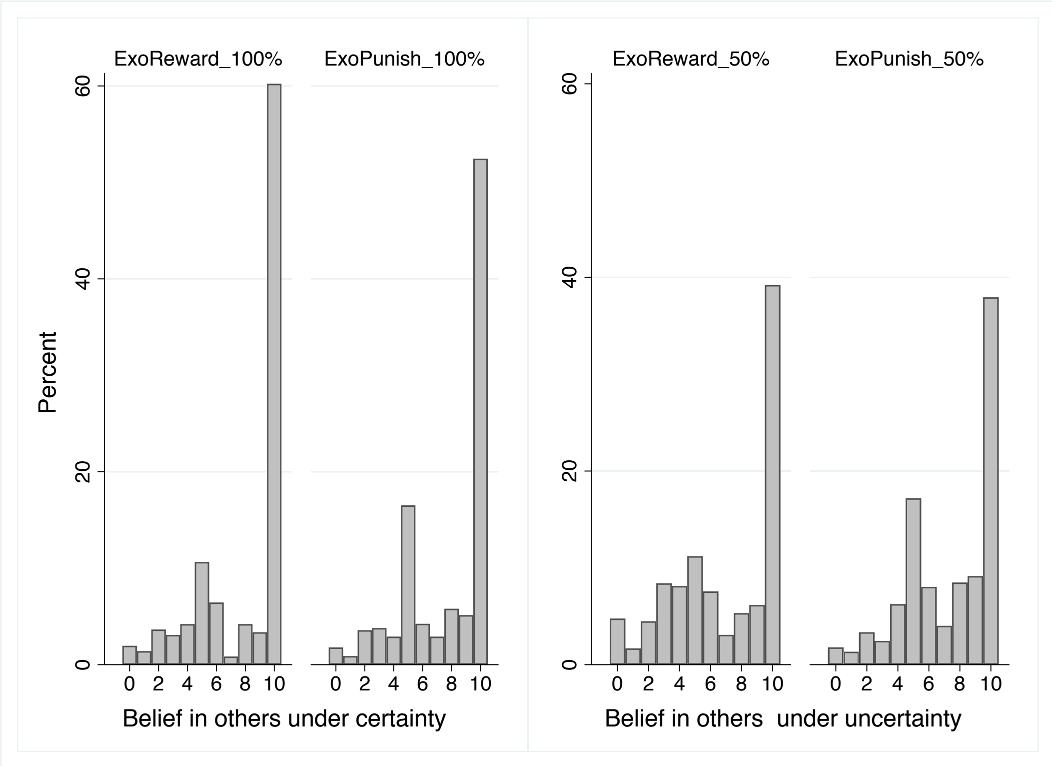

Fig. 5 Distribution of children's belief about the contribution of other group members

It can be seen from Figure 5 that under different probabilities of institutional implementation, the distributions of children's beliefs about the cooperation of the partners differ. When the exogenous rewards are implemented certainly, 60% of children believe that the other two group members contribute all their 10 tokens equally. However, less than 40% of children think that the other two group members will fully cooperate when the exogenous reward is implemented with a 50% probability. We also present the relationship between children's beliefs and contribution under exogenous punishment settings, which, by and large, confirm previous results in the exogenous reward.

We seem to find a synergy trend by comparing Figure 4 with Figure 5. For example, the proportion of contribution 0 and those who think others contribute 0 is very low, while the proportion of contribution ten and those who think others contribute 10 is large. So, is there a relationship between children's contribution levels and their beliefs? We take children's belief value $Belief_{ij}$ as the independent variable, subject *i*'s contribution level under each system $Contri_{ij}$ as the dependent variable, and use the ordinary least square model to estimate equation (2).

$$Contri_{ij} = \delta Belief_{ij} + \boldsymbol{\gamma}' \boldsymbol{X}_i + \varepsilon_{ij} \tag{2}$$

The results in Table 7 show that the belief about others' contribution significantly positively correlates with children's cooperation under exogenous mechanisms. Under *ExoReward_100%*, it is considered that the contribution level of the subjects will increase by 0.186 points for a one-point increase in the contribution of the other two group members. Under *ExoReward_50%*, it is considered that an increase of one point in the group's contribution, children's contribution level will increase by 0.241 points.

Why is the coefficient under uncertain environments larger than that of certain environments? A possible reason may be that in an uncertain environment, the participants' contribution level is more dependent on their expectations on their partners' contributions. The results of exogenous punishment show similarity. However, the coefficients are all smaller than those under the corresponding probability of exogenous rewards.

Table 7. The influence of belief about the other two members of the group on children's cooperation under exogenous systems

	Exogenous Reward		Exogenous Punishment	
	(1)	(2)	(3)	(4)
Variables	$Contri_{ExoReward\_100\%}$	$Contri_{ExoReward\_50\%}$	$Contri_{ExoPunish\_100\%}$	$Contri_{ExoPunish\_100\%}$
$Belief_{ExoReward\_100\%}$	0.183***			
	(0.034)			
$Belief_{ExoReward\_50\%}$		0.245***		
		(0.030)		
$Beliefe_{ExoPunish\_100\%}$			0.176***	
			(0.033)	
$Belief_{ExoPunish\_50\%}$				0.201***
				(0.031)
Observations	344	344	431	431
Adjusted R^2	0.126	0.217	0.079	0.089
F-value	5.830	12.901	4.651	6.655

Note: (1) Robust standard errors are in the parentheses, $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$; (2) Controls variables include gender, grade dummy variables, only child, whether they board in school at present, left-behind children and the distance between schools.

Notably, we are interested in, for pure freerides, do they also believe that other group members will contribute 0? Therefore, we present a bubble chart to show the relationship between children's cooperation and their beliefs under each mechanism.

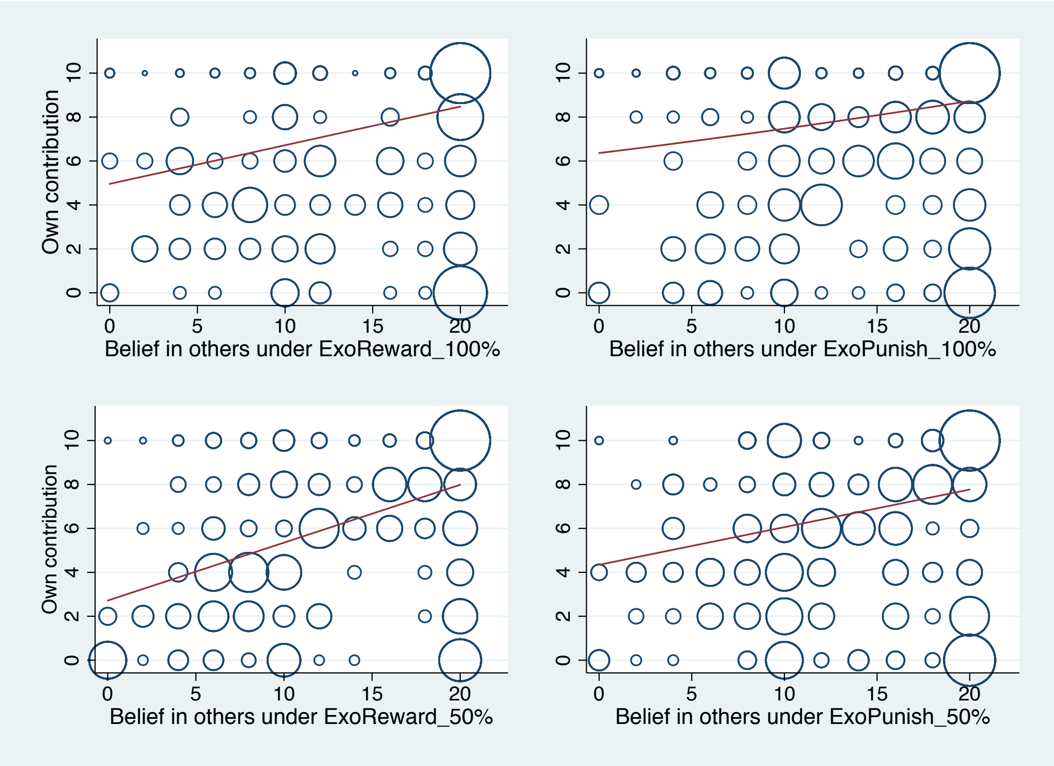

Fig. 6 Relationship between Children's Self-contribution and Belief in Others

Figure 6 demonstrates that children's belief in others is positively correlated with their own supply level, which is mutually supported by the regression results. When rewards and punishments are 100% implemented (two pictures in the first row), for median- and high-level cooperators, their beliefs are significantly positively correlated with their own contribution level, indicating that children show conditional cooperation. However, for free-riders, when the reward and punishment are implemented certainly, 58% and 45% of them respectively believe that the other two members would contribute all their endowments. These results suggest that free-riders who contribute 0 do not think others will contribute 0 when exogenous institutions are certainly implemented. On the contrary, they choose the dominant strategy of contributing 0 to get the maximum benefit based on their belief of others' high contribution.

When the mechanisms are implemented with a 50% probability, the two figures in the second row of Figure 6 show a similar trend but different magnitude compared with certain mechanisms. Under the *ExoReward_50%*, free riders' belief about the cooperation of others decreases compared with the *ExoReward_100%*. Besides, the bubble representing free ridders expecting others to contribute intermediate endowment becomes larger, and the bubble of believing others fully cooperating becomes smaller.

Based on the above analyses, we find that a certain percentage of children will not only consider the contribution level of others, but they can also make strategic choices to maximize their own interests according to this belief. We get the following conclusions in support of hypothesis 4:

Results 4: Children's belief about the contribution of other group members has a significant positive effect on their own cooperation level under exogenous mechanisms. In an uncertain environment, belief shows a greater effect than in an environment with certainty. Notably, this correlation is mainly reflected in the median- and high-level cooperators; however, a large proportion of free-riders take advantage of the effect of deterrence/attraction brought by the implementation of punishment/reward on the improvement of team cooperation and thus choose the dominant strategy zero contribution.

6. Conclusion

Based on a large-scale field experiment involving more than 1600 primary and secondary school students aged 7-17, we compare the differential effects of endogenous and exogenous mechanisms on children's cooperation levels. On the one hand, we find that many of children's behaviors are consistent with those of adult subjects, which provides experimental evidence to understand adult behavior and for testing the applicability of theoretical models such as social preference. First, children contribute in all incentive institutions, even though the dominant strategy across all regimes remains to be free-riding. This suggests both the validity of the regime and the prevalence of altruistic preferences among children as well, which is one of the key theories explaining the cooperative behavior of adults (Andreoni, 1995). Second, like adults, children also support reward and punishment systems. Moreover, there is a significant positive relationship between children's own cooperation level and their belief about the cooperation level of other group members. These results suggest that children also expect to achieve relatively fair and high-level group cooperation through external institutions, which provides supporting evidence for the applicability of reciprocity theory in children (Rabin, 1993). Finally, this paper also found that a certain proportion of children still choose to freeride despite implementing incentive mechanisms. This implies that individuals can use institutional rules to make strategic choices early as childhood.

On the other hand, we also found differences between children and adults in their reactions to the institutions. One of the main findings was no *endogenous premium* among children. By comparing our findings with those of Vollan et al. (2017), it can be concluded that children's behavior is more similar to that of workers, but differs from that of undergraduates. The possible reason is that undergraduates have WEIRD (Western, Educated, Industrialized, Rich, and Democratic) traits; that is, they are more likely to have democratic ideas due to being well educated (Henrich, 2010). Children are similar to workers in that they are often influenced by authoritarian norms from adults/leaders, parents and teachers. China’s primary and secondary school education has strict regulations, and students tend to follow the rules in the compulsory education stage. Consequently, the rules uniformly implemented by a third party are more binding than the social norms formed by group voting. In addition, these rules and regulations focus more on punishment. For example, individuals who do not comply with the norms will be criticized by the teacher in their name. Children’s aversion to losing their reputation in the class may be more effective than rewarding for excellent performance. Therefore, children’s cooperation level is higher than exogenous reward under exogenous punishment. However, when reward and punishment are decided by endogenous voting, the superiority of punishment over reward is reduced, especially in an anonymous environment with no reputation information.

This paper provides some policy implications. First, formal institutions with punishment such as school regulations and class rules, and positive money incentives can effectively facilitate children’s cooperation level. Besides, we provide experimental evidence for policymakers to save supervision and implementation costs since we found that uncertain institutions with a probability of implementation can also promote a majority of children’s cooperation. Finally, specific incentive institutions should vary for different populations. In particular, for children who are able to engage in free-riding behavior by utilizing the change brought by institutions of others’ contribution, the incentive effect of punishment or reward is limited. At this time, other informal institutions, such as moral education (Fan, 2000), social identification (Rege and Telle, 2004) and other non-material incentives, should also be taken into consideration.

This paper preliminarily investigates the effects of rewards and punishments on children’s cooperation in four public goods games, and lots of work remain to be done in the future. First of all, this paper takes a total contribution as the threshold for punishment or reward, which provides a fixed institutional environment for children to understand and make choices. Still, it is hard to quantitatively analyze the degree of children’s preference for punishment or reward. For example, children may choose not to support the endogenous punishment because the threshold value of contribution 10 is higher than their actual expectations. Therefore, peer punishment allowing children to choose not only whether to implement the institutions but also the implementation intensity could be introduced in the subsequent studies. Secondly, we only compared the 50% probability and 100% probability of institutional implementation, while future research can explore the various effects of different probabilities. Alternatively, the setting could be extended to the repeated games to study the learning effect of children in the face of uncertain punishment/ reward, and examine the influence of beliefs toward others on children's cooperation level in different rounds. Finally, since the sample students in rural China may be different from that of urban in responding to the institutions, future studies can also launch experiments with urban students to make a comparison.

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Appendix 1. Experimental Manual of Endogenous Reward

Game1 Magic with addition rule and voting rule!

Ok, in this game, you will get 10 tokens at the beginning. Then, *you need to decide how many tokens you want to hand in to a magician*. The magician will increase the number of tokens you give him, and distribute those evenly to you and your partners. **The magic rules are as follows:**

If no one hand in tokens to the magician, then everybody's final token amount will not change.

If you hand in 2 tokens to the magician, then the magician will change 2 tokens into 3, and give everybody 1 token back.

If you hand in 4 tokens to the magician, then the magician will change 4 tokens into 6, and give everybody 2 tokens back.

And so on.

In the same way, if other students in your group decide to hand in tokens to the magician, you will get extra tokens as well.

Voting rule: Now your group need to vote to decide whether to adopt the addition rule in this game. The addition rule will be applied if a majority of voters (2 or 3 voters) approves of it. The addition rule will not be applied if a minority (0 or 1 voter) approves.

The addition rule: *If anyone gives the magician 10 tokens, then at the end of this game, the magician will give extra 2 tokens to him/her.*

Please tick √ in the□ which you think is correct:

(1) If more than 2 members vote to support the addition rule and you give the magician 8 tokens, how many extra tokens will the magician give to you?

□ 0 　 □ 2 　 □ 4 　 □ 6 　 □8 　 □10

Please fill in the blanks:

(2) If all of you give ten dollars and your group votes not to use the addition rule, each of you will receive ______ tokens eventually. If your group decides to use the addition rule, each of you will receive______ tokens.

(3) If you do not give any token, the other two students each give ten and your group decides to use the addition rule. The other two students will each receive ______ tokens, you will receive______ tokens eventually.

Please decide:

1.Do you agree to use the addition rule? Please tick √ in your choice in □.

☐Agree 　 ☐Disagree

2. If your group decides to use the addition rule, how many tokens will you give to the magician?

☐0 　 ☐2 　 ☐4 　 ☐6 　 ☐8 　 ☐10

3. If your group decides not to use the addition rule, how many tokens will you give to the magician?

☐0 　 ☐2 　 ☐4 　 ☐6 　 ☐8 　 ☐10

Appendix 2. Experimental Manual of Exogenous Reward

Game 2 Magic with an addition rule!

Ok, in the next game, you will also get 10 tokens at the beginning of the game. Then, *you need to decide how many tokens you want to hand in to a magician*. The magician will increase the number of tokens you give him, and distribute those evenly to you and your partners.

The magic rules are as follows:

If no one hand in tokens to the magician, then everybody's final token amount will not change.

If you hand in 2 tokens to the magician, then the magician will change 2 tokens into 3, and give everybody 1 token back, including you.

If you hand in 4 tokens to the magician, then the magician will change 4 tokens into 6, and give everybody 2 tokens back, including you.

And so on.

In the same way, if other students in your group decide to hand in tokens to the magician, you will get extra tokens as well.

Addition rule: *If anyone gives the magician ten tokens, then at the end of this game, the magician may give extra two tokens to him/her.*

(1) The addition rule will work when you give how many tokens? (Please tick √ in the □ which you think is correct)

☐0 ☐2 ☐4 ☐6 ☐8 ☐10

Please fill in the blanks:

(2) If you give ten tokens and the other two members give 0, and there is the rule of addition, then you will end up with ____ tokens, and each of the other members will receive ____ tokens finally.

(3) If you do not give any token and each of the other two members give 10, and there is the addition rule, then you will end up with ____ tokens, and each of the other members will receive ____ tokens finally.

(4) If all of you give ten dollars, each of you will receive ____ tokens with the addition rule.

Please decide:

1. Assuming that the addition rule is bound to take effect, how many tokens will you give to the magician?

☐ 0 ☐ 2 ☐ 4 ☐ 6 ☐ 8 ☐ 10

In this case, how many tokens do you think the other two students in your group will give?

☐ 0 ☐ 2 ☐ 4 ☐ 6 ☐ 8 ☐ 10 ☐ 12

☐ 14 ☐ 16 ☐ 18 ☐ 20

How many tokens do you think the three students of another group will give?

☐ 0 ☐ 2 ☐ 4 ☐ 6 ☐ 8 ☐ 10 ☐ 12 ☐ 14

☐ 16 ☐ 18 ☐ 20 ☐ 22 ☐ 24 ☐ 26 ☐ 28 ☐ 30

2. Assuming that the addition rule has a half-chance to take effect, how many tokens will you give to the magician?

☐ 0 ☐ 2 ☐ 4 ☐ 6 ☐ 8 ☐ 10

In this case, how many tokens do you think the other two students in your group will give?

☐ 0 ☐ 2 ☐ 4 ☐ 6 ☐ 8 ☐ 10 ☐ 12

☐ 14 ☐ 16 ☐ 18 ☐ 20

How many tokens do you think the three students of another group will give?

☐ 0 ☐ 2 ☐ 4 ☐ 6 ☐ 8 ☐ 10 ☐ 12 ☐ 14