Information Networks and their Role in Threshold Public Goods Games: An Experimental Study

Ursula W. Kreitmair,[12*] Simanti Banerjee,[23] James M. Walker[24]

[1] School of Public and Environmental Affairs, Indiana University
[2] Vincent and Elinor Ostrom Workshop in Political Theory and Policy Analysis
[3] Department of Agricultural Economics, University of Nebraska, Lincoln
[4] Department of Economics, Indiana University
* Corresponding Author (ukreitma@indiana.edu)

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INTRODUCTION

- Many public goods are provided in discrete quantities and require raising funds beyond a threshold.

Lighthouses **Renewable Energy R&D** **National Parks**

- Social networks important – information exchange between social peers impacts donation behavior
- We use laboratory experiments to study role of social networks through which individuals share **information** on meeting **public goods** funding thresholds.

Primary Questions

- Do denser information networks influence fundraising success?
- Does impact of information networks depend on donor income levels?
- Does peer information impact individual decisions?

THRESHOLD PUBLIC GOODS

Decision Setting

- Individual, *i*, is part of group of *N* individuals
- Receives endowment of tokens e_i,
- Chooses m_i tokens to contribute to public good

Returns to Contributions

- Tokens not donated yield private return *p*
- If $\sum_{i \in N} m_i \geq T$ (a threshold level) public good is provided yielding payoff *b* to every *i*
- If $\sum_{i \in N} m_i < T$ public good not provided and all tokens refunded
- Contributions beyond *T* receive no additional payoffs

Nash Equilibria of Game

- Social Optimum: Threshold met exactly
- Free-riding Equilibrium: No one contributes
- Inefficient Nash Equilibrium: Threshold not met and no individual can unilaterally contribute to meet *T*

Information Neighborhoods

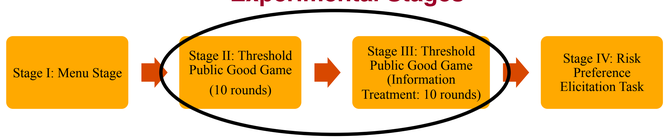
- l_{ij} is information relationship between individuals
  If l_{ij}=1 *i* receives information on *j*'s contribution
- *i*'s information neighborhood is set of individuals linked to her: $N_i(l) = \{j : l_{ij} = 1\}$
- Average "*viewable contributions*" therefore: $\sum_{j \in N_i(l)} m_j \,/\, |N_i|$

EXPERIMENTAL DESIGN & IMPLEMENTATION

Table 1:Experimental Treatments with 2x2 between-subjects design

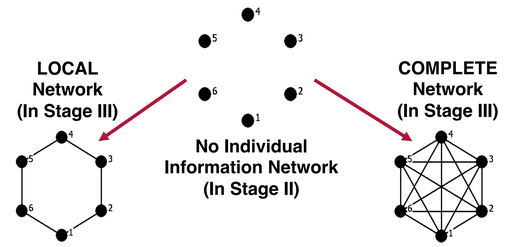
Endowment Level	Information Network: LOCAL	Information Network: COMPLETE
LOW (30 tokens)	LOW-LOCAL	LOW-COMPLETE
HIGH (50 tokens)	HIGH-LOCAL	HIGH-COMPLETE

Experimental Stages



- Data for 24 groups (6 groups per treatment)
- Subjects randomly assigned to groups of six (*N*=6) & Subject ID
- ID determined information neighborhoods (see diagram) and remained unchanged during experiment.
- Data collected at Indiana University in Spring 2015

Information Network Treatment Diagrams (Line segments indicate information neighborhoods)



Experimental Parameters

- *e* (endowment) = 30 tokens/50 tokens
- *T* (threshold) = 120 tokens
- *p* (private return) = 1
- *b* (individual benefit when threshold met) = 60

SUMMARY OF RESULTS

Impact of Networks and Income on Equilibrium Selection (Table 2)

- HIGH groups likely to contribute beyond threshold.
- More equitable distribution of contributions in COMPLETE treatments.
- COMPLETE information reduces tendency of HIGH groups to over-contribute.

Impact of Information Neighbors on Contributions (Table 3)

- Individuals increase contributions when threshold not met in previous round.
- Contributions in LOW groups unaffected by information of social peers.
- In HIGH-COMPLETE groups, contributions increase when average viewable contributions decrease.

RESULTS

GROUP CONTRIBUTION BEHAVIOUR

Figure 1: Group Contribution in tokens

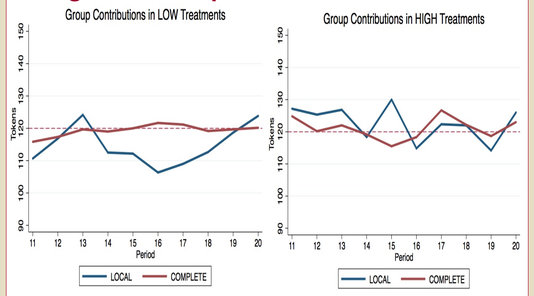
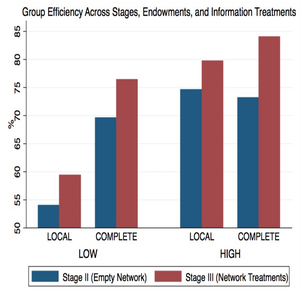


Figure 2: Group Efficiency



$$Efficiency = \frac{\pi^N - \pi^N_{\min}}{\pi^N_{\max} - \pi^N_{\min}}$$

In our experiment group efficiency:

- *E*=0 if $\sum_{i \in N} m_i > T$
- 0<*E*<100 if $\sum_{i \in N} m_i < T$
- *E*=100 if $\sum_{i \in N} m_i = T$

IMPACT OF NETWORK & ENDOWMENT ON MEETING THRESHOLD

Table 2: RE Logit Regression of Group Contributions

(1) BELOW; (2) AT (non-symmetric); (3) AT (symmetric); and (4) ABOVE Threshold

Independent Variable:	(1) $\sum m_i<T$	(2) $\sum m_i=T$	(3) $\sum m_i=T$ *symmetric*	(4) $\sum m_i>T$
Constant	1.07*	-1.87	7.79	-0.90
HIGH dummy	-1.13*	-3.40**	-0.047	2.20***
COMPLETE dummy	-0.14	-0.23	10.4*	-0.057
HIGH * COMPLETE	0.22	3.31*	-5.96	-1.40*
Observations	240	240	240	240

* p<0.10, ** p<0.05, *** p<0.01
Data from periods 11-20
Dummies included:
$\sum_{i \in N} m_{i,t=10}$,
$\sum_{i \in N} m_{i,t-1}$, and
periods

IMPACT OF INFO. NEIGHBORS ON Δ IN INDIVIDUAL CONTRIBUTIONS

Table 3: RE Regression of Δ in Ind. Contributions Given *e*

(1) LOW; (2) HIGH

Independent Variable: Change in *i*'s Contribution	(1) LOW	(2) HIGH
Constant	0.46	-0.36
LOCAL dummy	-0.29	0.26
Last period distance to T†	-0.18***	-0.28***
LOCAL * Distance to T	0.11*	0.0099
Δ in Viewable Contributions	0.41	0.83***
LOCAL * Δ in Viewable Contributions‡	-0.25	-0.66***
Observations	576	576

* p<0.10, ** p<0.05, *** p<0.01
Data from periods 13-20
Period dummies included
Errors clustered at the group level
† $\left(\sum_{i \in N} m_{i,t-1}\right) - T$
‡ $\frac{\left(\sum_{j \in N_i(l)} (m_{j,t-1} - m_{j,t-2})\right)}{|N_i|}$

IMPLICATIONS AND FUTURE WORK

Implications

- Information about social peers influence threshold public goods funding campaigns success:
  - Information about **more peers** may lead to greater **equitable** contributions.
  - Richer donors are more affected by their peers when they have **more information**
  - **Fund drives more efficient** (with less wasteful contributions) **if rich donor groups have more information**
- Individuals contributing **smaller endowment shares more likely to top up contribution shortfalls**

Future Work

- In current design **tokens returned** if threshold not met
  - I.e. no payoff risk to individuals
  - Peer information may impact outcomes differently with payoff risk
- **No uncertainty** about delivery of public good benefits if threshold met
- New Treatments
  - **No refund** – Tokens lost if threshold not met.
  - **Uncertainty about public good provision** – Even if T is met, public good provided with probability < 1

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