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Empirically-Informed Agent Based Modeling of Incentivized Forest Conservation - June 2019

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Empirically-informed agent based modeling of incentivized forest conservation

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Overview

1. Background

2. ABM of FFE

3. Netlogo

4. What is next?
Background

Payment for ecosystem services (PES):
- popular and ’easy’, BUT
- complex to design
  - do they work?
  - how (why) do they (not) work?
  - crowding out effect?
  - heterogeneous effect?
- context dependent
Background…

Framed field experiment (FFE):

- Nine villages in Ethiopia
- Sample of 432 household heads
- Formed groups of 8 randomly
- Each group endowed with 60 tree branches (‘forest stock’)

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ABM of FFE
The experiment: baseline

Payoff

$$\pi_{it} = x_{it} + 2 \left( \frac{60 - \sum x_{it}}{8} \right), \text{where } x_{it} \leq 5$$

- Individuals face social dilemma
- We observe history without policy
Payoff with PES

Individual PES:

\[
\pi_{it} = \begin{cases} 
  x_{it} + 2 \left( \frac{60 - \sum_{i=1}^{8} x_{it}}{8} \right) + 0.75 (RL - x_{it}), & \text{if } x_{it} \leq RL \\
  x_{it} + 2 \left( \frac{60 - \sum_{i=1}^{8} x_{it}}{8} \right), & \text{if } RL \leq x_{it} \leq 5
\end{cases}
\]

\(RL = \text{Above} \mid \text{Historical} \mid \text{Below}\)

- Group PES: \(\sum_{i=1}^{8} x_{it}\)
With and without PES

![Graph showing average harvest rate over rounds for Group and Individual scenarios.]

- **Y-axis**: Average harvest rate
- **X-axis**: Rounds
- **Legend**:
  - Group
  - Individual
Pay type and reference levels

- **Above**
  - Individual: 14, 0.96, 0.37, 0.43, 0.33
  - Group: 0.05, 0.14, 0.19, 0.49, 0.5

- **Historical**
  - Individual: 0.097, 0.27, 0.34, 0.67
  - Group: 0.075, 0.29, 0.46, 0.54, 0.79

- **Below**
  - Individual: 18, 0.42, 0.12
  - Group: 0.29, 0.38, 0.68

Legend:
- **Average reduction**
- **Average harvest with PES**
Baseline, PES and post-PES

![Bar chart](chart.png)
ABM of FFE data

- previous results are only aggregate values
- address the *how* of behavioral patterns, i.e., mechanism-based explanation
- formalize micro-level mechanisms that generate the phenomenon observed in experiments
- individual behavior affects group outcome, and group behavior affects individual behavior.
AgentEx (Schill et al, 2016)

- Cooperation in CPR games
  - focus of experiments
  - trust, communication (reduces social uncertainty)
  - not enough for sustainability (complexity in SES and uncertainty about resource dynamics)
  - environmental uncertainty

"Cooperation is not enough...for sustainable common-pool resource use"

- Sustainable ecosystem management depends on both social-social and social-ecological interactions (both affected by social and environmental uncertainties)
Netlogo
Pseudo-code

- **Setup:** users and stock (60 trees)
- **Harvest:** start random
- **Identify:** assign type (free rider, (un)conditional cooperators)
- **Update:** group average, others’ vs. own harvest
- **Reset:** show remaining trees and reset stock to 60
- **Report:** group total, group average, others’
What is next?

- Set rules for harvest (random?)
- Replicate behavioral patterns
- Explain heterogenous responses
- Explain interaction effects in treatments
- Show the role of individuals in group outcome
- Experiment level comparisons
What is next?...

- Can we use *behavior to explain behavior*?
- How to determine types of players:
  - Free rider: harvest highest or maximum?
  - Conditional cooperator: start random?
  - Unconditional cooperator: zero or least harvest?
- Validation?
Thank you!