Toward a delineation of the circumstances in which cooperation can be sustained in environmental and resource problems.

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Background

- Public Good games played in labs indicate that humans are prone to cooperate.
- Cooperation is an obstacle for real world social dilemmas.
- All agents are better off if they cooperate, but if everyone else cooperates, then individuals who do not cooperate are better off.
- 2 games: Voluntary Contribution Mechanism game (VCM or Public Goods game) and the Common Pool Resource game (CPR).

- VCM game
  - Pure public good
  - Agents can invest in their provision
  - No agent can be excluded
  - No option to destroy the public good
  - Benefits are a linear function of own contribution
  - Contributing zero is a dominant strategy if
    - All subjects only care about their own private payoffs, and
    - This is common knowledge
  - Average contributions are between 40% - 60% in the first period of interaction, declining over time, approaching zero in the last period.

- CPR game
  - Subjects can extract from a common pool.
  - Benefits are a decreasing function of the extraction levels chosen by the subject and other players.
  - Cooperation dissipates very quickly.
  - Aggregate extraction starts between the socially optimal and the selfish Nash equilibrium levels.
    - Converges to the selfish Nash equilibrium in 2 -3 periods.

Question

- What accounts for the different levels of cooperation seen in the VCM and CPR game?
  - Authors propose that the lack of cooperation in the CPR game is because some can undo the good work of others.
  - In the VCM game the worst a freerider can do is to not contribute.
  - To test this, they create a game that is identical to the VCM game except that subjects can either invest in or take from the public fund.

Claim game

- Full contribution is the social optimum, like the VCM game.
- Subjects are better off if they all contribute.
- No public good is created in the game's selfish Nash equilibrium.
- The private and social returns to investing the public good are uncertain.
  - They may be high is all others refrain from taking.
  - They may be zero if offset by the actions of others.

Real World Applications

- Where enforcement of rules and regulations is absent or imperfect because of information asymmetry or high transaction costs.
- Where peer-to-peer enforcement is weak or absent due to anonymity issues or fear of retaliation.
- Examples:
  - Corruption affecting the provision of public goods.
  - Appropriation of inputs contributed by others for the production of public goods (ground water reservoirs)
  - Obstructing the process of public good provisions (recycling programs)

Experimental Design & Procedure

- Subjects randomly matched into groups of n=4 players.
- Interact repeatedly for T=25 periods.
- Every period, each subject receives an endowment, e>0 points, and makes one decision.
  - Maximum contribution = e
  - Any unit of endowment not invested in the public fund increases subject's payoff by 1 unit.
- If public fund is not empty, a public good is created proportional to the size of the public fund by a factor of α.
- The public good equally benefits all subjects of the group, regardless of contribution.

- Difference between VCM and Claim game:
  - Subject's contribution (c_i)
    - VCM: $c_i \in \{0,1,...,e\}$
    - Claim game: $c_i \in \{-a, ...,-1,0,1,...,e\}$, where $a > 0$ is the maximum amount a subject can claim from the public fund.
  - Subject's decision:
    - Investment if $c_i \geq 0$
    - Claim if $c_i < 0$
  - Indicator function: $\delta_i = 1$, if $c_i < 0$ (claim), and $\delta_i = 0$ otherwise.
  - Sum of all investments:
    - $I = \sum_{i=1}^{n} = (1- \delta_i)\, c_i$
  - Sum of all claims
    - $C = \sum_{i=1}^{n} = \delta_i \mid c_i \mid$

- Payoff function of subject *i* choosing action c_i is equal to:
  - If $I \geq C, then\ \pi_i = e - c_i + \alpha(I - C)/n$
  - If $I < C, then\ \pi_i = \begin{cases} e - c_i & if\ c_i \geq 0 \\ e + \frac{|ci|}{c} I & if\ c_i < 0 \end{cases}$
- Note $\frac{\alpha}{n} < 1 < \alpha$ = a social dilemma and in all treatments $\alpha = 1.6$
- In Claim game, the action set [-a,e] is not restricted to non-negative so there are multiple selfish Nash equilibrium but all are characterized by I=0 in every period.

- Marginal Per Capita Return (MPCR) is

$$\frac{\alpha}{n} - 1 \; when \; I \geq C \; and \; -1 \; otherwise.$$

  - Endogenous MCPR is a distinguishing factor between VCM and CPR games, which sets the Claim game apart.
  - In VCM and linear Public Bad games the MCPR is independent of the decisions of the other subjects.
- 3 treatments in this experiment:
  - VCM [0,20]
  - Claim [-20,20]
  - Claim [-10,10]

Table 2
Payoff consequences of defecting and freeriding, as a function of the number of cooperators and (maximum) defectors in a group.

	VCM [0,20]		Claim [−20,20]		Claim [−10,10]	
Group composition	Payoff of a cooperator	Payoff of a defector	Payoff of a cooperator	Payoff of a defector	Payoff of a cooperator	Payoff of a defector
4 cooperators, no freerider	32		32		16	
3 cooperators, 1 freerider	24	44	16	56	8	28
2 cooperators, 2 freeriders	16	36	0	40	0	20

Table 1
Overview of the experiments.

Treatment	Number of groups	Average individual earnings	Minimal individual earnings	Maximal individual earnings
VCM [0,20]	9	€10.09	€9.00	€12.00
Claim [−20,20]	9	€9.22	€9.00	€12.00
Claim [−10,10]	8	€6.74	€6.50	€8.00

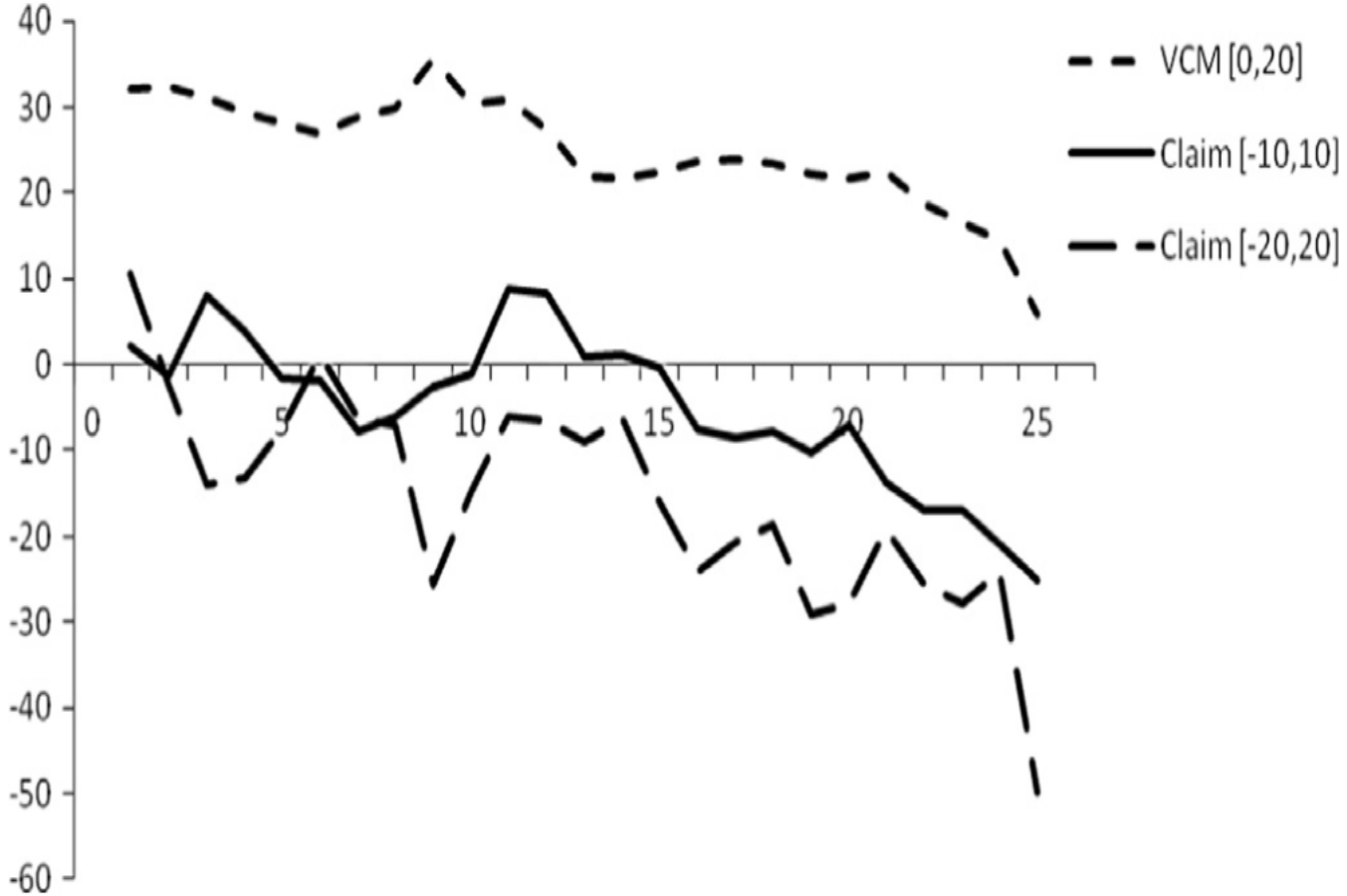

Fig. 1. Average net group contributions, *I–C*, in the VCM [0,20], Claim [−10,10] and Claim [−20,20] treatments in all 25 periods.

Observation 1

Average net contribution shares are lower in Claim [-10,10] and Claim [-20,20] than in VCM [0,20], and fail to be significantly positive even in the first period. These differences are not due to differences in subject pool, and they are also not the result of a framing effect.

Observation 2

The vector of contribution levels chosen in a group is a Selfish Nash equilibrium in a third to a half of the periods in the two Claim games, while this is only the case in one out of six periods in the VCM game.

Observation 3

Subjects who were observed to contribute at least 40% of their endowment to the public fund in the first period of the three treatments (the so-called pro-social subjects), continue to contribute positive amounts in the later periods of the VCM game, but not so in the two Claim games.

Observation 3

- In VCM [0,20] every subject was confronted with at least 2 cooperators, but not the in the two Claim games –some subjects observed one or more subjects making negative contributions in the first period.
- Observing one other group member contributing zero does not affect the probability of remaining an investor in any of the three treatments.
- The consequences of having one or more group member making a negative contribution (in the two Claim games), reduces the probability of remaining an investor.
- The payoff consequences of having two or more subjects choosing not to contribute in the VCM game are the same as those of one subject choosing a negative contribution in either of the two Claim games, the negative impact on a subject's propensity to continue to cooperate in the next period is larger.

Thank you.

Questions?