

# Programming Public Goods Experiments

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(I borrowed some of the slides from a public goods expert,  
my teacher professor Yan Chen)

# Voluntary Contribution: Experiment

- Each participant has 20 tokens in each round
- Tokens may be allocated to a private account or group account
  - Private account: converted to cash at a constant rate
  - Group account:
    - Yield a lower return to the individual
    - Yield an additional return that accrues to each participant in the group, including the contributor

# Analysis of VCM: 2-person case

- Suppose player 1 put  $x_1$  tokens into group account and player 2 puts  $x_2$  tokens into group account
- Rate of return from group account = 0.3
- Individual payoffs:

$$\pi_1 = 20 - x_1 + 0.3(x_1 + x_2) = 20 - 0.7x_1 + 0.3x_2$$

$$\pi_2 = 20 - x_2 + 0.3(x_1 + x_2) = 20 - 0.7x_2 + 0.3x_1$$

# Analysis of VCM

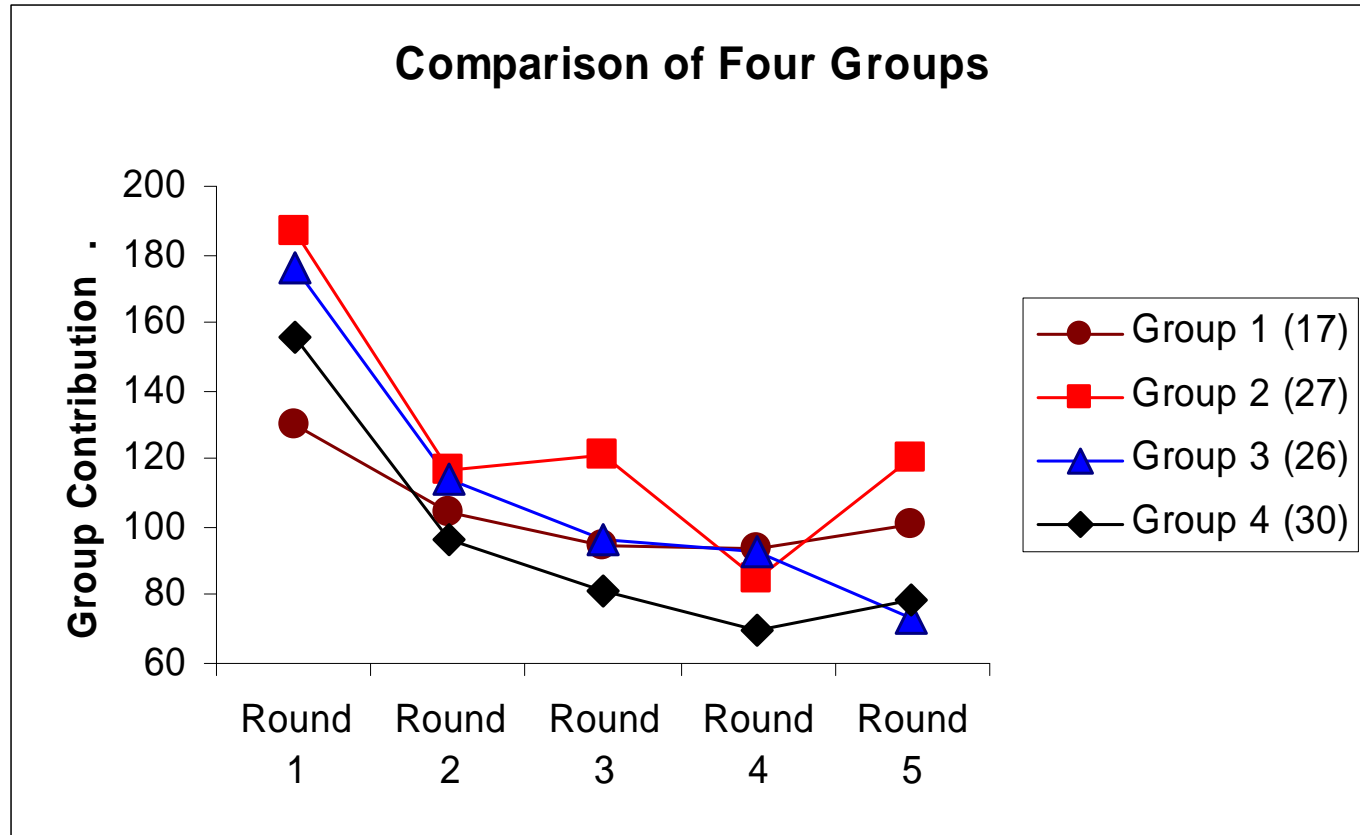
- Dominant strategy is to contribute nothing to group account:  $x_1=x_2=0$

- With n players

$$\pi_i = 20 - x_i + 0.3(x_i + \sum_{j \neq i} x_j) = 20 - 0.7x_i + 0.3 \sum_{j \neq i} x_j$$

- Dominant strategy is still to contribute nothing to group account:  $x_i=0$
- However, when  $n > 3$ , the Pareto optimal outcome is to contribute everything to the group account

# Experimental Data



# VCM Experiments

- Some contribution in the beginning
- Contribution declines over time, but usually not to zero
- What affect the outcomes:
  - Repetition
  - Experience
  - Group size
  - Marginal per capita return
  - Communication

# Programming in Ztree

- Intro
  - License and Reference
  - What Z-Tree can handle
- Installation
- Programming a Simple Game  
(Public Good Game)

# Installation

1. Download files from <http://benjaminchiao.org/download/ztree.zip>
2. Put zTree.exe and zLeaf.exe in the directory C:\myztree\
  3. Create 2 shortcuts on the desktop to zLeaf:
    4. Modify properties/target of the links (adjust the numerical value below to fit your screen resolution):
      1. C:\myztree\zLeaf.exe /size 640x484 /position 20,10 /language en /name first
      2. C:\myztree\zLeaf.exe /size 640x484 /position 670,10 /language en /name second
    5. Create shortcut on the desktop to zTree
    6. Start zTree

# Public Good Game

```
EfficiencyFactor = 1.6;
Endowment = 20;
TotalProfit = 0;
NoPeriods = 10;
Period = 0;
while (Period < NoPeriod) {

    Show Endowment/Contribution dialog

    Profit = Endowment - Contribution + EfficiencyFactor *
             SumContribution/numberSubjects
    Show Contribution, SumContribution, Income
    Write Contribution, Profit into data file

    TotalProfit = TotalProfit + Profit;
    Period = Period + 1;
}
Write TotalProfit into payment file
```

Other variations of public goods  
experiment that can be easily run  
in lab

# Nash-Efficient Public Goods Mechanisms

- Theory:
  - Groves-Ledyard
  - Walker
  - Hurwicz
- Experiment:
  - Smith (79)
  - Chen and Plott (96)
  - Chen and Tang (98)

# Refinements of Nash: Provision Point Mechanism (PPM)

- Bagnoli and Lipman (1989)
- Cost of public good:  $C$   
(minimum level of funding needed)
- Individuals voluntarily contribute  $x_i$
- Total contribution:
  - If  $X \geq C$ , provide the public good  $X = \sum_i x_i$
  - Otherwise, fully refund the contributions

# PPM: Nash Equilibria

- In the VCM experiment, let  $n=4$
- Let the **provision point** be  $C=80$
- Recall: each person has 20 tokens
- Public account has a marginal return of 0.3
- Is zero contribution still a NE?
- What about everyone contributing 20 tokens?

# PPM: Nash Equilibria

- Let  $n=5$
- Let the **provision point** be  $C=80$
- Recall: each person has 20 tokens
- Public account has a marginal return of 0.3
- What is the set of Nash equilibria?
  - Everyone contribute zero?
  - Everyone contribute 20?
  - Other NE?

# PPM: Summary

- Set of **inefficient NE**: any combination of contributions which do not reach the provision point *and no one can unilaterally increase her contribution to reach the provision point.*
- Set of **efficient NE**: any combination of contributions which add up to exactly the provision point
- Provision point changes the Prisoner' Dilemma into a game of chicken

# PPM: Lab and Field Experiments

- Lab experiments: results varied
  - Successful provision of efficient level of public goods in some experiments
  - Unsuccessful in others
- Field experiments
  - List and Lucking-Reiley (2002): PPM provides 20% more contribution than VCM
  - Association of Oregon Faculties: lobbyist
  - Green Choice Program of Niagra Mohawk Power Company of NY
  - Canada's New Democratic Party: fund-raising campaigns