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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?
  - ▶ heterogenous 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')

# 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

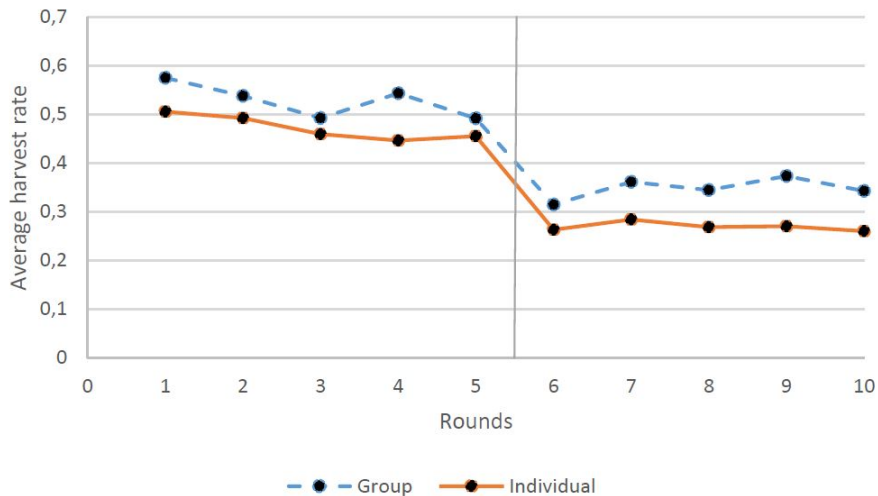
## Individual PES:

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

$RL = \text{Above} \mid \text{Historical} \mid \text{Below}$

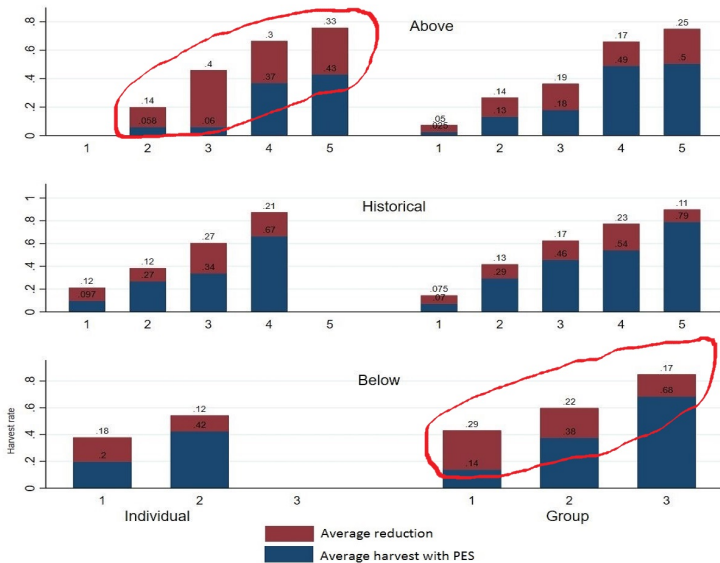
- Group PES:  $\frac{\sum_{i=1}^8 x_{it}}{8}$

# With and without PES

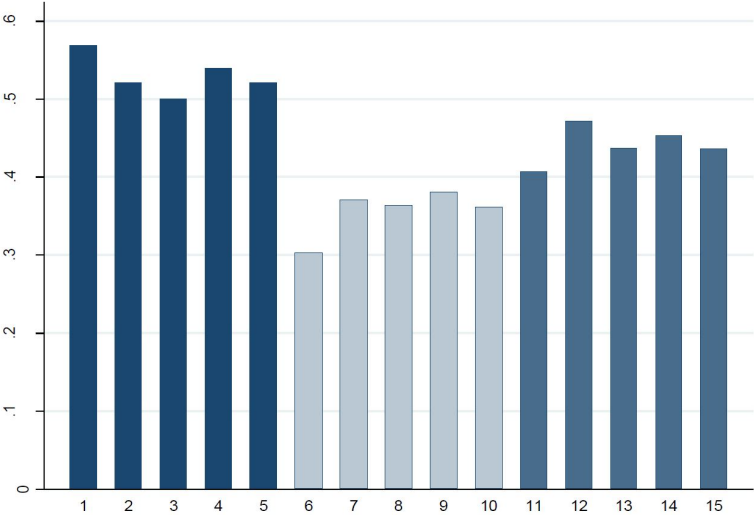




# Pay type and reference levels



# Baseline, PES and post-PES



# 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

setup

go 

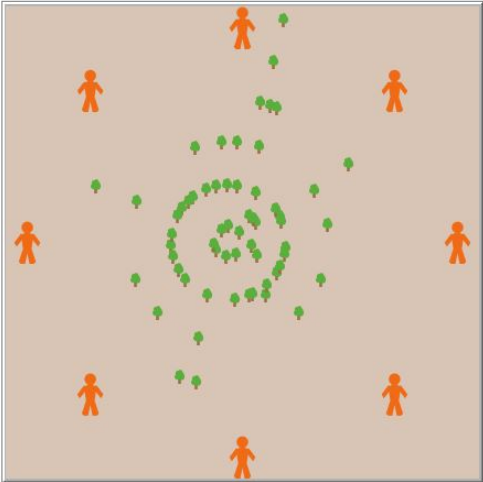
stockSize 60

numberUsers 8

Treatments

payModality  
collective ▾

referenceLevelType  
below ▾



# 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!