

Delegation and Public Pressure in a Threshold Public Goods Game

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Motivation

The spread of infectious diseases, resource overharvesting, ocean acidification, climate change have several features in common:

- (i) They are subject to sudden transitions from more benign states to harmful ones (tipping)
- (ii) Addressing them requires widespread cooperation in the face of individual incentives to free-ride
- (iii) Public pressure influences decision-makers

Motivation

- Uncertainty aggravates the coordination task
 - on the location of the threshold
 - On the likelihood of the common loss
- Since these decisions require deliberation and voting, we look at the interplay between delegation and public goods provision
- We thus focus on a public goods game where subjects contribute to reach a threshold to avoid an uncertain common loss

Motivation

- Delegation:
Does delegation improve upon single-actor decisions, or are delegates more prone to pursue self-interest at the expense of the group?
- Public Pressure:
What is the role of preference signaling by the constituency in steering delegates' choices?

Motivation

- The research question:

Will a group of delegates who are responsible to different constituencies and different degrees of public pressure, reach a collective target, which if missed may trigger severe losses?

Experimental TPGG findings

- The expected loss of crossing the threshold and uncertainty about the threshold are the most important determinants of collective action (Barrett and Dannenberg, 2012)
- The threshold's role as a catalyser of cooperation is hindered when risk and especially ambiguity is introduced (Dannenberg et al., 2014)
- Wealth inequality and the credibility of the pledges constitute further difficulties. Early action can help by signalling willingness to cooperate with high initial contributions (Tavoni et al., 2011)

Leadership in Experiments

- Moxnes and van der Heijden (2003) find that contributions to a 'public bad' decrease with leadership
- Leading by example, rather than by words, appears to be more effective in motivating cooperation in public goods games (Czap and Czap, 2011)

Delegation in Experiments

- In dictator games, the delegation of the decision right on the part of the dictator decreases sharing (Hamman, Loewenstein and Weber, 2009)
- When all team members have common payoffs, the audience passively observes the game played, and receives feedback of the outcomes under variety of games, behavior in Prisoner's Dilemma, Stag Hunt, and Trust games becomes less cooperative with delegation (Charness and Jackson, 2007 and 2009; Charness et al., 2007, Song, 2008)

Model

- N teams, each composed of k members
- Each member has initial endowment e and thus each team has endowment $E = ke$
- Each team i decides simultaneously
 - how much to contribute as a team, C_i
- Collectively, the N teams must reach a contribution threshold T, if probabilistic losses are to be avoided
- No team alone can unilaterally reach the threshold: $E < T$

Model

- If $\sum_i C_i \geq T$, then the group successfully avoid the potential loss and subjects enjoy the remaining amount, $E - C_i$
- Otherwise, each team is left with $q \in [0, 1)$ of the remaining amount with probability p (and enjoys the remaining amount with probability $1-p$)
- There is no rebate
- Threshold:
 - certain threshold T
 - uncertain equally likely thresholds T_1 and T_2 : $T = 0.5T_1 + 0.5T_2$

Model: Equilibria

- Under threshold certainty, the game has two symmetric pure strategy Nash Equilibria:
- No Contribution (NC): no team contributes any positive amount
 - At NC, each team's expected payoff is: $pqE + (1-p)E$
- Symmetric Provision Contribution (SPC): each team contributes C^* such that total contribution is equal to the threshold, $C^* = T/N$
 - At SPC, each team's payoff is: $E - C^*$

Experimental Design: Sessions

- Paper & Pencil Experiments done at Sogang University, Korea: 3 Treatments, 8 groups for each, and 4 teams in each group, in total 96 teams. 224 subjects (T1 = 32, T2 = 96, T3 = 96).
- Randomly form $N = 4$ teams of size $k=1$ (for Treatment 1) and $k=3$ (for Treatments 2 and 3), which remain unchanged throughout the session.
- 1 practice round & 6 rounds of one-shot games, repeated for different p values and threshold (un)certainty.
- No feedback to minimize learning.
- Endowment: $E = 120$ laboratory Dollar to play in each round.
- One round is chosen randomly to determine earnings.

Experimental Design: Rounds

- Pledge stage: Teams announce how much they intend to contribute and how much they expect the other teams to contribute.
- Contribution Stage: 4 teams play a one-shot TPGG,
 - Deciding simultaneously their contribution to the public good
 - Threshold: to reach a certain threshold $T = 240$ laboratory \$ (or the corresponding uncertain and equally likely thresholds, $T_1 = 190$ or $T_2 = 290$),
 - knowing that failing to collectively reach the threshold means losing 90% of their remaining endowment with a probability p .

Rounds

	Practice Phase	Game Phase					
		Round 1	Round 2	Round 3	Round 4	Round 5	Round 6
Loss Uncertainty (p)	0.55	0.75	0.55	0.95	0.95	0.55	0.75
Threshold Location Uncertainty	Uncertain \tilde{T} ($T_1=190$ $T_2=290$)	Certain T ($T=240$)	Certain T ($T=240$)	Certain T ($T=240$)	Uncertain \tilde{T} ($T_1=190$ $T_2=290$)	Uncertain \tilde{T} ($T_1=190$ $T_2=290$)	Uncertain \tilde{T} ($T_1=190$ $T_2=290$)
Damage (q)	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Highest Expected Payoff Equilibria	NC	SPC	NC=SPC	SPC	SPC2	NC	SPC2

Experimental Design: Election

- Purpose of the practice round:
 - Players get some idea about their teammates' willingness to contribute and expectations from other teams, which is used to elect the team's delegate.
- Voting:
 - Every team member is a candidate and can vote for anyone, including him/herself.
- Majority rule:
 - In case of a tie: elect the least wanted candidate to eliminate
 - In case of another tie: randomly eliminate one candidate.
- Random elimination was only needed in 3 teams out of 64.

Experimental Design: Treatments

- **Treatment 1 (NoD):** No Delegation (1-member 'teams')
- **Treatment 2 (DnoM):** Delegation and no Messages
 - After voting and contribution stage of practice phase, delegates moved to meeting room to play all 6 rounds.
 - We inform non-delegates and ask their opinion in each round.
- **Treatment 3 (DM):** Delegation and Messages
 - Now, all team members move to a common room.
 - Seats: Delegates in the first rows; teammates just behind them.
 - Signal: After the pledge stage, non-delegates send their opinions to the team's delegate via experimenters.
- Teams split earnings evenly among the members in T2 & T3.

Experimental Design

- Instructions, Example, and Control Questions: we make sure that all subjects understand the game features.
- Subjects are randomly divided into 4 teams via allocating the ID cards. They go to different rooms.
- ID Card: In each round, ID card assigns a letter to determine the subject's team and a number to determine his member ID. This is to minimize any learning and reputation effects.
 - Subjects remain in the same team.
 - Every subject knows only his own ID letter and number, and teammates ID letters, but no one else's letter or number.
- E.g., ID A3112442 means that the subject belongs to team A (or group A) and his or her ID number is 3 in the practice round, 1 in Round 1, 1 in Round 2, 2 in Round 3, and so on.

Experimental Design: Practice Phase

- The session begins with the unpaid *practice phase*: play a game with uncertain threshold and with probability $p = 0.55$.
- Each team member decides how much to pledge and how much he expects from other teams to contribute.
- The decisions of team members are projected to the screen with their current ID number in every room.
- No communication within teams.
- Then, they decide how much to contribute, but contributions are not announced to other teams to avoid learning.
- Lab assistants used a smart phone app *KakaoTalk* to coordinate throughout the experiment from different rooms.

Subjects' Characteristics

Treatment	noD	DnoM	DM	p-value of equality test
Male	0.563 (0.504)	0.563 (0.499)	0.615 (0.489)	0.736
Age	22.468 (2.016)	23.156 (6.204)	22.739 (2.128)	0.708
Enrolled semesters	5.094 (2.277)	5.125 (2.084)	4.927 (2.001)	0.549
ECON/BUS major	0.625 (0.492)	0.583 (0.496)	0.604 (0.492)	0.906
General risk (0-10 scale)	4.250 (1.901)	4.885 (2.352)	4.821 (2.356)	0.507
Lottery (1-5)	4.469 (1.244)	3.990 (1.326)	4.074 (1.331)	0.543
Global warming (0-10)	6.438 (1.950)	6.313 (2.104)	6.358 (2.138)	0.645
Recycling (0-10)	7.188 (2.007)	7.500 (1.886)	7.495 (2.093)	0.574
Number of subjects	32	96	96	

Treatments recap

	Loss Uncertainty (p)	Threshold Location Uncertainty (\tilde{T})	Delegation	Messages
NoD ($N=4, k=1$)	✓	✓ (Rounds 4-6)		
DnoM ($N=4, k=3$)	✓	✓ (Rounds 4-6)	✓	
DM ($N=4, k=3$)	✓	✓ (Rounds 4-6)	✓	✓

Timing

NoD

1-member team

Practice phase in team room

1-member teams move to
common room

Pledge & Contribution stages:
The 4 teams play 6 rounds

DnoM

3-members team

Practice phase in team room

Team members elect a delegate
via majority voting

Delegates move to common
room

Pledge & Contribution stages:
The 4 delegates play 6 rounds

Teammates share their opinion
on team's contribution to
experimenter only

DM

3-members team

Practice phase in team room

Team members elect a delegate
via majority voting

Everyone moves to common
room

4 delegates sit on the front row
Their teammates sit behind
them

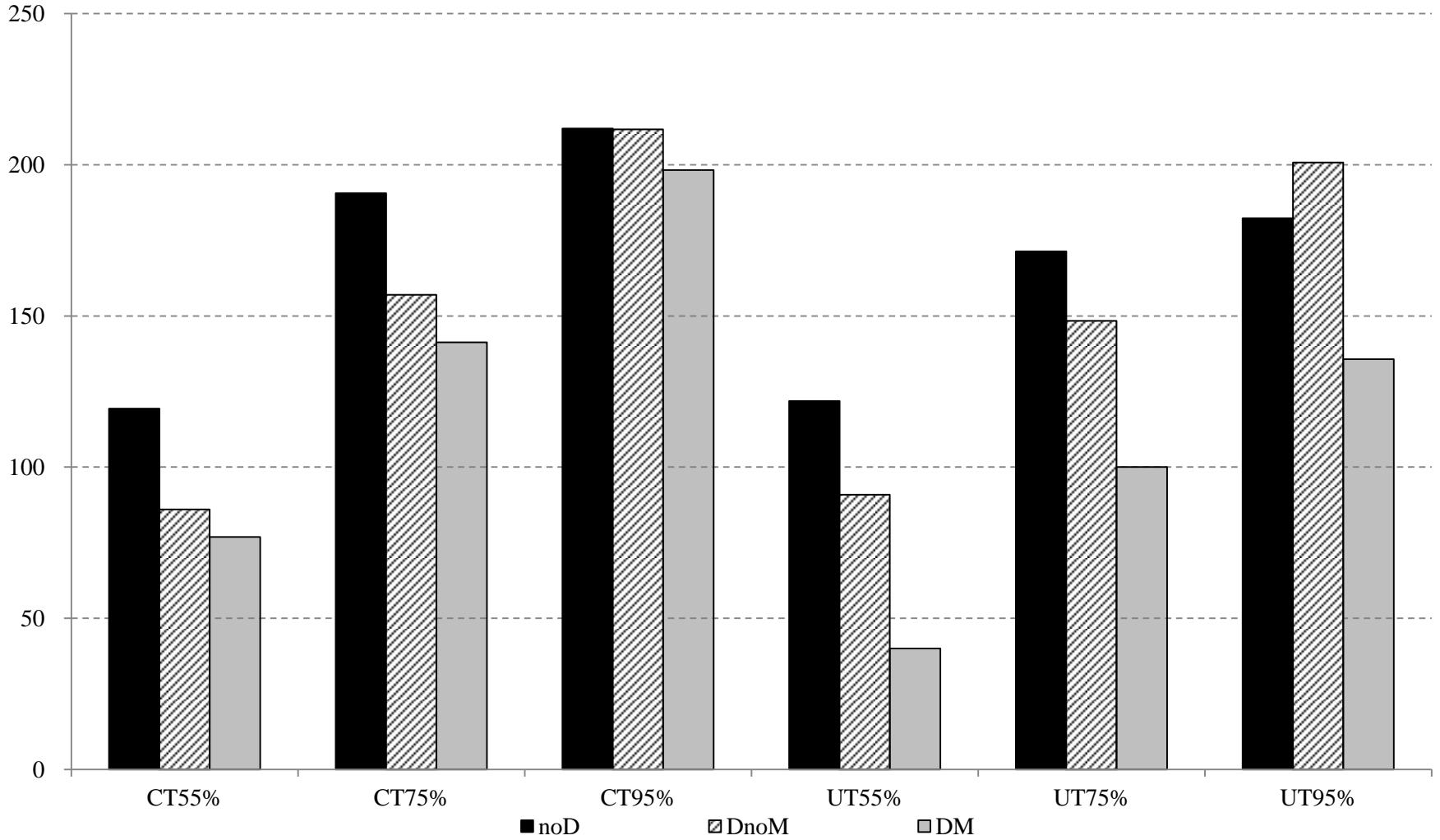
Pledge & Contribution stages:
The 4 delegates play 6 rounds

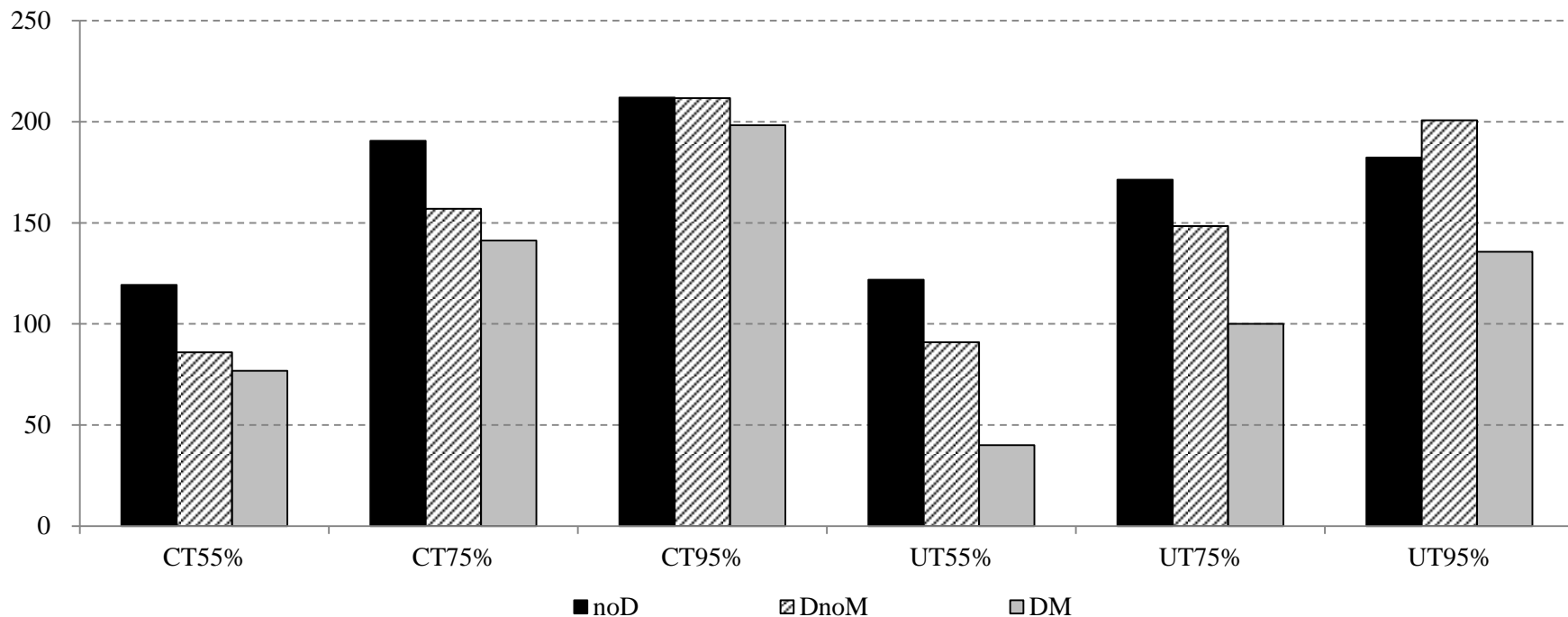
Teammates share their opinion
on team's contribution to
delegates via experimenter

... Results

... Group-level analysis

Average Group Contribution



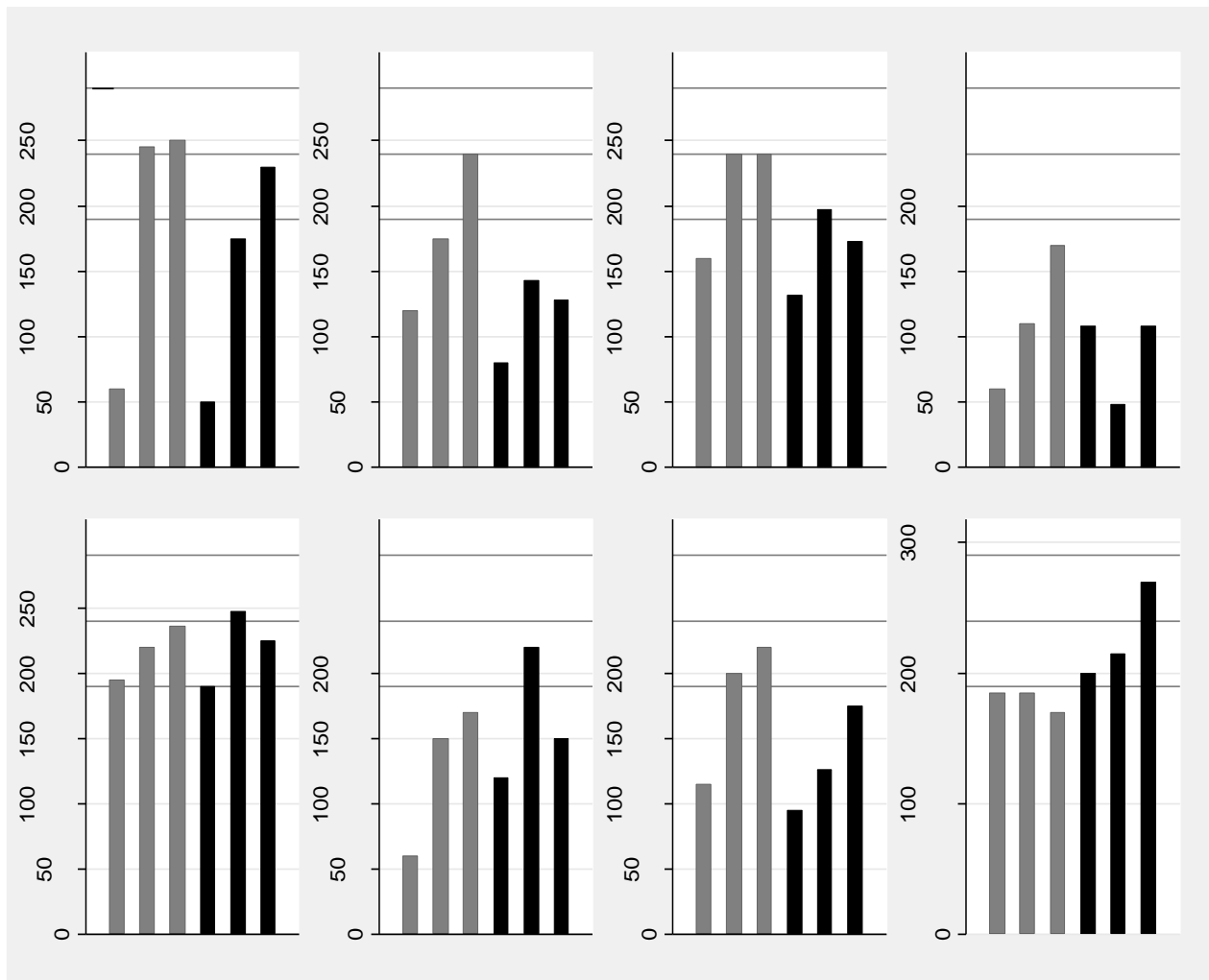


- *First*, as the disaster probability increases (from 55% to 95%), the group contribution increases (both in CT & UT)
- *Second*, participants tend to contribute less when they face uncertainty about thresholds
- *Third*, we find that the average group contribution is highest in noD, while it is lowest in DM

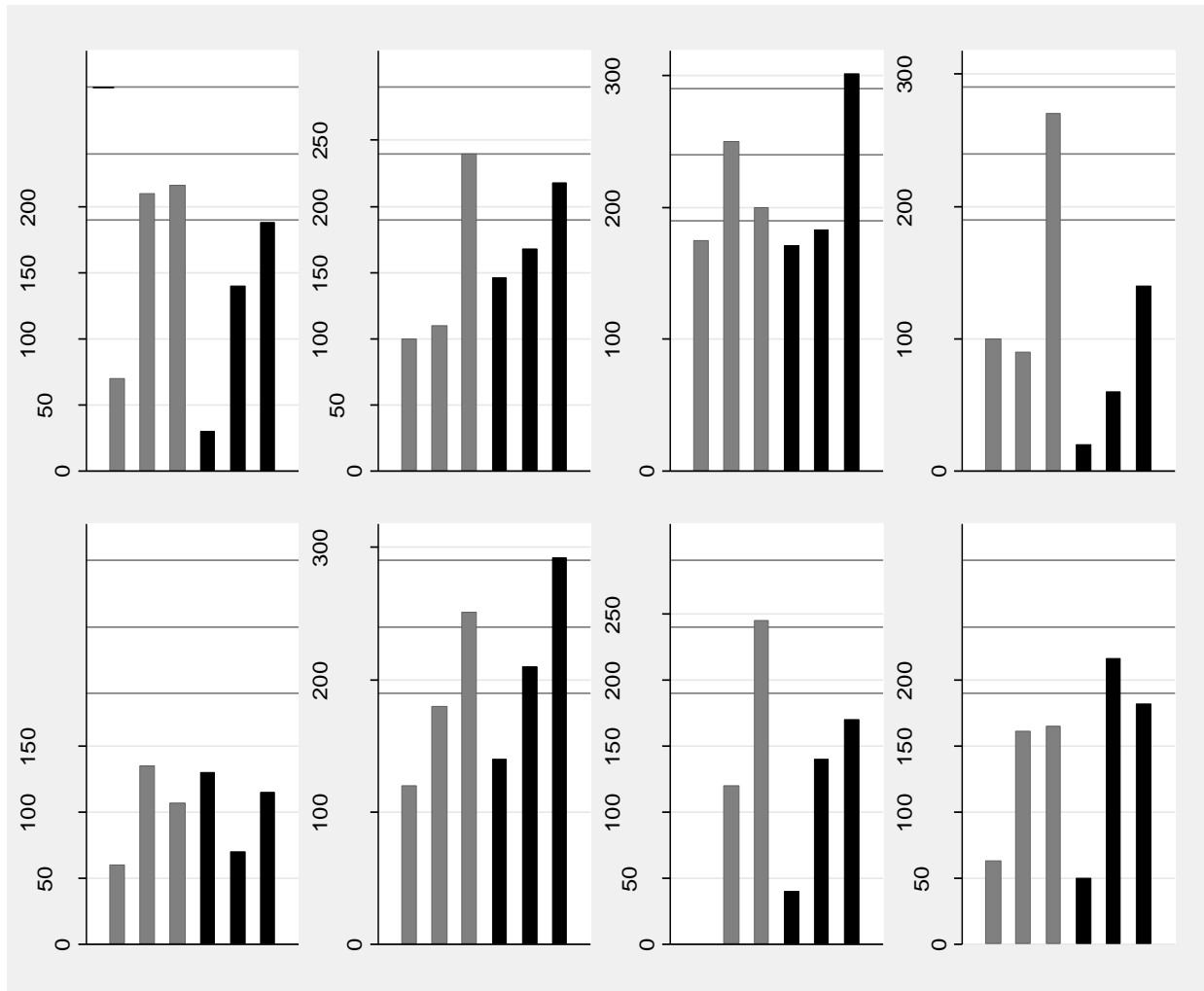
Reaching Thresholds?

	C55	C75	C95	U55_L	U75_L	U95_L	U55_H	U75_H	U95_H
NoD	0 / 8	2 / 8	3 / 8	2 / 8	4 / 8	3 / 8	0 / 8	0 / 8	0 / 8
DnoM	0 / 8	1 / 8	4 / 8	0 / 8	2 / 8	3 / 8	0 / 8	0 / 8	2 / 8
DM	0 / 8	0 / 8	4 / 8	0 / 8	0 / 8	1 / 8	0 / 8	0 / 8	0 / 8

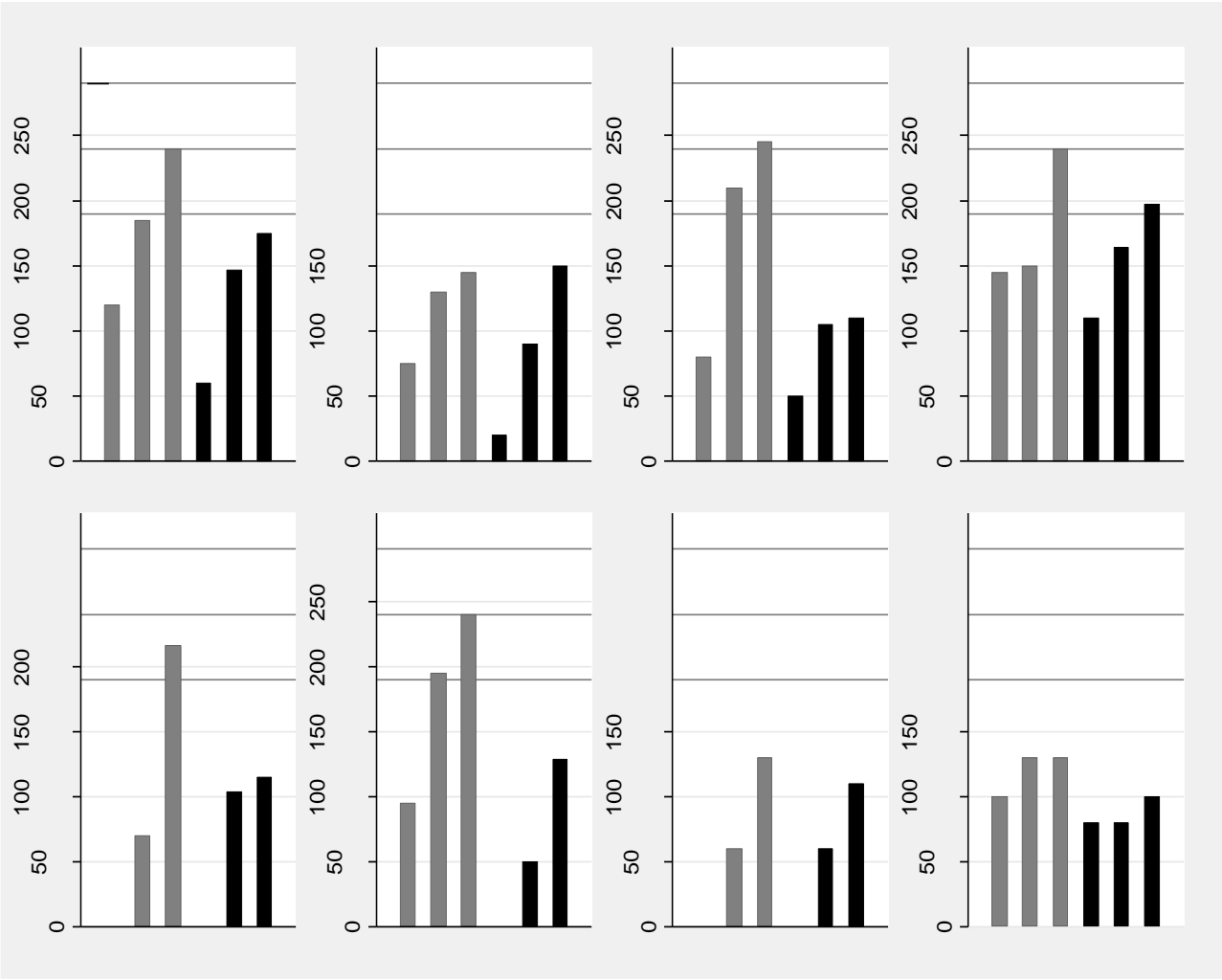
noD: 8 Groups and 6 Rounds



DnoM: 8 Groups and 6 Rounds



DM: 8 Groups and 6 Rounds



Group-level Regression

$$C_{jr} = \beta_0 + \beta_1 DnoM_j + \beta_2 DM_j + \gamma_1 p75_r + \gamma_2 p95_r + \gamma_3 UT_r + \epsilon_{jr}$$

	(1) All	(2) p = 55%	(3) p = 75%	(4) p = 95%	(5) First round (CT75%)
DnoM	-17.15 (18.96)	-32.19 (25.16)	-28.31 (24.15)	9.06 (21.03)	-33.63 (25.12)
DM	-50.92*** (17.91)	-62.19** (23.65)	-60.38*** (21.48)	-30.19 (17.95)	-49.38* (25.46)
75% chance of disaster	62.27*** (8.86)				
95% chance of disaster	100.98*** (10.19)				
Uncertain threshold	-22.42** (8.65)	-9.83 (9.03)	-23.04* (11.81)	-34.38** (13.17)	
Constant	123.1*** (14.04)	125.5*** (18.66)	192.5*** (16.83)	214.4*** (12.45)	190.6*** (16.24)
Observations	144	48	48	48	24
R-squared	0.471	0.209	0.225	0.193	0.152

Equilibria

	Practice Phase	Game Phase					
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Loss Uncertainty (p)	0.55	0.75	0.55	0.95	0.95	0.55	0.75
Threshold Location Uncertainty	Uncertain \tilde{T} ($T_1=190$ $T_2=290$)	Certain T ($T=240$)	Certain T ($T=240$)	Certain T ($T=240$)	Uncertain \tilde{T} ($T_1=190$ $T_2=290$)	Uncertain \tilde{T} ($T_1=190$ $T_2=290$)	Uncertain \tilde{T} ($T_1=190$ $T_2=290$)
Damage (q)	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Highest Expected Payoff Equilibria	NC	SPC	NC=SPC	SPC	SPC2	NC	SPC2

... Results

... Team-level analysis

Delegates vs Constituency

	DnoM		(1)	DM		(2)	(3)	(4)
	Non-delegates' beliefs (not delivered)	Delegates' decisions	Delegates = Non-delegates	Non-delegates' beliefs (delivered)	Delegates' decisions	Delegates = Non-delegates	Non-delegates DnoM = DM	Delegates DnoM = DM
CT55	27.94 (25.81)	21.50 (25.17)	0.248	25.47 (26.97)	19.22 (25.12)	0.277	0.744	0.548
CT75	40.45 (25.58)	39.25 (25.22)	0.828	38.95 (26.28)	35.31 (26.94)	0.527	0.598	0.718
CT95	42.97 (31.67)	52.94 (20.08)	0.108	49.30 (24.05)	49.56 (23.62)	0.959	0.205	0.540
UT55	26.02 (25.69)	22.72 (28.38)	0.569	26.61 (28.90)	10.00 (20.32)	0.005	0.998	0.022
UT75	45.05 (30.18)	37.09 (28.82)	0.220	44.03 (30.08)	25.00 (28.30)	0.004	0.902	0.044
UT95	52.97 (30.01)	50.19 (25.12)	0.653	52.95 (27.69)	33.94 (30.11)	0.003	0.849	0.095

Team-level Regression

$$c_{ijr} = \beta_1 Pldg_{-ijr} + \beta_2 Exp_{-ijr} + \gamma_1 p75_r + \gamma_2 p95_r + \gamma_3 UT_r + \gamma_4 M_{ijr} + \alpha_{ij} + \tau_r + \epsilon_{jr}$$

Treatment	noD	DnoM			DM		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Avg. pledge by others	-0.040 (0.102)	0.053 (0.066)	0.053 (0.066)	0.051 (0.067)	0.039 (0.047)	0.061 (0.051)	0.065 (0.049)
Avg. expectation by others	-0.044 (0.213)	0.319 (0.235)	0.319 (0.237)	0.325 (0.231)	-0.186 (0.137)	-0.169 (0.166)	-0.183 (0.163)
75% chance of disaster	18.739*** (5.353)	15.068** (5.541)	15.082*** (5.440)	15.154*** (5.487)	15.084*** (5.336)	8.177* (4.733)	8.733* (4.734)
95% chance of disaster	24.859*** (5.243)	30.286*** (6.528)	30.303*** (6.562)	30.554*** (6.623)	29.065*** (6.266)	16.877*** (5.758)	16.889*** (5.921)
Uncertain threshold	-3.878 (5.494)	-4.512 (5.928)	-4.508 (5.961)	-4.216 (5.954)	-9.601* (5.333)	-12.065** (4.761)	-11.495** (4.729)
<i>Team members' beliefs</i>							
Average			-0.001 (0.116)			0.483*** (0.119)	
Lower				0.025 (0.089)			0.342*** (0.115)
Higher				-0.032 (0.107)			0.136 (0.084)
Constant	38.342* (22.410)	-4.724 (12.597)	-4.705 (12.692)	-3.931 (13.892)	-15.904 (18.516)	-13.386 (19.755)	-12.074 (19.091)
Team FE	Y	Y	Y	Y	Y	Y	Y
Round FE	Y	Y	Y	Y	Y	Y	Y
Observations	192	192	192	192	192	192	192 ²³
R-squared	0.478	0.588	0.588	0.589	0.614	0.672	0.676

Team Pledges and Contributions

	Pledge	Expectation	Contribution	Contribution > Pledge	Contribution = Pledge	Contribution < Pledge
noD	57.81 (19.79)	62.69 (14.37)	41.57 (27.40)	0.19 (0.39)	0.32 (0.47)	0.47 (0.50)
DnoM	52.78 (25.49)	65.70 (15.29)	37.28 (28.04)	0.30 (0.46)	0.24 (0.43)	0.46 (0.50)
DM	50.17 (25.09)	62.58 (18.64)	28.84 (28.56)	0.18 (0.39)	0.25 (0.43)	0.57 (0.50)

Discrepancies between Pledge and Contribution

Graphs for NoD, DnoM and DM,
resp.

% (contribution = pledge)

NoD: 32.3%

DnoM: 24.5%

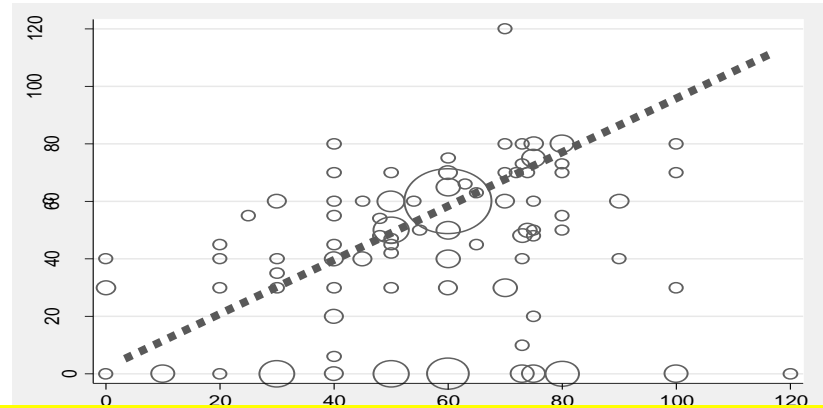
DM: 25.0%

% (contribution < pledge)

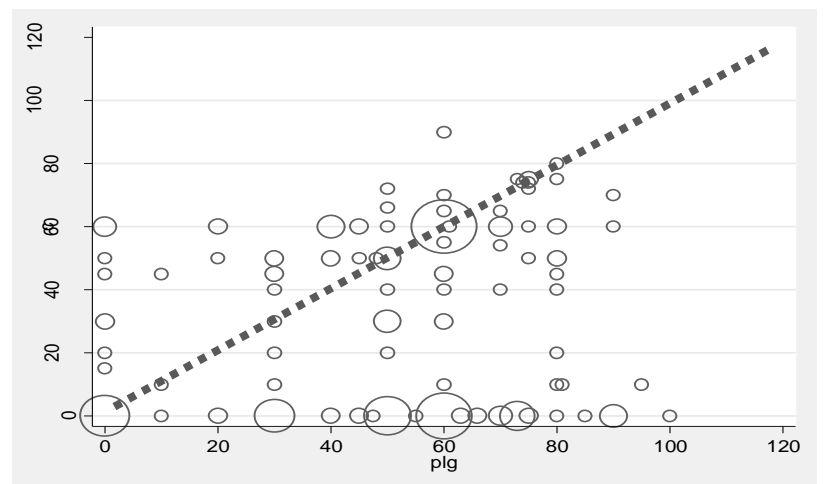
NoD: 49.0%

DnoM: 45.8%

DM: 56.8%



Between pledge and contribution, there is communication between delegate and team members in DM.



Who Was Elected as Delegate?

	(1)	(2)
	Elected	Vote for self
Vote for self	0.380*** (0.069)	
Male	-0.048 (0.079)	0.240*** (0.077)
Age	0.011 (0.012)	0.018 (0.018)
Enrolled semesters	0.011 (0.019)	-0.018 (0.023)
ECON/BUS major	0.034 (0.072)	0.023 (0.076)
General risk preference	0.014 (0.015)	0.019 (0.016)
Ballot number 2	0.176** (0.077)	0.083 (0.079)
Observations	191	191
Pseudo R squared	0.168	0.074

Main Concern in Decision Making

	T1	T2	T3
<i>Main concern</i>			
Threshold level	49.81 (0.25)	44.70 (0.16)	52.89 (0.09)
Cash amount after contribution	39.42 (0.13)	33.10 (0.22)	17.48 (0.22)
Other players' choices	32.80 (0.34)	36.12 (0.31)	25.96 (0.28)
Probability of disaster	45.91 (0.28)	37.67 (0.31)	31.40 (0.41)

Dependent Variable: Average team contribution

The table shows the answers of delegates only from the survey questions

Conclusions

- In this paper, we study the impact of delegation in a threshold public goods game
- Delegates are responsible to different constituencies and different degrees of public pressure

We find that:

- Delegation *without preference communication* reduces team contributions, but not significantly
- Delegation *with preference communication*, on the other hand, has a significantly negative effect. Delegates weigh heavily the non-cooperative opinions
- ‘Bad suggestions’ disrupt cooperation

Thank you...

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