Can cooperation be trained?

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Australian Conference of Economists
Melbourne
15-16 July 2019

Motivation: rodent control

- Part of a larger project on strategies to promote food security in northern Laos
- In Asia, rodents consume 54 million tonnes of cereals (mostly rice) per year ... enough to eliminate malnourishment for 217 million people: in 2009, for example, 85,000 people in Luang Prabang had to receive food assistance due to a rodent outbreak
- Lots of work on how to reduce these losses: IRRI, CSIRO, ACIAR
- Ecologically Based Rodent Management: combine knowledge about biology, behavior and habitat of this pest, with a comprehensive set of techniques (storage, village cleanliness and rodent culling
- Rapid rates of reproduction are the main challenge: females have up to 6 litters per year, of 5-10 rats, that become sexually active at 3 weeks
- $\Rightarrow$ coordinated action by farmers is key (Singleton et al., 2010; John, 2014)
- $\Rightarrow$ coordination problems are more general than pest management

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Games as pedagogical device: in the classroom

- Bergstom & Miller (2000), *Experiments with Economic Principles*
- Frank (1997): students who play a CPR game understand better the tragedy of the commons
- Cartwright and Stepanova (2012): better learning if game complemented with other strategies – write a report
- Kaplan and Balkenborg (2010) for a review of this approach

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Games as pedagogical device: in the field

- Cardenas and Carpenter (2005): three villages in Colombia, two rounds of the same game: participants cooperate more in second round, and the authors suggest that this reflects learning about the benefits of cooperation but present no evidence of changes in behavior in real life
- Rommel et al (2015): two person PD, how being paired with different types influences giving behavior in a framed DG (give to an environmental conservation charity)
- Meinzen-Dick and co-authors (2016, 2018): economic games are used to teach the nature of externalities in the context of increased use of groundwater in South India; Turianski (2016) and Stopnitzky (2016) are similar applications to different contexts.

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Games as pedagogical device: in the field

- Evaluation of impact of most of these interventions:
  - Before-After, and if there is a comparison group, it is not totally clear how it is constructed
  - Relative emphasis on learning about the problem (vs. learning about types)
  - Turiansky (2016) is the exception to these comments
- Our contribution: experimental evaluation of a framed CPR game, with emphasis on understanding mechanisms

Rodent pressure as a framed CPR

- Simulate decision to allocate time between production of a private good (rice production) and contributing to the production of a common resource (pest pressure), when the outcome of that effort depends on their neighbors' decisions

Total time	Your time – rodent control							
other players	0	1	2	3	4	5	6	7
0	7000	7000	7000	6500	5500	4500	3500	2500
1	7500	7000	7000	6500	5500	5000	3500	2500
2	7500	7500	7000	6500	6000	5000	4000	2500
3	7500	7500	7000	6500	6000	5000	4000	2500
4	7500	7500	7000	6500	6000	5000	4000	2500
5	7500	7500	7500	7000	6000	5000	4000	3000
6	8000	7500	7500	7000	6000	5500	4000	3000
7	8000	8000	7500	7000	6500	5500	4500	3000
8	8000	8000	8000	7000	6500	5500	4500	3000
9	8000	8000	8000	7000	6500	5500	4500	3000
10	8000	8000	8000	7500	6500	5500	4500	3500
11	8500	8000	8000	7500	6500	6000	4500	3500
...	...							
28	10000	10000	9500	9000	8500	7500	6500	5000

- CPR game – treatment – was played in 18 randomly selected villages in LP, in May 2018; 18 other villages as control group

Rodent pressure as a framed CPR

- No communication, players informed of total amount of time dedicated to rodent control and that payoffs would correspond to real money
- Groups of 5 individuals (5 per village), 2 test rounds, session 1 (7 rounds), brief discussion, voting on second session, session 2 (7 rounds)
- Group composition: up to 12 players (out of 25) interviewed at baseline, all randomly selected from village lists
- Session 1: Average contribution = 2.5 units of time per round; Average payoff = 51,000 LAK ≡ 9 AUD
- Session 2, played by 50% players, is very similar
- Games are followed by a debriefing session – all players invited, 85% attended
- CPR game is followed by a EBRM training session in all 36 villages, emphasizing the importance of collective hunts (Jakel et al (2016))

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Impact of playing a CPR game - Data

- Three surveys: November 2017 (baseline) and May 2018 (before treatment) and November 2018 (after treatment)
- 36 villages, 12 respondents per village (November 2017)
    - 95% report that rodent damage is reason why harvested area < planted area
    - Average damage: 20% of planted area
    - Individual strategies (traps) are the most common way to control rodents; no collective hunts
    - Almost 90% of the respondents report that their efforts benefit neighbors – and vice-versa
- Randomization led to the construction of balanced groups at baseline Balance
- Attrition is high, but uncorrelated with treatment status Attrition
- Noncompliance (invited, but didn't play the game) is low (9%), and correlated with distance to plot Non-compliers

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Impact estimates

We estimate the following model:

$$Y_{i,1} = \alpha + \beta T_i + \gamma Y_{1,0} + X_i \delta + \epsilon_i \quad (1)$$

- T_i = village allocated to CPR game (ITT) / and hh played game (LATE)
- X_i = unbalanced covariates at baseline (assets, upland status)
- Y_i = outcomes of interest: participation in EBRM training activities, collective hunting, damage, other collective activities
- Inference: Wild bootstrap (to account for small number of clusters) and q-values (to account for correlated outcomes)

Impact estimates

	EBRM training	Hunting training	Hunting village	Hunting village (days)	Damage rice (%)	Community activities (days)
ITT, no covariates						
β	0.088	0.095*	0.098	0.298	-3.753**	-0.032
s.e	(0.063)	(0.050)	(0.069)	(0.251)	(1.713)	(0.670)
wild BS	(0.181)	(0.072)	(0.174)	(0.290)	(0.038)	(0.938)
q-value	[0.359]	[0.359]	[0.359]	[0.412]	[0.359]	[0.639]
ITT, covariates						
β	0.098*	0.105***	0.140**	0.391	-4.425**	-0.133
s.e.	(0.049)	(0.037)	(0.061)	(0.268)	(1.936)	(0.638)
wild BS	(0.094)	(0.021)	(0.068)	(0.262)	(0.047)	(0.856)
q-value	[0.081]	[0.069]	[0.070]	[0.141]	[0.070]	[0.558]
LATE, no covariates						
β	0.108**	0.116**	0.119**	0.364	-4.606**	-0.035
s.e	(0.050)	(0.054)	(0.045)	(0.124)	(0.012)	(0.994)
wild BS	(0.176)	(0.062)	(0.173)	(0.293)	(0.034)	(0.962)
q-value	[0.107]	[0.107]	[0.107]	[0.122]	[0.107]	[0.573]
LATE, covariates						
β	0.117**	0.126**	0.167***	0.468*	-5.346***	-0.144
s.e	(0.055)	(0.062)	(0.060)	(0.242)	(1.904)	(0.514)
wild BS	(0.095)	(0.019)	(0.071)	(0.275)	(0.049)	(0.856)
q-value	[0.066]	[0.066]	[0.021]	[0.068]	[0.021]	[0.559]
Control mean	0.662	0.508	0.344	0.349	18.772	5.831
N	399	399	399	399	333	336

Impacts are largely homogeneous - although reductions in damage seem to be concentrated on plots that are closest to the village (< 2km).

What drives this change?

- We think of the CPR game as a pedagogical device (which may lead to changes in behavior and, then, economic outcomes). Participants can learn (at least) two things:
  - The relation between own/other payoffs and the actions of others/oneself
  - How willing are others to cooperate?
- Close to 90% of players are aware of their interdependency at baseline. This reaches almost 100% at endline
- We have no baseline data on expectations re others' willingness to cooperate. At endline 52.6% stated that they learned that others were more willing to participate in collective activities than they expected, while 15% stated the opposite and approximately 32% learned nothing
- What is the relative importance of these two channels? We use causal mediation analysis (Imai et al, 2011) to address this question

What drives this change?

	EBRM training	Hunting training	Hunting village	Hunting village (days)
Learning about the benefits of collective rodent control				
ACME	0.050	0.070	0.050	0.193
(95% CI)	(0.008 , 0.101)	(0.023 , 0.130)	(0.005 , 0.104)	(0.017 , 0.402)
Direct effect	0.040	0.007	0.009	0.037
(95% CI)	(-0.076 , 0.161)	(-0.120 , 0.141)	(-0.114 , 0.139)	(-0.447 , 0.546)
Learning about others' willingness to use time for rodent control				
ACME	0.126	0.178	0.198	0.414
(95% CI)	(0.061 , 0.199)	(0.104 , 0.262)	(0.117 , 0.273)	(0.147 – 0.709)
Direct effect	-0.035	-0.100	-0.131	-0.182
(95% CI)	(-0.157 , 0.092)	(-0.231 , 0.038)	(-0.256 , 0.001)	(-0.697 – 0.357)

Sensitivity analysis suggests that these results can be interpreted as causal.
Still to do: address multiple mediators.

Conclusion

- Playing a framed CPR increases participation in cooperative activities - cooperation can be trained...
- The impact seems important in terms of damage reduction: between -3.7% and -5.3% ($\equiv$ -20% and -28% of mean losses in control villages)
- The impact seems to be context specific - no transference to general "social capital"
- Open questions:
  - Are effects lasting? seems so
  - General equilibrium effects?
  - Intensity of treatment

Balance

	Treatment		Control			
Variable	Mean	SD	Mean	SD	Δ	p-value
Age	43.741	(0.785)	43.144	(0.783)	0.597	0.590
Female	0.032	(0.012)	0.060	(0.016)	0.028	0.170
Literacy	0.838	(0.025)	0.852	(0.024)	-0.014	0.691
Years schooling	4.435	(0.187)	4.579	(0.192)	-0.144	0.593
Labor availability	3.051	(0.094)	2.991	(0.097)	0.060	0.656
Male adults	1.556	(0.057)	1.495	(0.060)	0.060	0.466
Household size	6.250	(0.156)	6.167	(0.180)	0.083	0.727
Dependency ratio	1.247	(0.060)	1.224	(0.061)	0.023	0.786
Asset: Transportation	0.103	(0.072)	-0.099	(0.064)	-0.203**	0.036
Asset: Agriculture	0.050	(0.079)	-0.048	(0.055)	0.097	0.313
Asset: Durables	0.044	(0.062)	-0.039	(0.074)	0.083	0.390
Cropland (ha)	3.238	(0.155)	3.412	(0.153)	-0.175	0.422
Livestock (TLU)	4.345	(0.404)	5.362	(0.558)	-1.017	0.141
Group membership	0.718	(0.031)	0.722	(0.031)	-0.005	0.915
Rodent damage	0.969	(0.011)	0.944	(0.015)	0.025	0.175
Share rodent damage	21.402	(0.930)	20.430	(0.911)	0.972	0.456
Yield (t/ha)	2.413	(0.069)	2.298	(0.068)	0.115	0.238

(Cont.)

Balance

	Treatment		Control			
Variable	Mean	SD	Mean	SD	Δ	p-value
Rodent control (RC)	0.885	(0.021)	0.850	(0.023)	0.035	0.268
RC during sowing	0.742	(0.029)	0.729	(0.029)	0.013	0.740
RC during tillering	0.688	(0.031)	0.686	(0.030)	0.002	0.962
RC during booting	0.712	(0.030)	0.687	(0.030)	0.025	0.561
RC during flowering	0.821	(0.025)	0.807	(0.025)	0.014	0.694
RC during harvest	0.821	(0.025)	0.788	(0.026)	0.033	0.364
Bordering other plot	0.879	(0.021)	0.806	(0.026)	0.073**	0.029
Own benefit of RC of others	0.887	(0.020)	0.898	(0.019)	-0.011	0.691
Neighbours benefit of own RC	0.866	(0.023)	0.838	(0.025)	0.028	0.418
Spend more time on RC in WS	0.727	(0.025)	0.751	(0.025)	-0.025	0.486
Use traps	0.894	(0.021)	0.833	(0.025)	0.060*	0.069
Number of traps	28.875	(1.577)	31.046	(3.920)	-2.171	0.608
Hunting	0.051	(0.015)	0.051	(0.015)	0.000	1.000
Times hunting	1.269	(0.637)	0.847	(0.503)	0.421	0.604
Flooding/Fumigating/Digging (FFD)	0.130	(0.023)	0.120	(0.022)	0.009	0.772
Times FFD	0.958	(0.251)	0.972	(0.291)	-0.014	0.971
Village: access in rain season	0.389	(0.033)	0.333	(0.032)	0.056	0.230
Village: Upland	0.444	(0.034)	0.556	(0.034)	-0.111**	0.021
Village: Low and Upland	0.500	(0.034)	0.389	(0.033)	0.111**	0.020
N	216		216			

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Attrition

Attrition	W1/W2	W1/W3	W2/W3	Overall
Treatment	-0.050	-0.039	-0.017	-0.058
s.e.	(0.063)	(0.034)	(0.029)	(0.065)
Wild-BS	(0.495)	(0.303)	(0.594)	(0.419)
N	432	432	365	432

Note: W1, W2 and W3 stand for wave 1, 2 and 3 of the household survey, respectively. Standard errors in parentheses are clustered at village level. Estimates of the effect of treatment on attrition conditional on covariates (Asset index: Transportation, Bordering other plot, Upland, Low and Upland).

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Non-compliers

Variable	Non-compliers Mean	Non-compliers SD	Compliers Mean	Compliers SD	Δ	p-value
Age	42.167	(2.688)	44.309	(0.850)	-2.142	0.443
Female	0.056	(0.056)	0.034	(0.014)	0.021	0.648
Literacy	0.833	(0.090)	0.829	(0.029)	0.005	0.960
Years schooling	4.167	(0.643)	4.520	(0.212)	-0.353	0.610
Labor (adults)	2.889	(0.301)	2.994	(0.101)	-0.105	0.750
Male adults	1.333	(0.162)	1.549	(0.063)	-0.215	0.288
Household size	5.722	(0.630)	6.211	(0.170)	-0.489	0.390
Dependency ratio	1.111	(0.202)	1.273	(0.069)	-0.162	0.472
Asset index	0.112	(0.184)	0.117	(0.073)	-0.005	0.983
Cropland (ha)	2.842	(0.461)	3.374	(0.173)	-0.532	0.344
Livestock (TLU)	4.800	(1.290)	4.318	(0.451)	0.482	0.743
Group membership	0.667	(0.114)	0.726	(0.034)	-0.059	0.597
Rodent damage	0.941	(0.055)	0.969	(0.013)	-0.029	0.508
Share rodent damage	22.617	(3.648)	20.895	(1.001)	1.722	0.606
Distance plot and residence	4.612	(0.473)	2.674	(0.161)	1.938***	0.000
Yield (t/ha)	2.521	(0.259)	2.337	(0.075)	0.184	0.460

(Cont.)

Non-compliers

	Non-compliers		Compliers			
Variable	Mean	SD	Mean	SD	Δ	p-value
Rodent control (RC)	0.986	(0.010)	0.861	(0.025)	0.125	0.118
RC during sowing	0.804	(0.089)	0.726	(0.033)	0.078	0.465
RC during tillering	0.798	(0.090)	0.672	(0.034)	0.127	0.257
RC during booting	0.802	(0.090)	0.714	(0.033)	0.089	0.411
RC during flowering	0.980	(0.014)	0.800	(0.029)	0.180*	0.052
RC during harvest	0.923	(0.056)	0.793	(0.030)	0.129	0.173
Bordering other plot	0.931	(0.056)	0.878	(0.024)	0.053	0.492
Collaborate with neighbours	0.831	(0.078)	0.636	(0.033)	0.195*	0.068
Own benefit of RC of others	0.876	(0.076)	0.883	(0.022)	-0.007	0.926
Neighbours benefit of own RC	0.944	(0.056)	0.846	(0.027)	0.099	0.260
Spend more time on RC in WS	0.903	(0.058)	0.734	(0.027)	0.168*	0.054
Use traps	0.944	(0.056)	0.880	(0.025)	0.064	0.415
Number of traps	29.667	(3.691)	26.977	(1.480)	2.690	0.573
Hunting	0.056	(0.056)	0.040	(0.015)	0.016	0.754
Times hunting	0.111	(0.111)	1.360	(0.775)	-1.249	0.607
Flooding/Fumigating/Digging (FFD)	0.056	(0.056)	0.114	(0.024)	-0.059	0.449
Times FFD	1.111	(1.111)	0.703	(0.220)	0.408	0.597
N	18		175			

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