Simulating the effects of strong reciprocity on fair allocations

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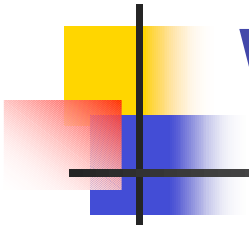
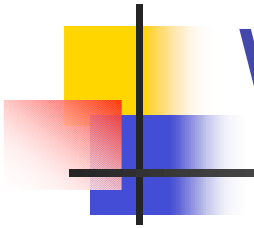
Dissertation outline

- The role of cooperation in provisioning global public goods
- The ability of strong reciprocity to maintain cooperation
- The role of asymmetries on cooperative outcomes



Why study cooperation?

- An enigma to evolutionary biology
  - Rise of multi-cellular life
  - Animal societies
- Human social dilemmas
  - International diplomacy
  - Common pool resource management



Why is cooperation a mystery?

- The problem of free-riding and cheating
  - Evolutionary biology predicts against it
  - Economic game theory predicts against it

Explanations of cooperation

- Kin selection
- Very small group stability
- Reciprocal altruism
- Tag recognition
- Group selection
- Strong reciprocity

What is Strong Reciprocity?

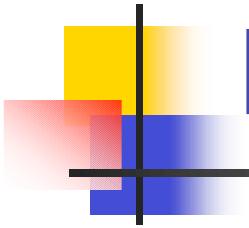
- Agents do 1 of the following:
  - Punish cheaters
  - Reward cooperators
- In either case, the acting agent:
  - Incurs a cost to punish or reward
  - Receives no material benefit for doing so

Altruistic punishment

- The costly punishment of free-riders without material gain to the punisher
- 2nd order public good
- Currently in favor as an explanation

Fehr & Gächter (2000,2002)

- Results
  - Without punishment:
    - Investment fell from about 50% to 25%
  - With punishment:
    - Investment rose from about 50% to 80%
- Conclusion
  - Altruistic punishment can maintain cooperation



My questions

- Will altruistic punishment lead to cooperation in a simulation?
- What happens as the reciprocity factor is systematically varied?
- What are the relative effects of punishment and rewarding?
- Is cooperative behavior desirable?

The ultimatum game

- Player A is given an endowment and then offers a portion to Player B
- If Player B accepts:
  - Both keep their allocation of the endowment
- If Player B rejects:
  - Both players get 0

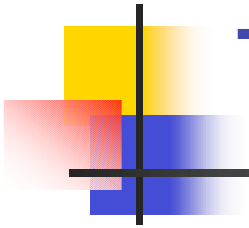
The ultimatum game

- Roth (1991), Slonim (1998), Cameron (1999)
  - Empircal results from "around the world"
  - Jerusalem, Llubljana, Pittsburg, Tokyo, Tucson, Los Angeles, Yogyakarta
  - Modal offer 50% (mean 40-50%)

- Conclusion
  - Human cooperation is a universal trait

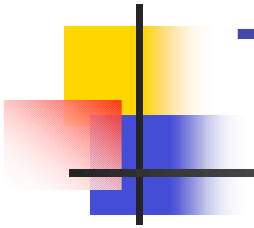
The ultimatum game

- Henrich (2000)
  - Studied the Machiguenga of Peru
  - Hunting/gathering, fishing, swidden agriculture
  - Family units economically independent
  - No social structure above the family unit
- Modal offer 15% (mean 25%)
- Conclusion:
  - Some social institution maintains cooperation



The simulation

- ABM of the ultimatum game
  - 3 positions – doner, responder, observer
- Written in Java
- Spatially explicit
  - 25 x 25 torroidal landscape

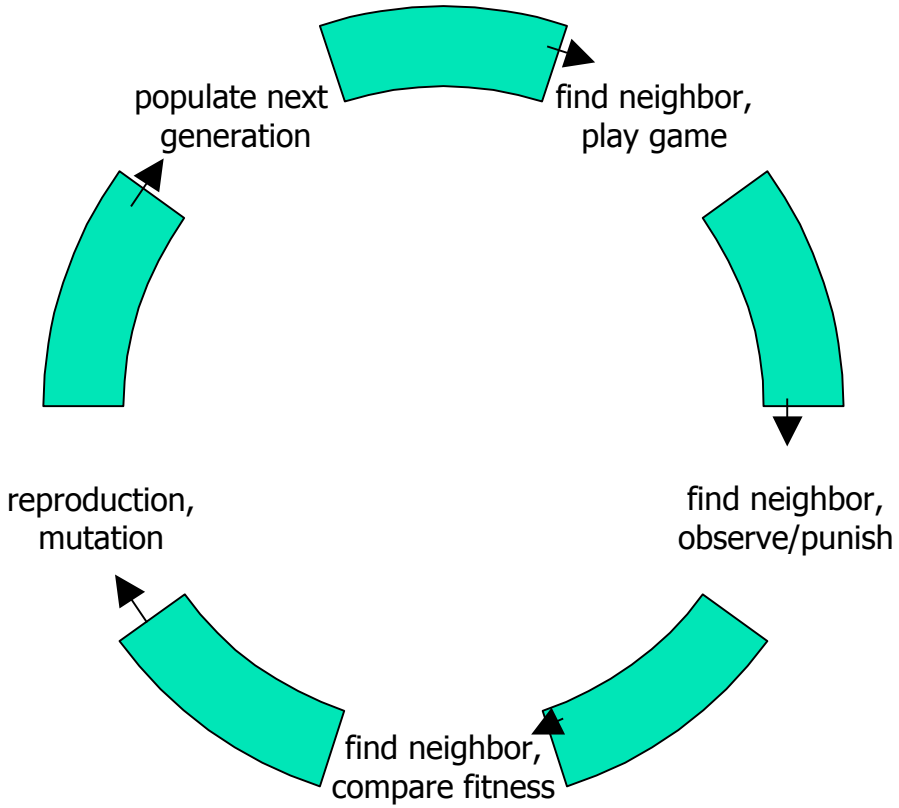


The agents

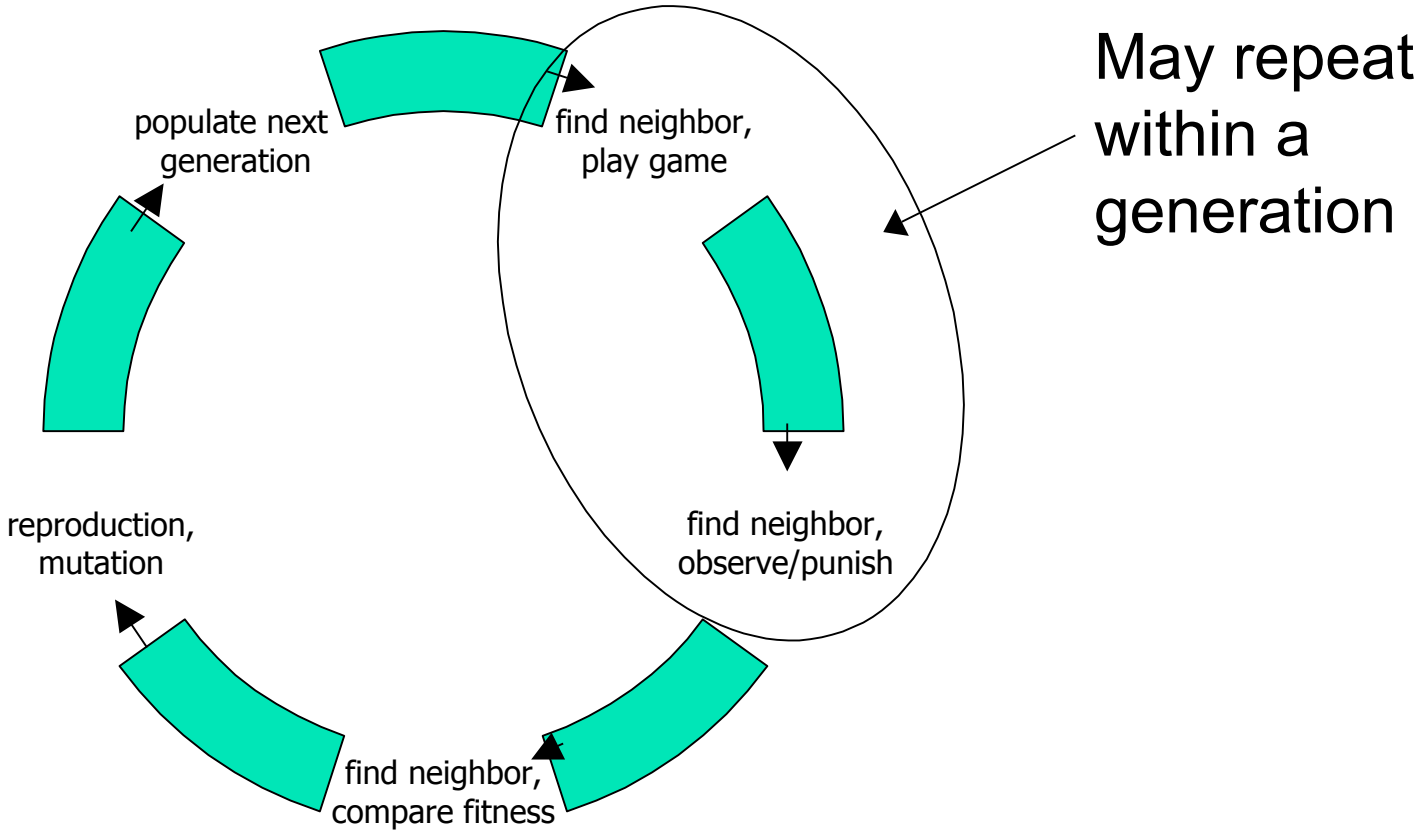
- Have 4 traits randomly seeded on [0,1]
  - Offer (when they are the proposer)
  - Acceptance threshold (when they are responder)
  - Punishment threshold (when they are observer)
  - Punishment amount (when they are observer)

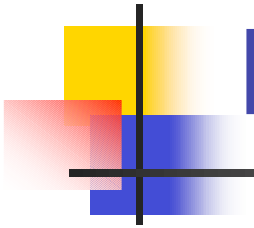
- A single generation
  - Game routine
  - Observation/punishment routine
  - Mating/fitness assessment routine

A single generation



A single generation





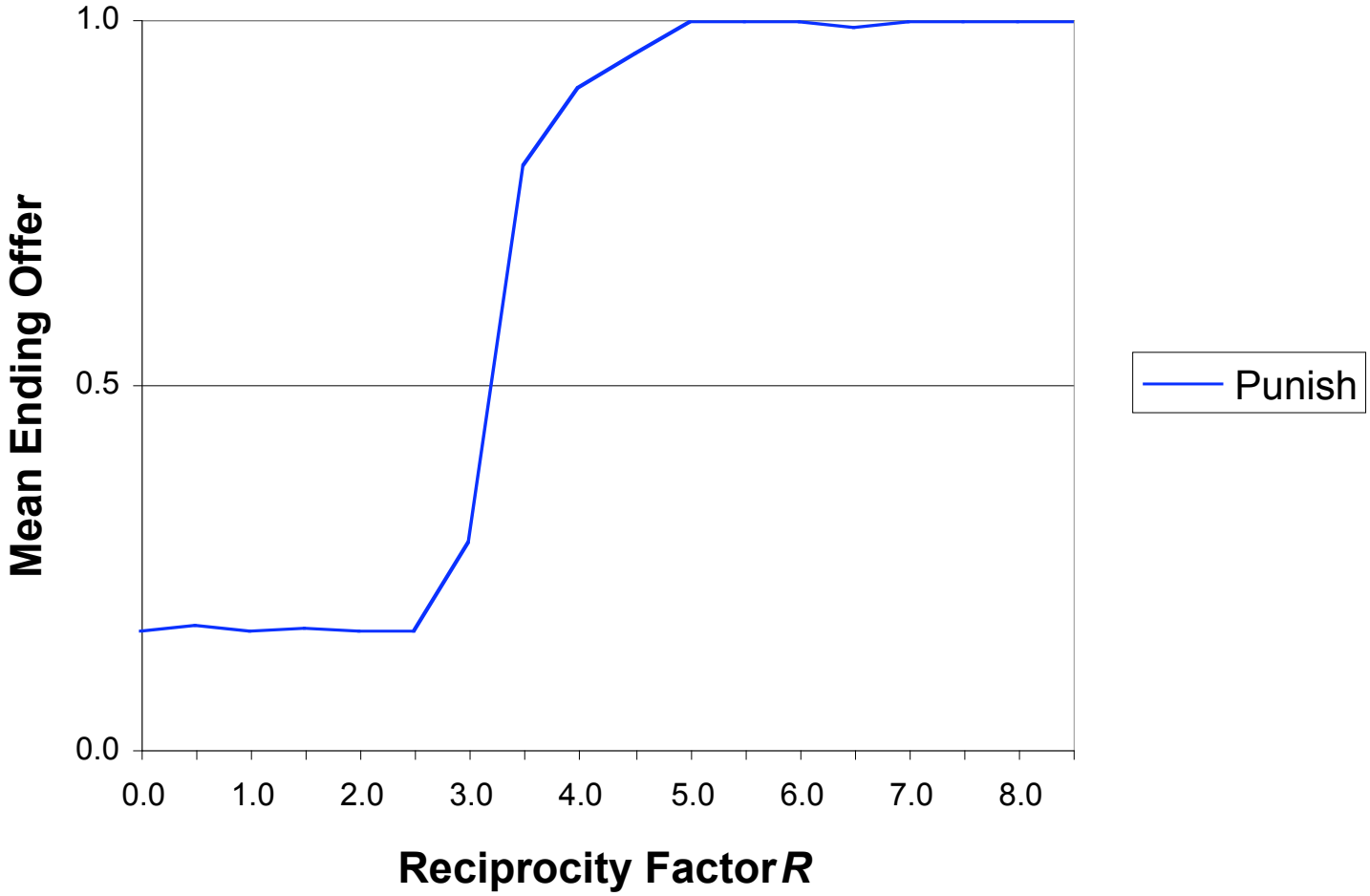
Model parameters

- Spatial dimensions (population)
- Radius of neighborhood
- Games per generation
- Mutation rate
- Reciprocity factor *R*

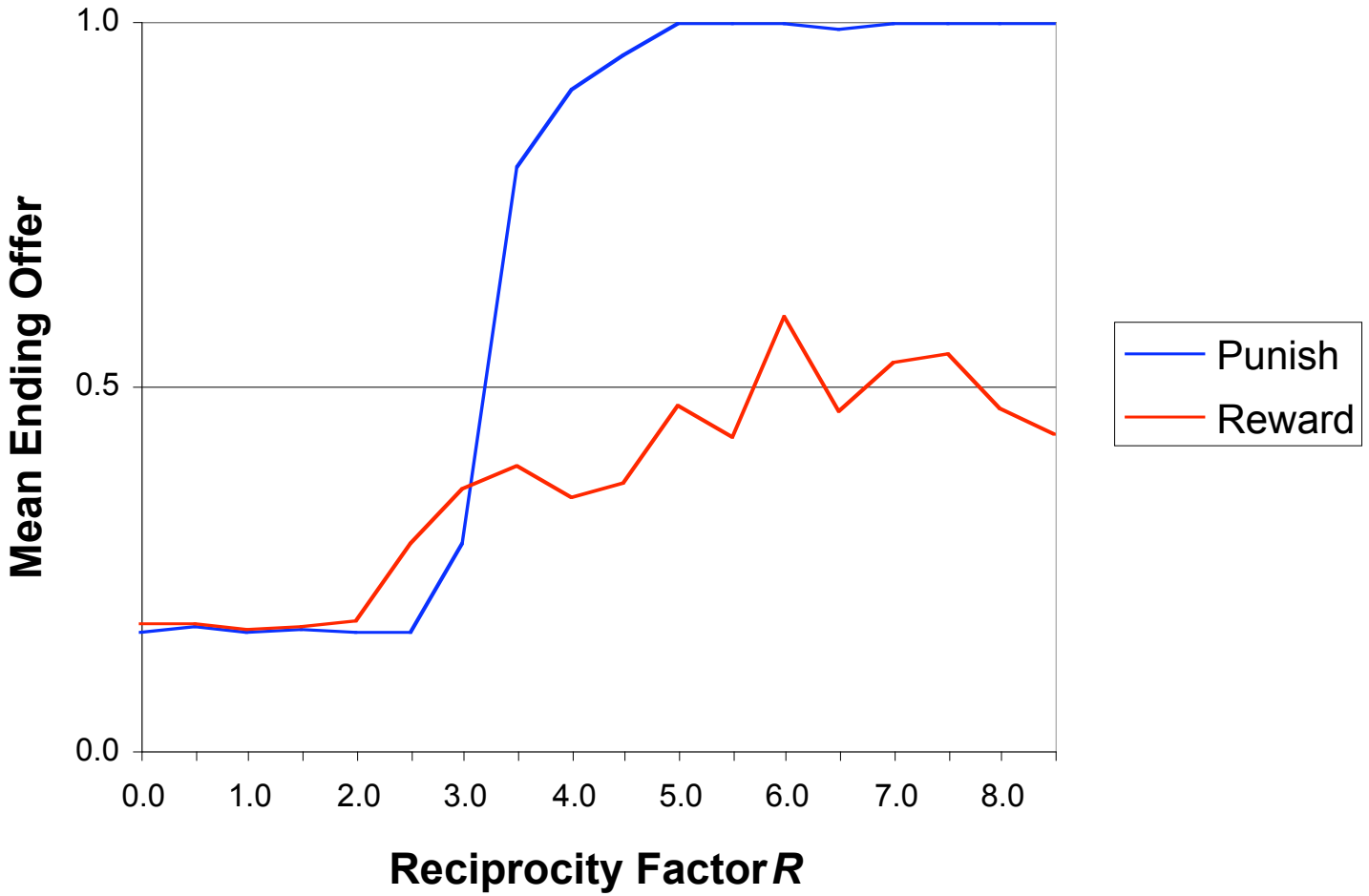
Neighborhood size

- Neighborhood = 1
  - Even with no punishment or rewarding, offers evolved much higher than Nash equilibrium (mean offer ≈ 0.17)
- Neighborhood > 1
  - results ≈ economic predictions (mean offer ≈ 0.01)

Results


1.0
0.5
0.0
Mean Ending Offer
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Reciprocity Factor R
Punish

Results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Mean Ending Offer
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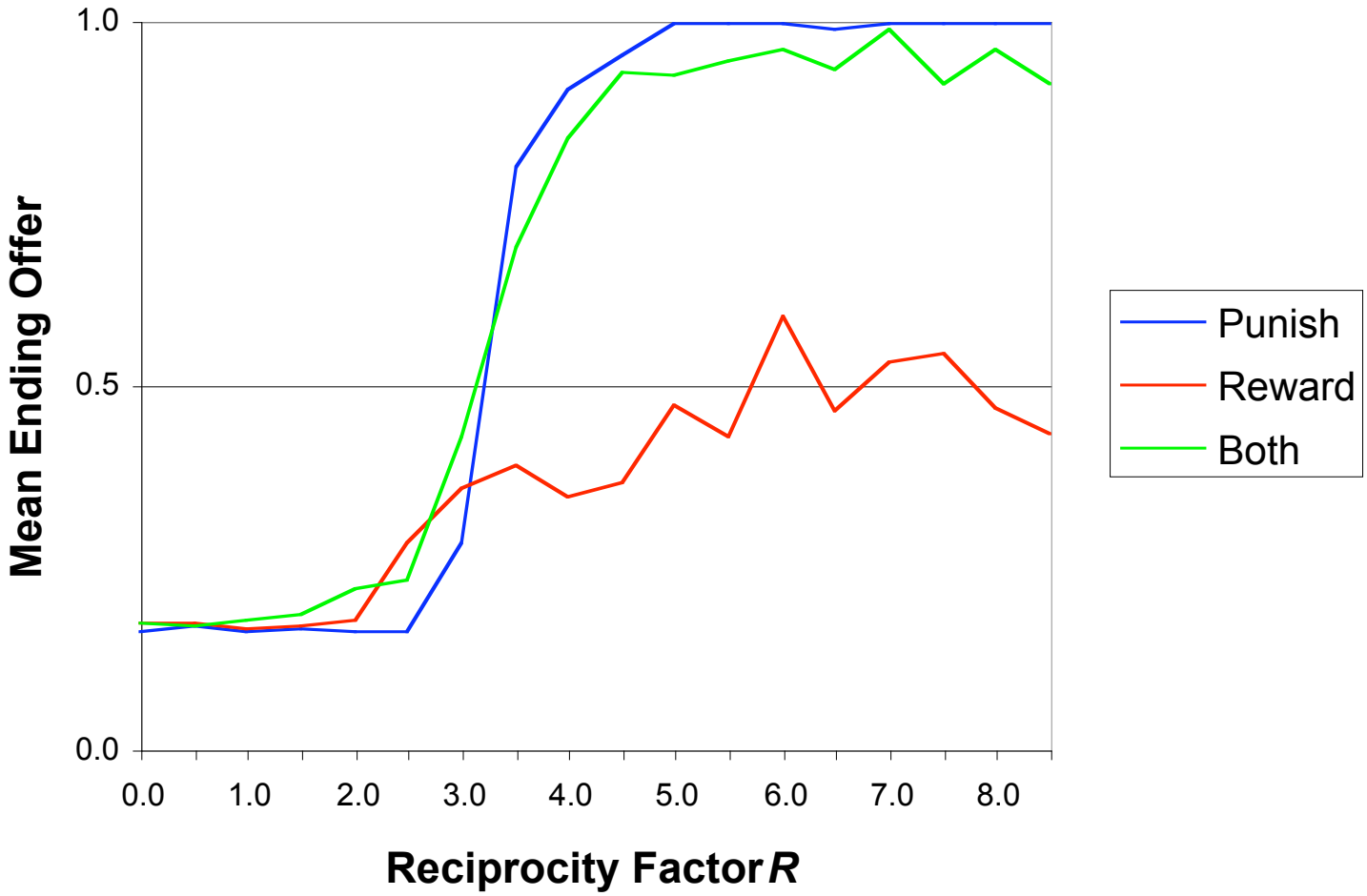
Reciprocity Factor *R*
Punish
Reward

Results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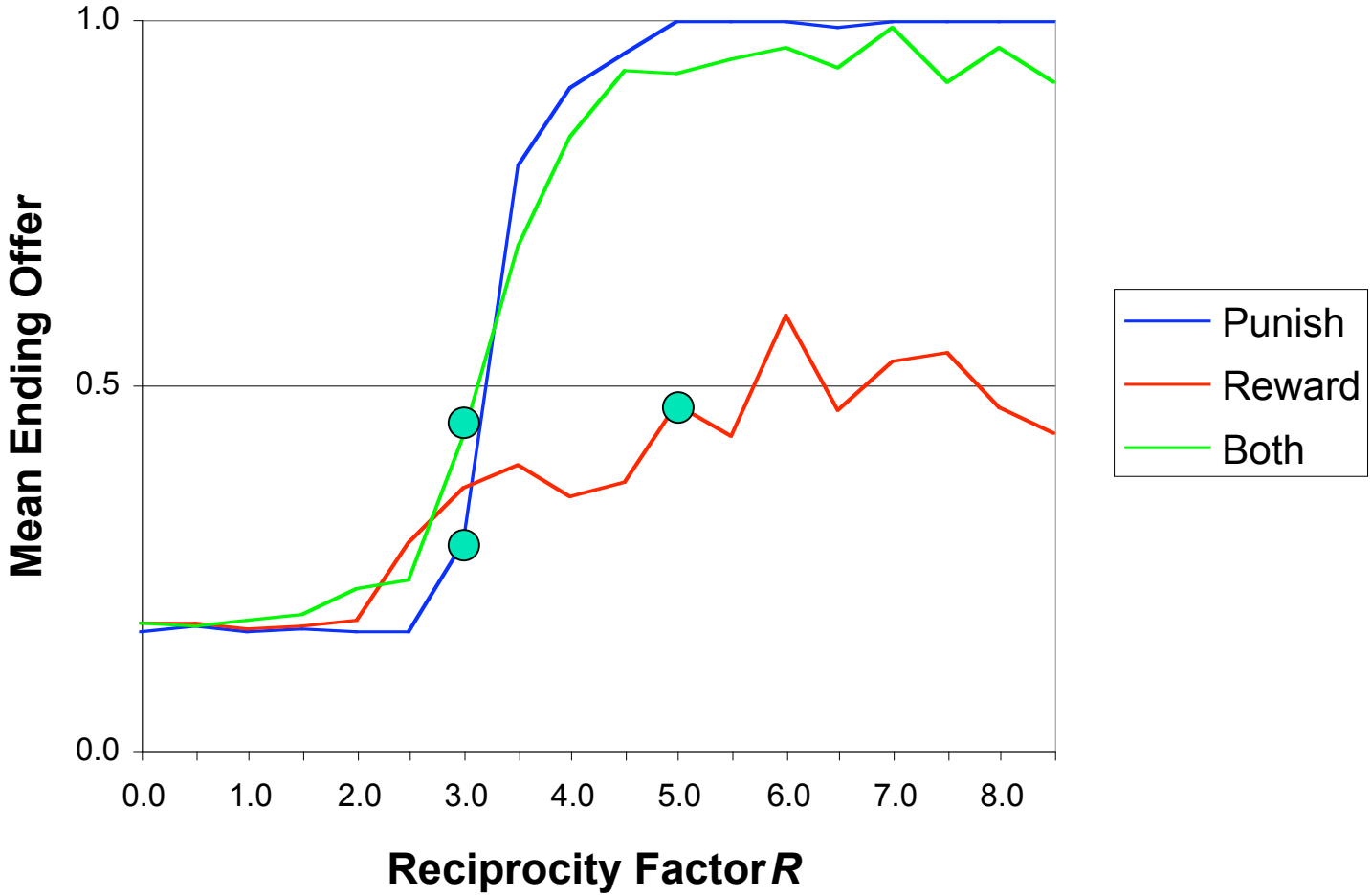
Mean Ending Offer
0.0
1.0
2.0
3.0
4.0
5.0
6.0
7.0
8.0
Reciprocity Factor R
Punish
Reward
Both

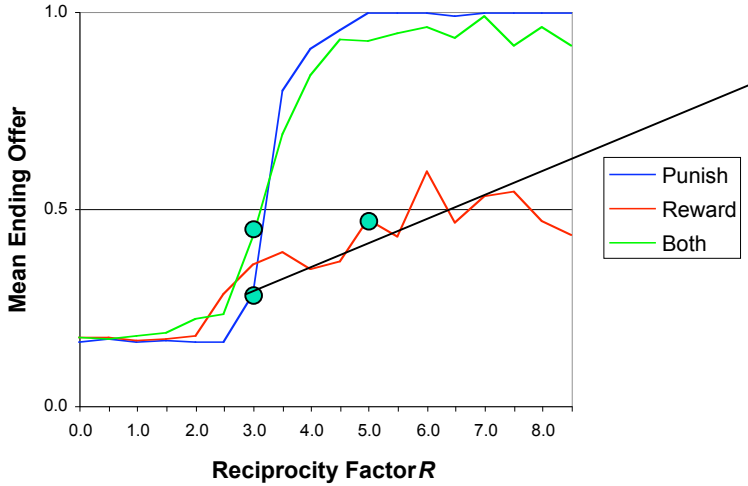
Examine distribution

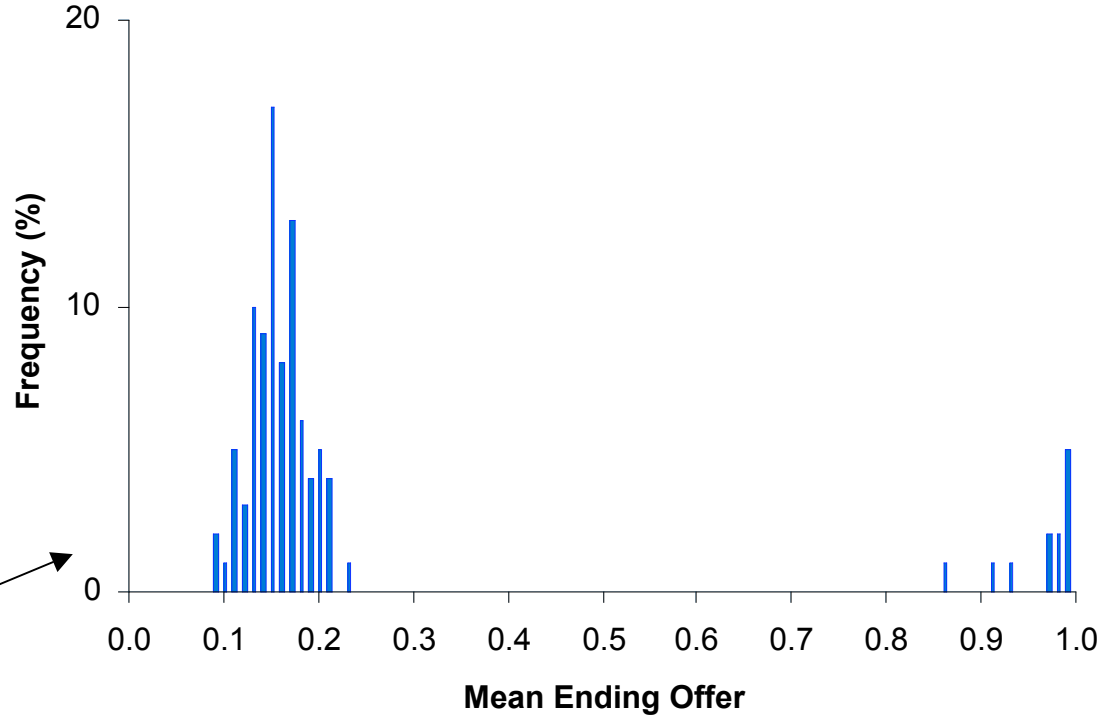


Distribution: Punishment

R = 3.0

mean offer = 0.25

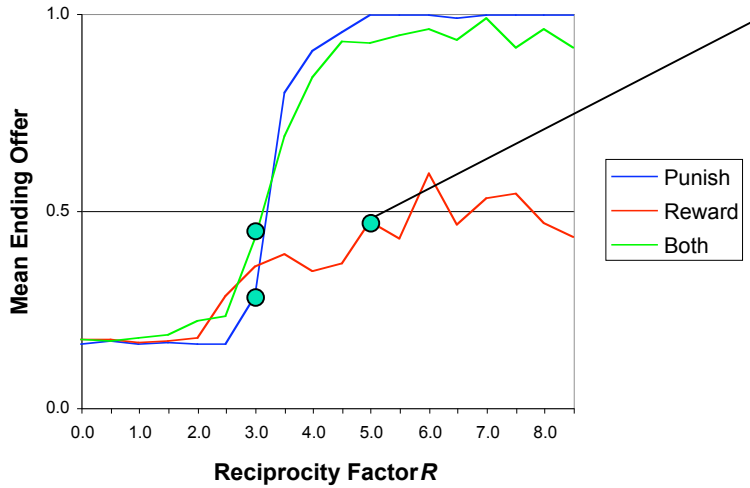


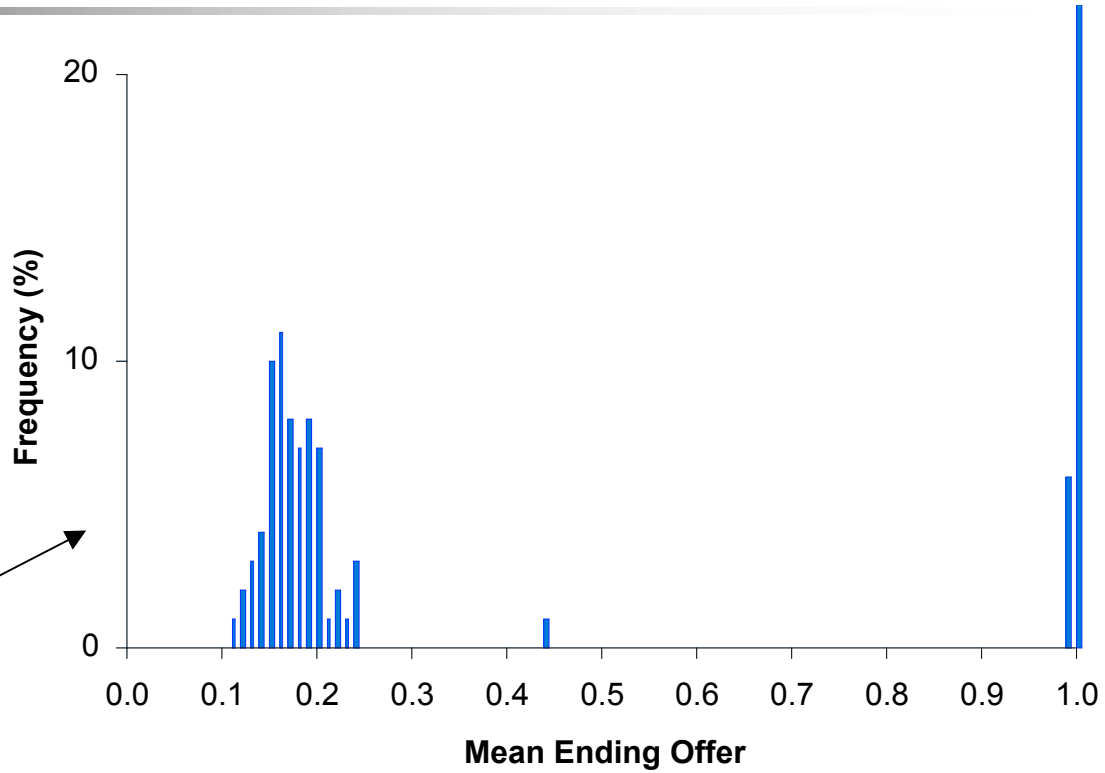


Distribution: Reward

R = 5.0

mean offer = 0.47

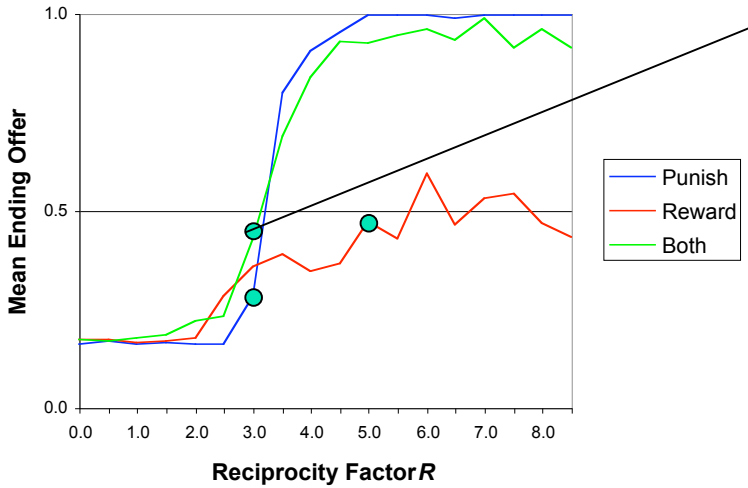


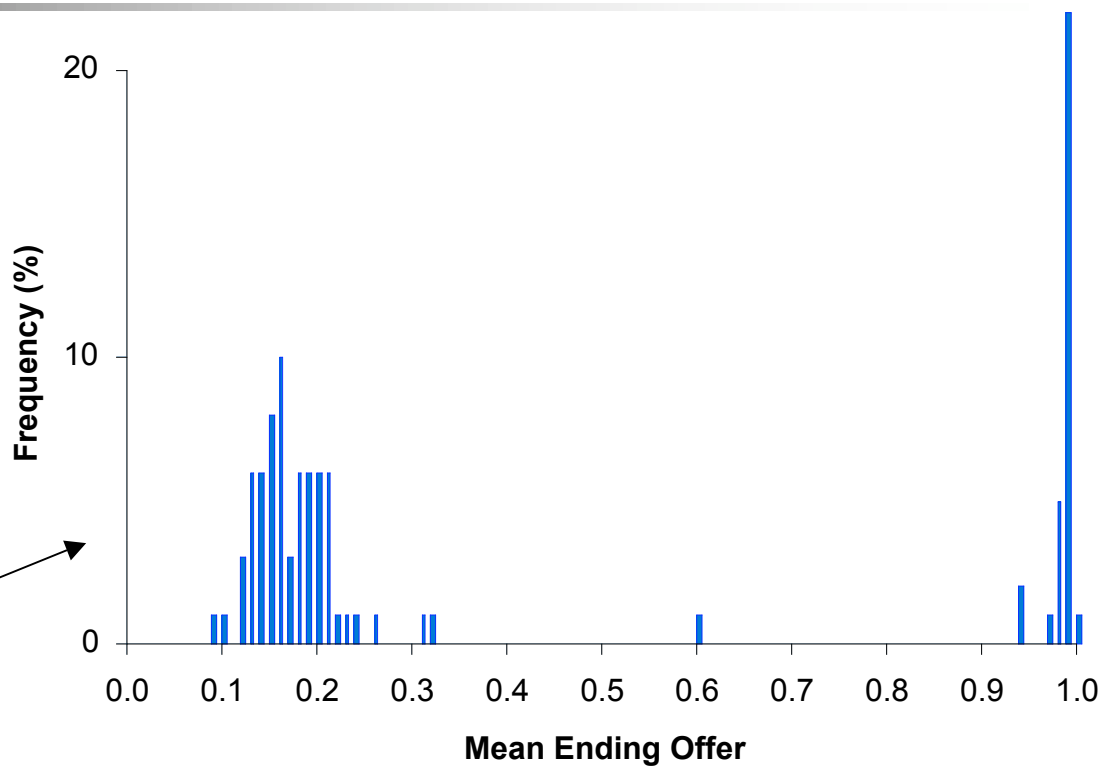


Distribution: Both

R = 3.0

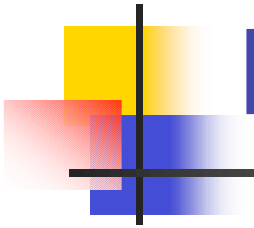
mean offer = 0.43





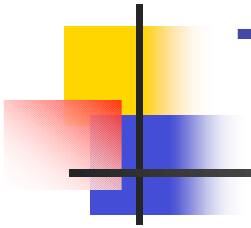
Conclusions

- Strong reciprocity alone does not lead to fair allocations in the ultimatum game
- Both punishment alone and rewarding alone lead to bistable outcomes
- Allocations do not diverge from Nash equilibrium unless the model is spatially explicit



Future research

- Analysis of "altruism"
  - Define relative fitness in this context
  - Define bounds of agent rationality
- Move to simulations of common-goods games
  - Currently working on *N*-person prisoner's dilemma
  - Coupled with lab experiments



Thank you!

- Discussion
- Question
- Feedback