Reward, Punishment and Children's Cooperation Preference

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1. Motivation

Cooperation

- A central problem for biology and social science (Darwin, 1871; Fehr & Fischbacher, 2004; Imhof et al., 2005; Williams, 1966)
- Prisoner’s Dilemma or Public Goods Games
- People cooperate much more than predicted by classic economic theory, but their contributions decline with repetition (Ledyard, 1995)
- Conditional Cooperation, Free rider (Fischbacher et al., 2001)

Q: How to restrain free-riding behavior through some institution?

- Punishment and reward (Balliet et al., 2011; Chaudhuri, 2011)

Punishment

- Ostrom (1992) “Covenants with and without a Sword: Self-Governance is Possible” pioneering work
- Fehr and Gachter (2000): “without punishment-with punishment (costly)” and “partner-stranger”, 2*2 PGG

Reward

- Vyrastekova and van Soest (2007): Pure transfer vs. “net positive” rewards, Common Pool Resource (CPR) game
- Yang et al. (2018a): Endogenous reward that taxes the gross income

Both reward and punishment have positive effects on cooperation (Balliet et al., 2011).

Q: Which has the better effect? – Depends on specific experimental design

- The combination of reward and punishment works best (Andreoni et al., 2003; Sefton et al., 2007)
- Changed group member: Punishment is more effective than reward (Choi and Ahn, 2013)
- Fixed group member: Punishment is more effective than reward (Balliet et al., 2011); There is little difference between punishment and reward (Choi and Ahn, 2013)

Exogenous institution vs. Endogenous institution

- Difference: whether there is a voting system
- **Endogenous premium** (Dal Bó et al., 2010)
- Population heterogeneity: endogenous premium exists in undergraduates but not in workers（Vollan et al., 2017）
- **Q: Is there an endogenous premium in children?**

Punishments/Rewards with Uncertainty

- Walker (2004) : reward/punishment are implemented with 50% probability in PPG
- Dai et al. (2015) : investigate the impact of various audit schemes on PPG
- Yang et al. (2018b) : introduce lottery mechanism in PPG for the first time
- Jiao et al. (2020) : introduce the probabilistic reward and punishment mechanism in PPG

Reward, punishment and children's cooperation

Children's cooperation preference

- Harbaugh and Krause (2000) : An early experiment using PPG to study children's cooperation.
  - Like adults, children contribute a certain amount to PPG, and older children are more generous in the first round.
- **Other factors** that influence cooperation in children
  - Moral education (Fan, 2000), group size (Alencar et al., 2008), level of parental cooperation (Cipriani et al., 2013), gender (Cardenas et al., 2014) and group differences (Angerer et al., 2016).
- Sutter et al. (2019) : Literature review
  - "Economic behavior of children and adolescents – A first survey of experimental economics results"

Only a few studies introduce reward or punishment mechanisms to children's cooperation experiment

- Lergetporer et al. (2014)： Prisoner's Dilemma, third-party punishment
- Gummerum and Chu (2014)： Ultimatum Game, second- or third-party punishment
- Bernhard et al. (2020)： Ultimatum Game, second- or third-party punishment
- Lee and Warneken (2020)： Ultimatum Game, third-party punishment or help

Why should we study children's preference?

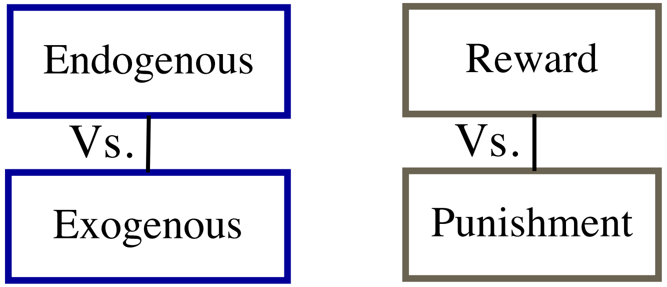
List et al. (2021)

- Understand children themselves for immediate purposes
  - ➢ Understand models of human capital formation and early childhood education
  - ➢ Understand how best to invest in child development and skill formation
- Provide a unique glimpse into understanding adults

Further work should explore specific cultural beliefs and institutions that influence cooperative behavior and how their acquisition and application shapes children's behavior across development.

—— House et al. (2013)

Previous literature


Endogenous

Vs.

Exogenous

Reward

Vs.

Punishment

Undergraduates with lab experiment

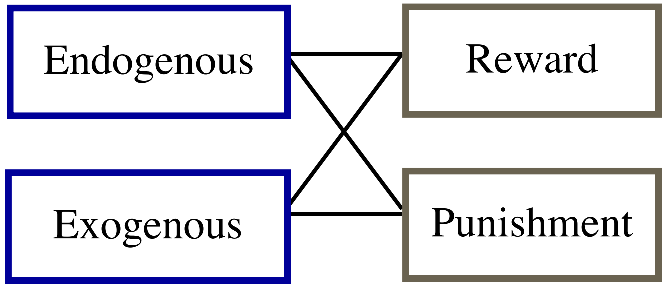
Ultimatum game or prisoner’s dilemma game

Without uncertainty, 100%

Descriptive analysis

Small-scale sample, <200

Our contribution


Endogenous

Exogenous

Reward

Punishment

2*2 framework

Students in middle and primary school with field experiment

Public goods games

With uncertainty, 50%

Beliefs and mechanism analysis

Large-scale sample, >1600

Research question

(1) What’s the effects? Is there an endogenous premium in children?

(2) What’s the institutional preference of children?

(3) How to save cost?

(4) Why do they change their cooperation?

Research hypothesis

H1. The effect of exogenous institution is greater than that of endogenous institution, and there is no endogenous premium in children.

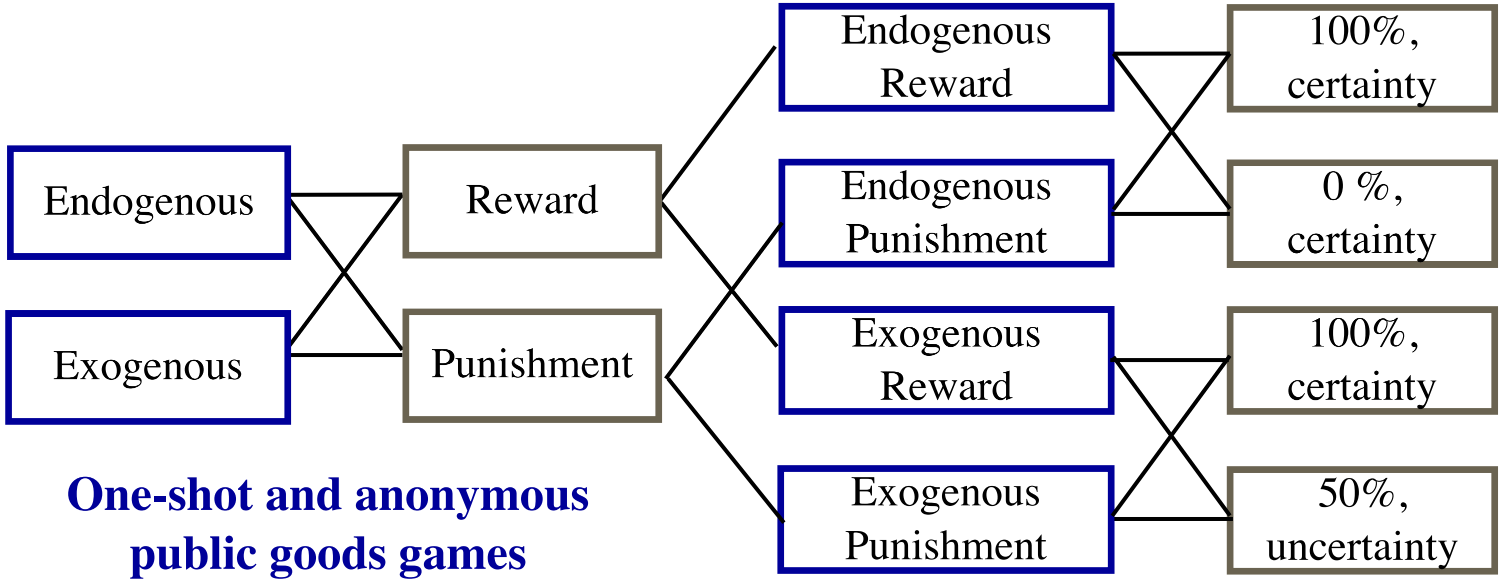
H2. Rewards are more popular.

H3. The probability implementation of reward or punishment can also improve the level of cooperation, and the greater the probability, the better the effect.

H4. There was a significant positive correlation between beliefs in others and the level of public goods supply.

2. Experimental Design

2.1 Experimental Design



Endogenous

Exogenous

Reward

Punishment

Endogenous Reward

Endogenous Punishment

Exogenous Reward

Exogenous Punishment

100%, certainty

0 %, certainty

100%, certainty

50%, uncertainty

One-shot and anonymous public goods games

VCM

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

Reward

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

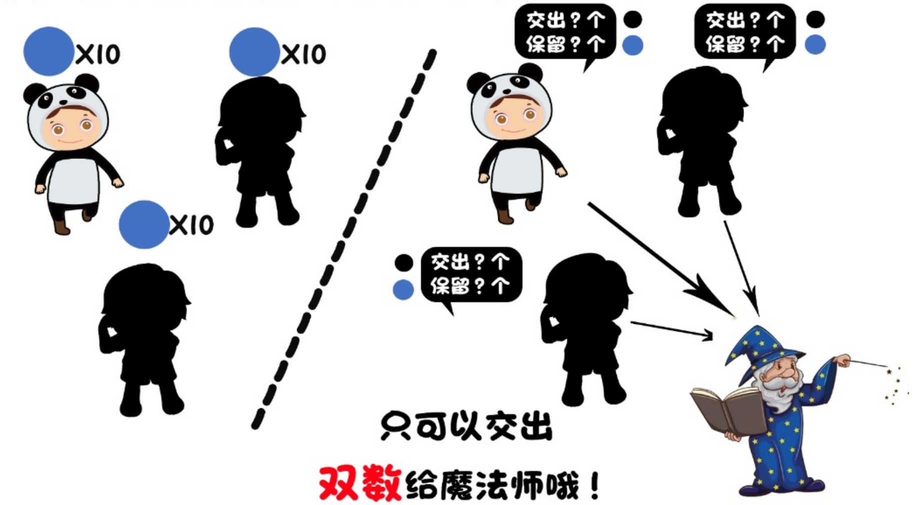
Punishment

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

游戏2：魔法变变变-加法规则

在这个游戏中：● =

【1】开始时每个人都收到10个游戏币 【2】可以把一些游戏币交给魔法师


×10
×10
×10
交出？个 ●
保留？个 ●
交出？个 ●
保留？个 ●
● 交出？个
● 保留？个

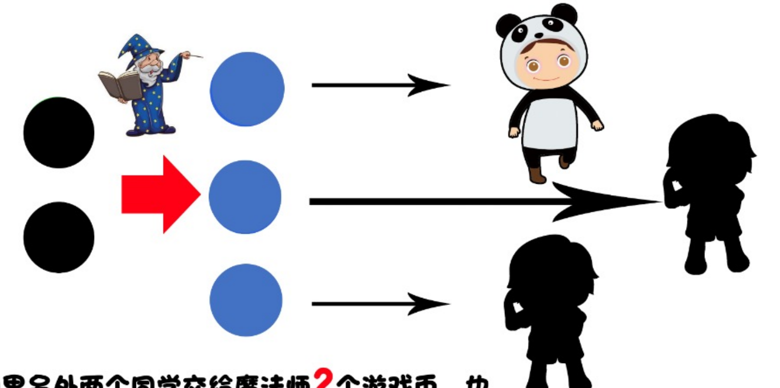
只可以交出

双数给魔法师哦！

游戏2：魔法变变变-加法规则

在这个游戏中：● =

【3】魔法师会把每**2**个存进去的游戏币变成**3**个，然后平分给大家



如果另外两个同学交给魔法师**2**个游戏币，也会变成**3**个，然后分给你**1**个。

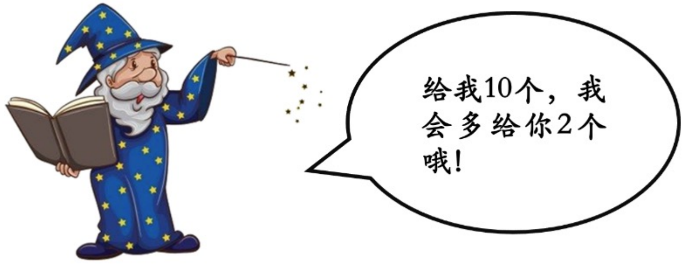
游戏2：魔法变变变-加法规则

在这个游戏中：● =

注意！

加法规则：

如果任何一个人交给魔法师的币为**10个**，那么到游戏最后，魔法师会**多给**这个人**2个**游戏币！


给我10个，我会多给你2个哦！

游戏 3：魔法变变变与投票、加法规则

在这个游戏中：● =

注意！

投票规则：

你和另两个同学**投票**决定是否使用加法规则。

2人同意 或者 **3**人同意 = **使用**

0人同意 或者 **1**人同意 =**不使用**

Table1 Group division

Group	Group1	Group2	Group3	Group4	Total
Institution	EndoReward	EndoPunish	ExoReward	ExoPunish	1602
Rules	Addition Rule Voting Rule	Deduction Rule Voting Rule	Addition Rule	Deduction Rule	
Observation	367	430	357	448	

One example: Endogenous Reward

Voting rule: Now you and your team members 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.

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

What they need to answer:

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

   ☐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

Another example: Exogenous Reward

What they need to answer:

Certainty

1.1 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

1.2 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

1.3 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

Uncertainty

2.1 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

2.2 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

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

☐ 0 ☐ 2 ☐ 4 ☐ 6 ☐ 8 ☐ 10 ☐ 12 ☐ 14

2.2 Experimental Process

- **Time & Place**
  - April and May 2019
  - Santai, Beichuan, Dujiangyan in Sichuan Province
- **Sampling method**
  - Schools were selected according to the distance to the county
  - Grade 2, 4, 6 and 9 in 11 schools
  - One class is selected from each of the four grades
  - 1602 students in primary and middle school, 38 classes
- **Student Questionnaire**
  - After the experiment
  - Demographic characteristics of the child
- **Payment**
  - Tokens exchanged to the subjects
  - The average returns of experimental group 1 to group 4 are 15.10, 16.55, 14.77 and 13.14 tokens, respectively
- **Parent Questionnaire:**
  - Family meeting
  - Basic family information including financial status, the education level of parents and the situation of migrant workers, children’s nursing information, etc

Table 2 Conversion ratio

Token	Candy	Pen	Notebook	Exchange
Grade 2	3:2	4:1	6:1	1:0.2
Grade4	3:2	4:1	6:1	1:0.2
Grade 6	1:1	3:1	4:1	1:0.3
Grade 9	3:4	2:1	3:1	1:0.4

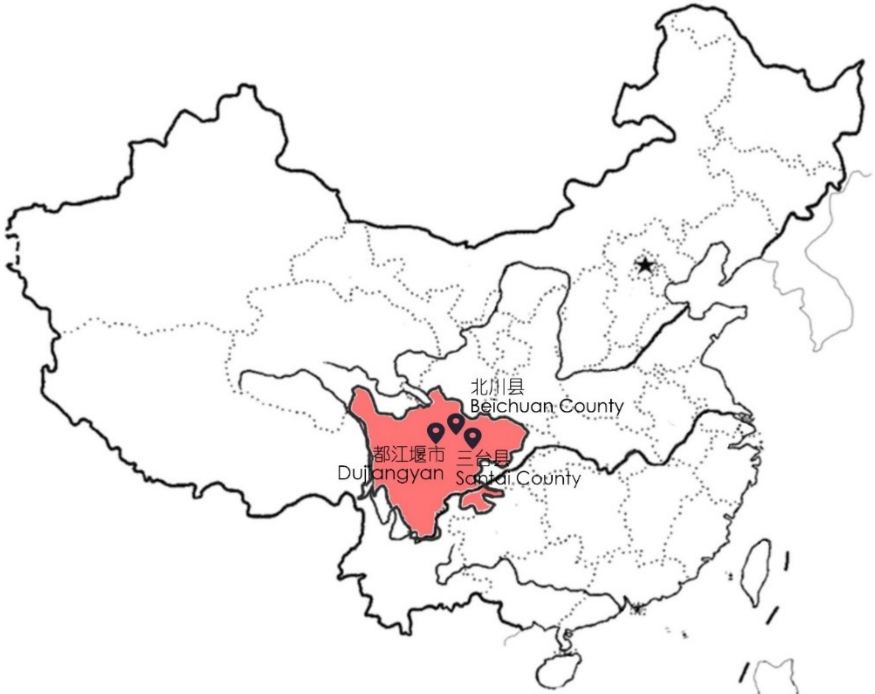
Year: 2018, 2019 (partial Panel data)

1632 students & 1632 caregivers

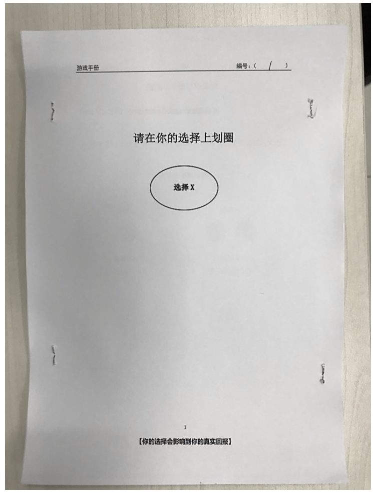
4 grades
38 classes
11 schools
3 counties

Santai County
Beichuan County
Dujiangyan

Sichuan Province


北川县
Beichuan County
都江堰市
Dujiangyan
三台县
Santai County

# Paper and pen experiment
# A stapled booklet.



游戏手册　　编号：（　/　）

请在你的选择上划圈

选择 X

1

【你的选择会影响到你的真实回报】

3. Results

3.1 Comparison of the effects of the mechanisms

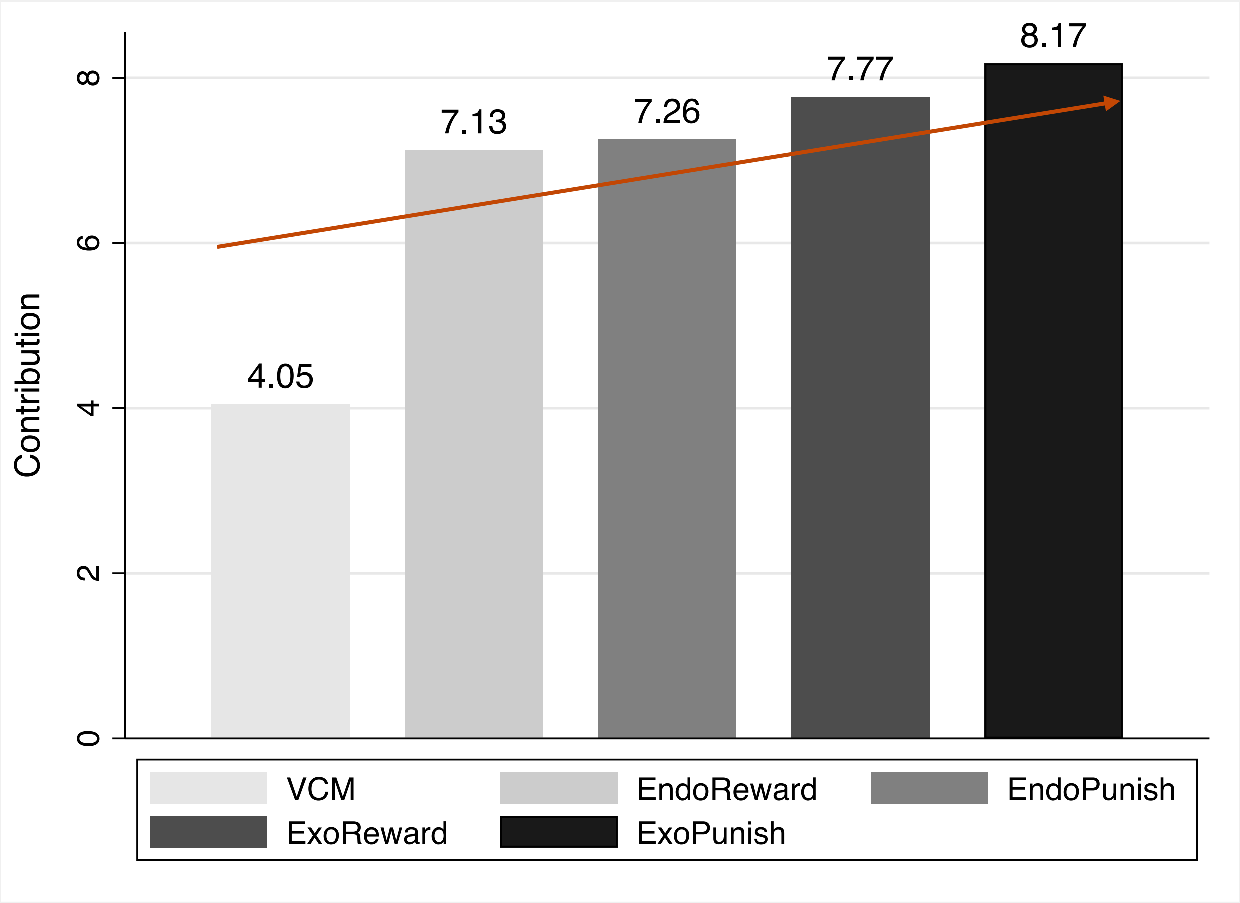


Fig. 1 Mean contribution under different mechanisms

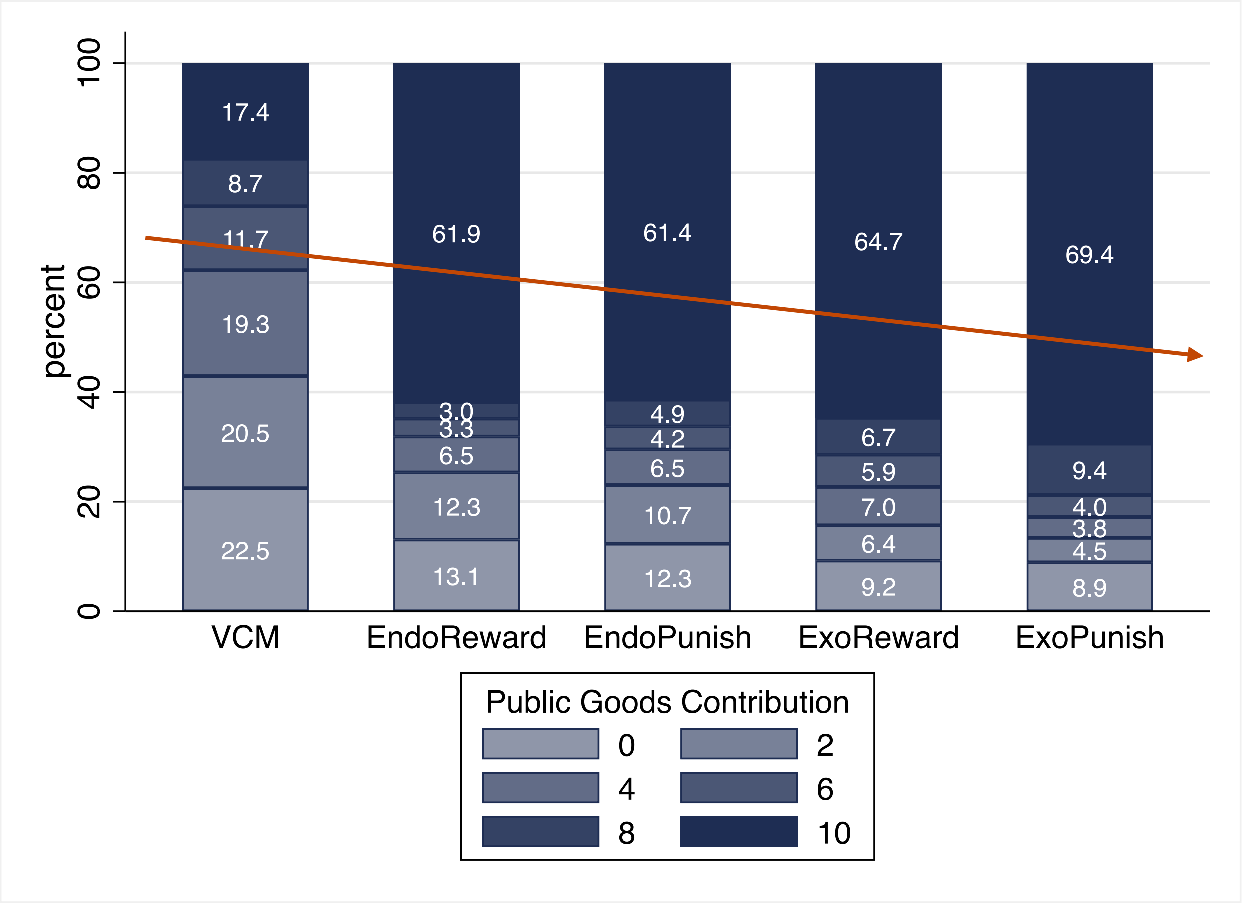


Fig. 2 Distribution of contribution under various mechanisms

Exogenous punishment (8.17) > exogenous reward (7.77) > endogenous punishment (7.26) > endogenous reward (7.13)

Comparation with adults

	This paper	**Vollan et. al (2017)**		
		Full sample	Undergraduates	workers
VCM contribution	43%	47%	29%	64%
EndoPunish contribution	73%	50%	37%	63%
EndoPunish contribution	82%	60%	45%	74%
Vote for punishment	36%	42%	52%	32%
VCM free-riders	23%	22%	25%	6%
EndoPunish free-riders	12%	25%	37%	13%
ExoPunish free-riders	9%	26%	40%	13%
VCM full-contributor	17%	21%	7%	27%
EndoPunish full-contributor	61%	47%	40%	55%
ExoPunish full-contributor	69%	48%	38%	64%

Regression

$$Contri_i = \boldsymbol{\beta Treat_i} + \boldsymbol{\gamma X}_i + \varepsilon_i$$

$$Contri_i = \boldsymbol{\beta Treat_i} + \delta_1 VCM_i + \boldsymbol{\gamma X}_i + \varepsilon_i$$

Table 4 Influence of different mechanisms on children's cooperation level (OLS)

	Full sample		**Excluding Grade 2**
	(1)	(2)	(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
Observation	1602	1531	1102
Adjusted-R^2	0.012	0.017	0.012
F-value	7.528	3.265	2.075

Note :(1) In parentheses are robust standard errors, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; (2) Regression controls variables such as gender, dummy variable of grade, only child, currently living in school, left-behind child and distance of school, etc. (3) The reference group was endogenous reward.

- **Results 1**: The effects of exogenous institutions on the improvement of children's cooperation level are better than that of endogenous institutions, that is, children do not have endogenous premium. In exogenous mechanisms, the effect of punishment is greater than that of reward, while in endogenous mechanisms, the effect of reward and punishment is not significantly different.

3.2 Which institution is more popular, reward or punishment?

Table 5. Contribution difference between supporters and opponents

	EndoReward（87.74% supporters）					EndoPunish（35.58% suppoters）				
	Total	supporters		opponents	Mean diff	Total	supporters		opponents	Mean diff
VCM	3.78	4.02		2.09	1.93***	4.78	5.99		4.11	1.88***
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: T-test is used for the mean difference between supporters and opponents under various institutions. *, ** and *** represent the significance level of 10%, 5% and 1%, respectively.

Table 6 Cooperation of supporters

Variable	EndoReward		EndoPunish	
	(1)	(2)	(3)	(4)
	With reward	Without reward	With punishment	Without punishment
Vote for reward	2.761^{***}	1.525^{***}		
	(0.700)	(0.438)		
Vote for punishment			0.811^{**}	0.674
			(0.403)	(0.416)
Observations	348	348	408	408
Adjusted-R^2	0.086	0.131	0.045	0.027
F-value	3.811	7.186	3.546	2.324

Note :(1) In parentheses are robust standard errors, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; (2) Regression controls variables such as gender, dummy variable of grade, only child, current residence, distance of school, and fixed effect of county.

Result 2: Rewards are more popular than punishments; People with high levels of cooperation are more likely to be supporters of institutions. No matter whether a certain reward or punishment measure is implemented, the cooperation level of the supporters is higher than that of the opponents, and the difference is more significant in the reward situation.

4. Discussion

4.1 How to reduce the cost of institution implementation?

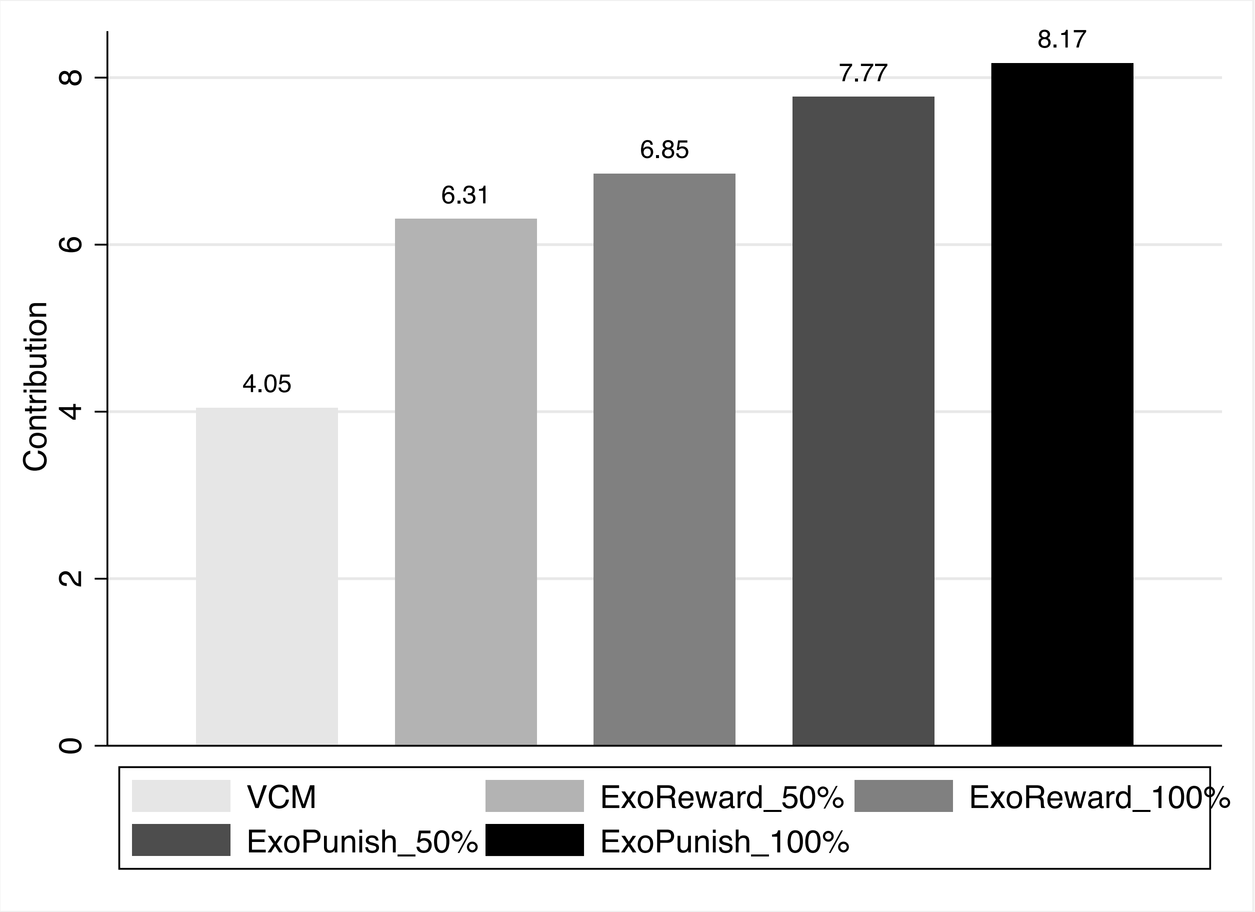


Fig. 3 Children’s cooperation with and without uncertainty

Result 3

- The uncertainty of the implementation probability of reward or punishment could also improve children's cooperation level, but the effect was not as good as that of the inevitable implementation of reward and punishment mechanism.

- Under the condition of 50% probability, punishment also improved children’s cooperation level more than reward.

4.2 Belief and children’s cooperation

High level of VCM cooperation
↓
Being supporters of the reward/punishment
↓
More contributions than opponents
↓
Higher belief in the other members of the group

Table 7 The influence of beliefs of others’ contribution on children’s cooperation

	Exogenous Reward		Exogenous Punishment	
	(1)	(2)	(3)	(4)
	Contribution 100%	Contribution 50%	Contribution 100%	Contribution 50%
ExoReward 100%_belief	0.183***			
	(0.034)			
ExoReward 50%_belief		0.245***		
		(0.030)		
ExoPunish 100%_belief			0.176***	
			(0.033)	
ExoPunish 100%_belief				0.201***
				(0.031)
Obseravtion	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) In parentheses are robust standard errors, * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$; (2) Regression controls variables such as gender, dummy variable of grade, only child, current residence, distance of school, and fixed effect of county.

One question: For free-riders, do they also expect the rest of the group to contribute 0?

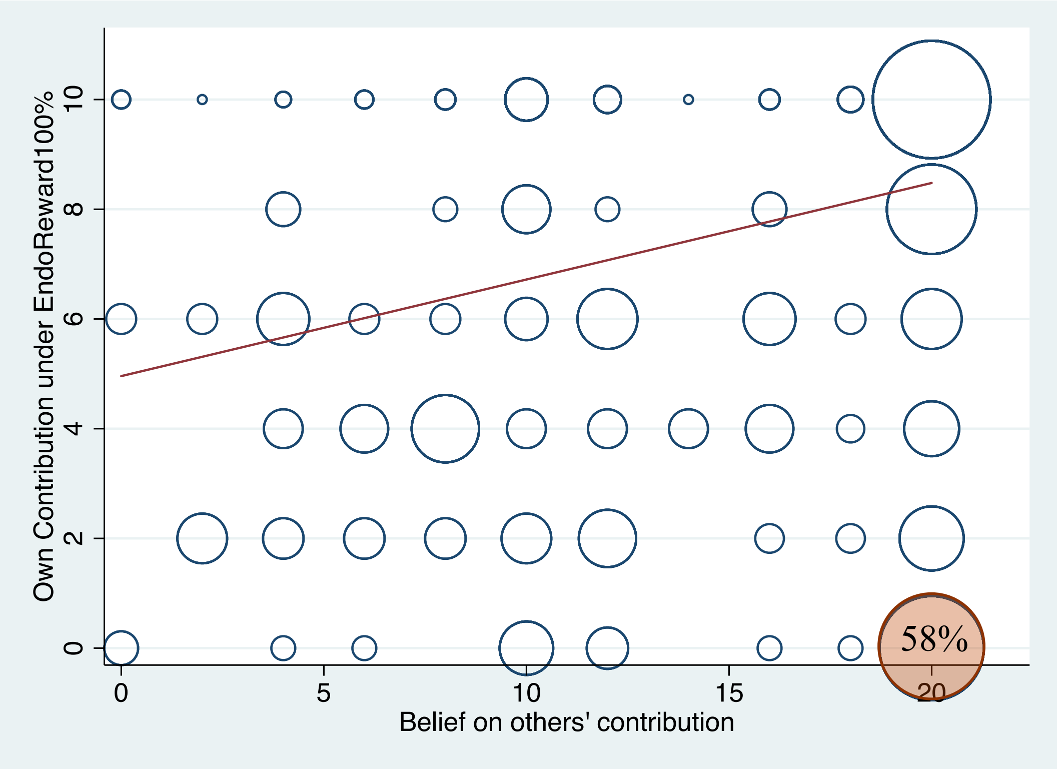


Fig.7 Belief and contribution in ExoReward_100%

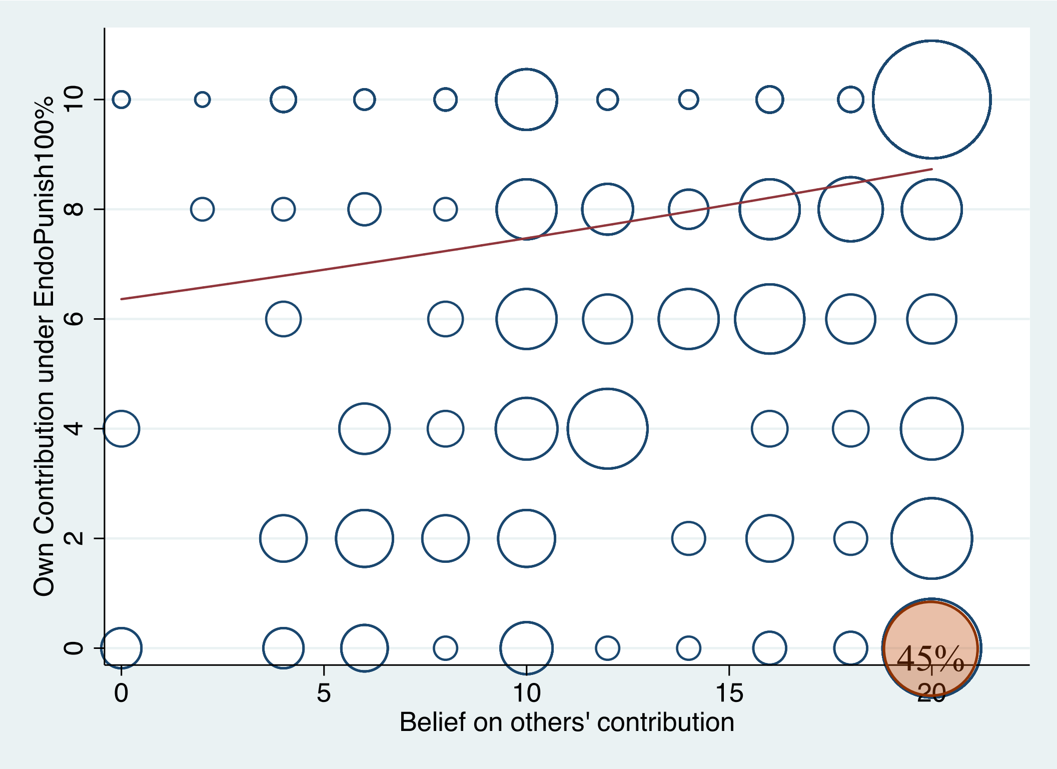
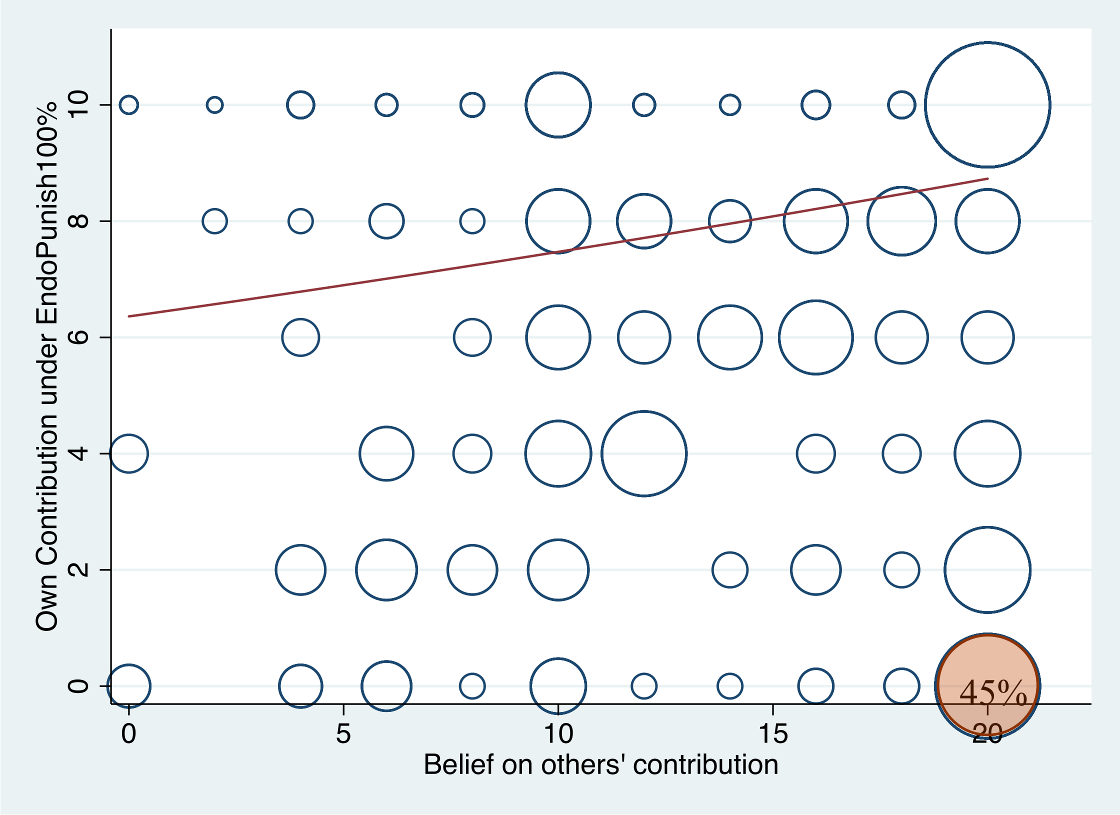
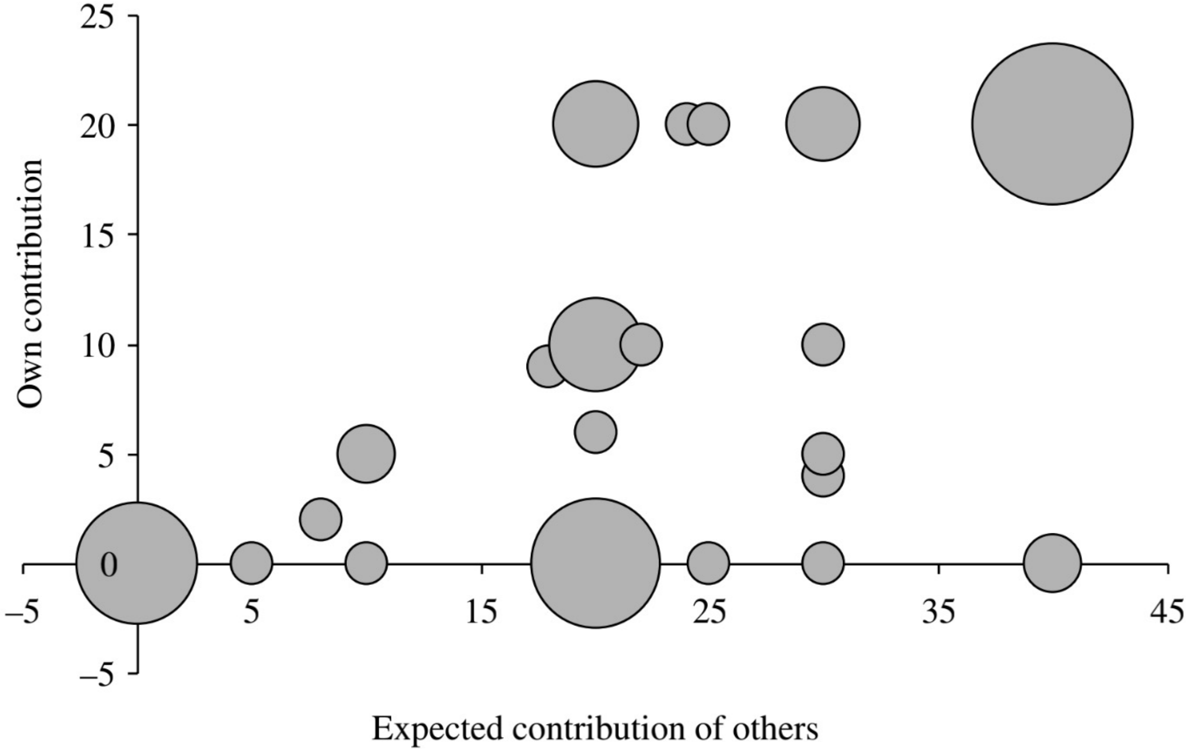


Fig.8 Belief and contribution in ExoPunish_100%

Children are already able to take strategic actions that fit the predictions of neoclassical economics!



ExoReward



Tyran and Feld (2006)

Children seem to be more strategic than adult!

5. Conclusion

(1) All the mechanisms could significantly promote children's cooperation level, but the effects are different. Exogenous mechanisms are more effective than endogenous mechanisms, and punishment is more effective than reward.

(2) Reward is more popular. More cooperative individuals are more likely to be supporters of incentive policies.

(3) Mechanisms with 50% probability of enactment could also improve children’s cooperation significantly, but the effects are inferior to certain ones.

(4) We found a significant positive correlation between students’ supply level and their belief in the contribution of other members. Free-riders made the dominant strategy choice precisely by taking advantage of the deterrence/attraction of punishment/reward on team cooperation improvement.

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THANKS!

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