International Negotiations
Games, Strategies and Negotiations
Game Theory in Action

Costas Roumanias

AUEB, Department of International and European Economic Studies

February 3, 2024

How useful is Game Theory in analysing strategic interdependencies?

- We have developed tools that can predict how rational agents will behave in situations of strategic iterdependence
- How well does Game Theory capture actual players' behaviour in reality?
- Three ways to test game theoretic predictions:
  1. Set up experiments that closely reproduce the theoretical conditions of games
  2. Get data from actual situations where people interact strategically and compare their choices to the predictions made by theoretical models
  3. Set up computer tournaments

The ultimatum game: are the SPNE of the game convincing as a solution?

- We have developed tools that can predict how rational agents will behave in situations of strategic iterdependence
- The ultimatum game predicts that in situations when an ultimatum is given, the party that moves first (gives the ultimatum) will go away with the whole pie (or at least most if it)
- Is this prediction verified in action?
- Many empirical studies have tried to test this result
- Pairs of players are matched randomly, playing the game against each other only once
- Results differ considerably from the unique SPNE of the game

Experimental evidence for the ultimatum game

- Let's examine players actual strategies from the ultimatum game in experiments

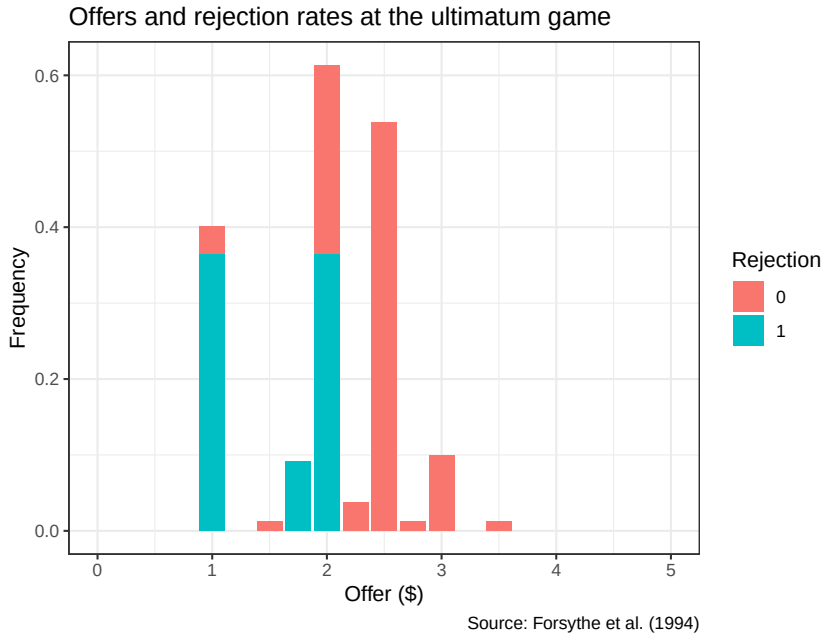


Figure: The ultimatum game with $ 5 total stakes

Experimental evidence for the ultimatum game

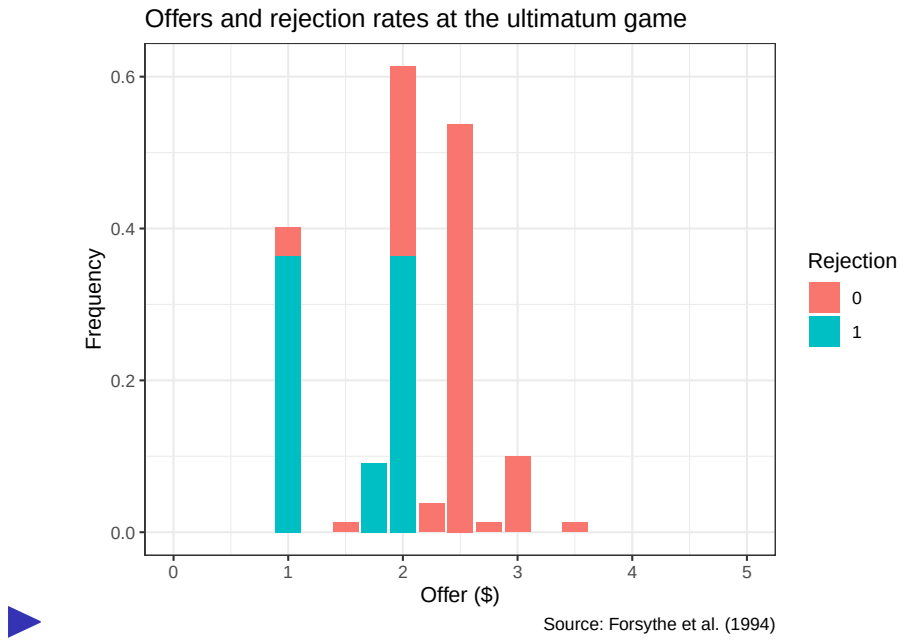


Figure: The ultimatum game with $ 5 total stakes

- Note that:
  1. Many offers are much higher that predicted by the SPNE of the game
  2. there are significant rejection rates even for high ($2 out of $5) offers

Experimental evidence for the ultimatum game

- We see that predictions of SPNE differ for both P1 and P2!
- Why is that the case? Is dynamic Game Theory flawed as a tool?

Why do experimental results differ?

1. Payoffs are not identical to monetary gains. For example if we are to divide \$5 between the two of us and I take \$4, leaving \$1 for P2, then P2's *utility* might not be equal to the actual division: $[U^1(4,1), U^2(4,1)] \neq (4,1)$. Since we observe player 2 rejecting an offer and preferring nothing to \$1, we can deduce that for P2, $U^2(9,1) < U^2(0,0)$
2. This of course means that equity considerations enter the players utility function (so that what players actually take from playing the game is not just money, but also a sense of fairness etc...)

Why do experimental results differ?

3. Would we expect the same punishing attitude from player 2 to persist if say stakes had risen to $4,000- $1,000?How about if the stakes were $4,000,000- $1,000,000
4. What are the cultural components in these equilibria? Would the game be played differently by cultures with different customs and traditions?

Why do experimental results differ?

- W.r.t. the first observation, there can only be one answer: clearly, money received is not actual utility. Particularly for small amounts, fairness is very important
- People might be willing to sacrifice a few dollars (perhaps more than a few) in order to punish someone who, they perceive, treated them unfairly
- This brings back the conversation to something we have already hinted (and to which we shall return): Make sure you get the payoffs of the players right!
- In games of negotiation, failing to identify all parties (players) involved or failing to identify what their true interests (payoffs) are, might lead to a collapse of the negotiation whereas a solution could have been reached if negotiators could spot what parties want to take out of a negotiation

Why do experimental results differ?

- W.r.t. observation no 3 things can get quite intriguing:
- Some early studies (Cameron 1999) have found that increasing the stakes doesn't significantly alter players' behaviour: high offers and rejection rates persisted
- Other studies (Slonim & Roth 1998, Munier & Zaharia 2002) however found that rejections rate fell as stakes rose
- A relatively recent study sheds light on what might happen as stakes rise:

High stakes - Andersen, Steffen et al. (2011)

- Andersen et al. (2011)
- Ultimatum game in poor villages in India
- 4 different pie sizes:
  1. ₹ 20 ($\simeq$ €0.22)
  2. ₹ 200 ($\simeq$ €2.2)
  3. ₹ 2000 ($\simeq$ €22)
  4. ₹ 20 000 ($\simeq$ €220)
- Note that the large pie is equivalent to up to 7 months of salaries (high stakes)
- Let's examine the distribution of offers:

High stakes - Andersen, Steffen et al. (2011)

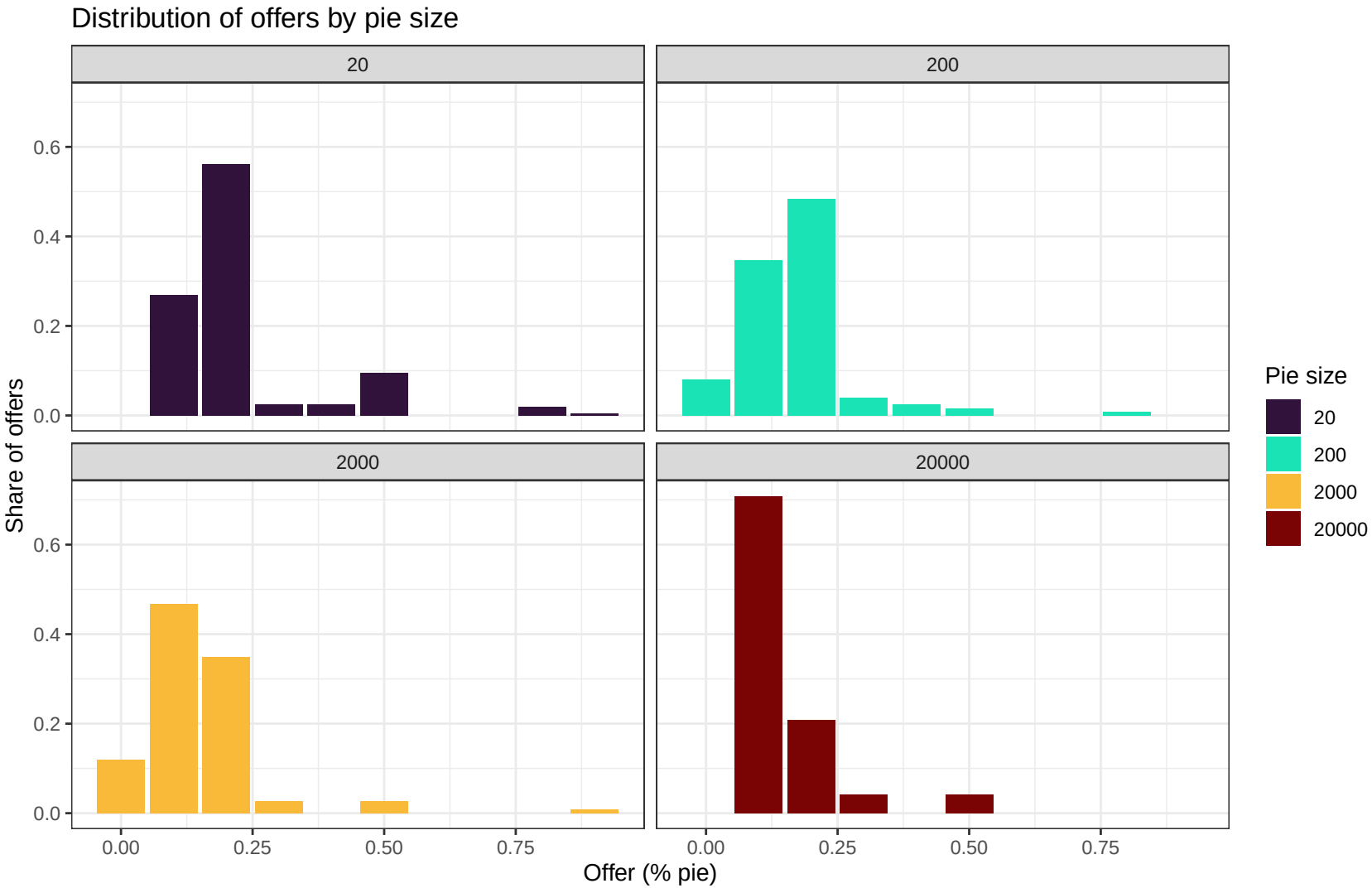


Figure: The ultimatum game with varying pie sizes

High stakes - Andersen, Steffen et al. (2011)

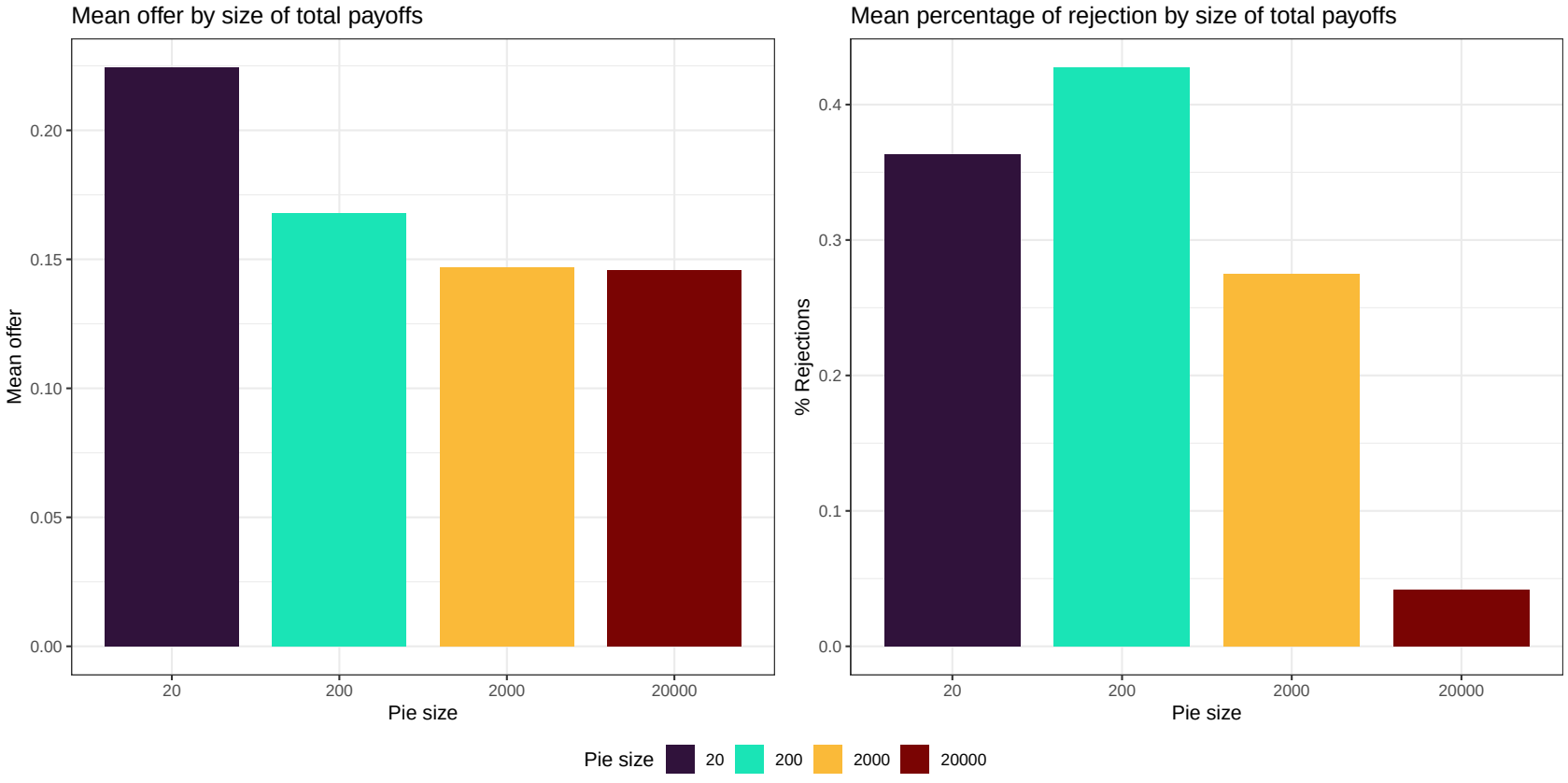


Figure: Mean offer and rejection rates with varying pie sizes

High stakes - Andersen, Steffen et al. (2011)

- It is clear that both offers and rejections rates shrink as the pie size increases. For total prizes of ₹20,000, the mean offer is below 15% (a very low offer compared to standard past experiments in Western societies with small stakes), and the mean rejection rate is below 5%
- As the stakes get higher offers get smaller and rejections tend to disappear
- we can apply regression analysis to estimate the probability of rejection as the stake rises
- The probability of rejection shrinks down to zero as the pie size rises above a month's wage

High stakes - Andersen, Steffen et al. (2011)

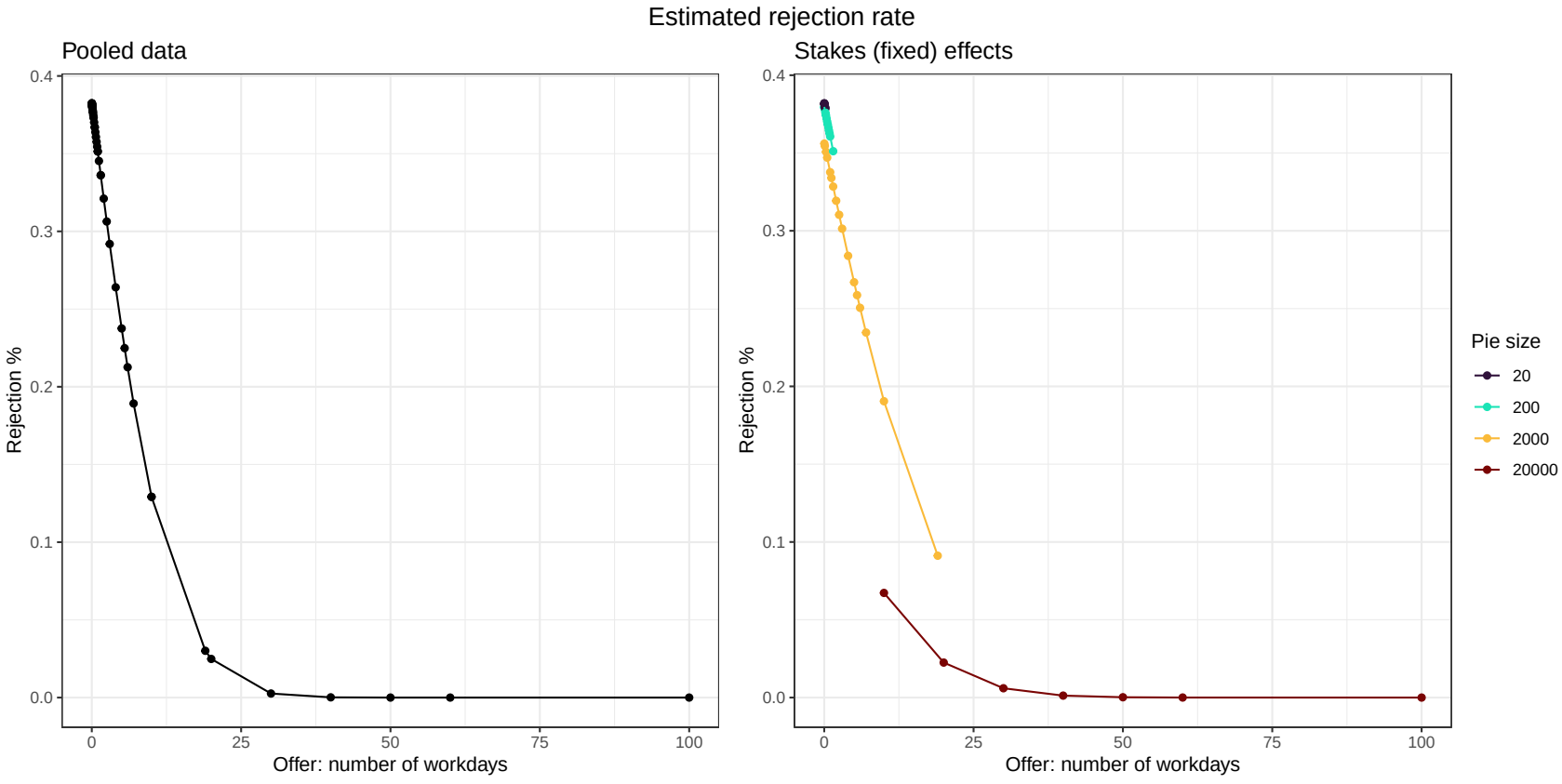


Figure: Probability of rejection as a function of the pie size (expressed as number of daily wages)

Ultimatum game and stakes - Lessons drawn

- Some clear messages emerge from our conversation so far:
- First that there are elements of behavioural patterns in players' behaviour: particularly for games with small stakes, people tend to take into consideration other factors and not engage in pure cost-benefit analysis. In particular, fairness or equality concerns seem to weigh into their decisions
- Hence it seems that payoffs do not coincide with actual monetary gains from playing the game
- However, as the stakes in India rose to levels of 6-7 months salaries, players 2, stopped rejecting low offers and started accepting players' 1 low offers with a high proability
- It seems that as the staker rise, the players psychological payoffs tend to converge to monetary payoffs: A player 2 seems to reject an offer equal to 5% of a €10 pie much more easily than she would reject 5% of million euros!

Cultural differences and strategic play

- In negotiations, it is possible that you will have to deal with people of varying cultures
- Is it reasonable to assume that all sitting at the table share the same understanding of how the game is played?
- Is it possible that people with different customs/cultural backgrounds might perceive the process differently?
- Do we expect someone from downtown Manhattan to play a game in the same way as someone from Sub-Saharan Africa?
- How do different cultures played the ultimatum game?

Cultural differences and strategic play

- Henrich et al. (2001, 2005) organised rounds of the ultimatum games in small foraging societies around the world
- Large geographical spread around the world:

The ultimatum game in small-scale societies

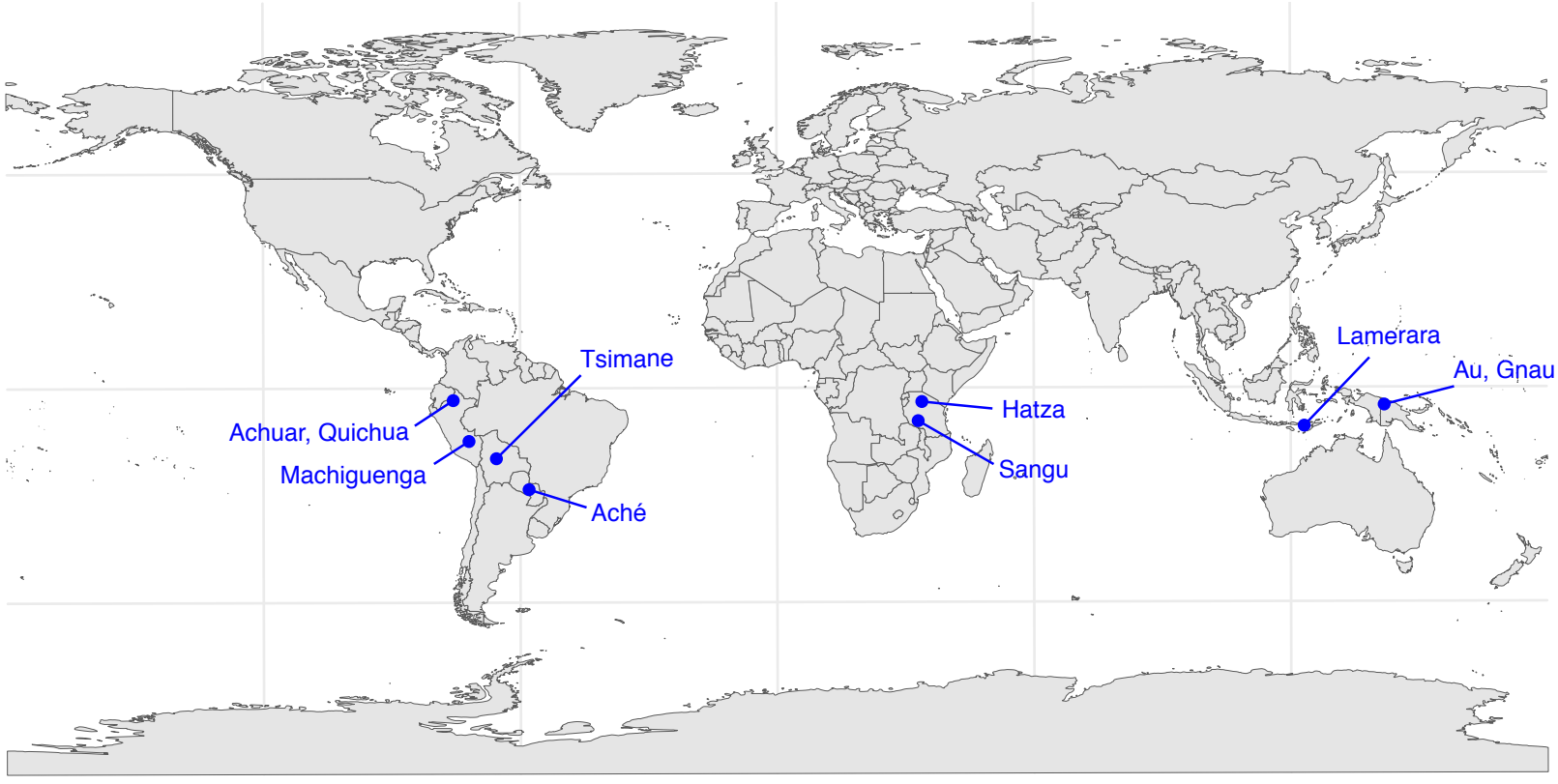


Figure: Some of the societies in Heinrich et al. (2005)

Cultural differences and strategic play

- The table presents the offers by player 1 and the responses of player 2 in some characteristic cases of small foraging societies

Group	Country	Mean offer	Rejection rate	Rejections of low offers
Machiguenga	Peru	0.26	4.8%	10%
Hadza	Tanzania	0.40	19%	80%
Tsimane	Bolivia	0.37	0%	0%
Quichua	Equador	0.27	15%	50%
Au	P. N. G.	0.43	27%	100%
Gnau	P. N. G.	0.38	40%	50%
Sangu	Tanzania	0.42	5%	100%
Achuar	Equador	0.42	0%	0%
Aché	Paraguay	0.51	0%	0%
Lamerara	Indonesia	0.58	0%	0%

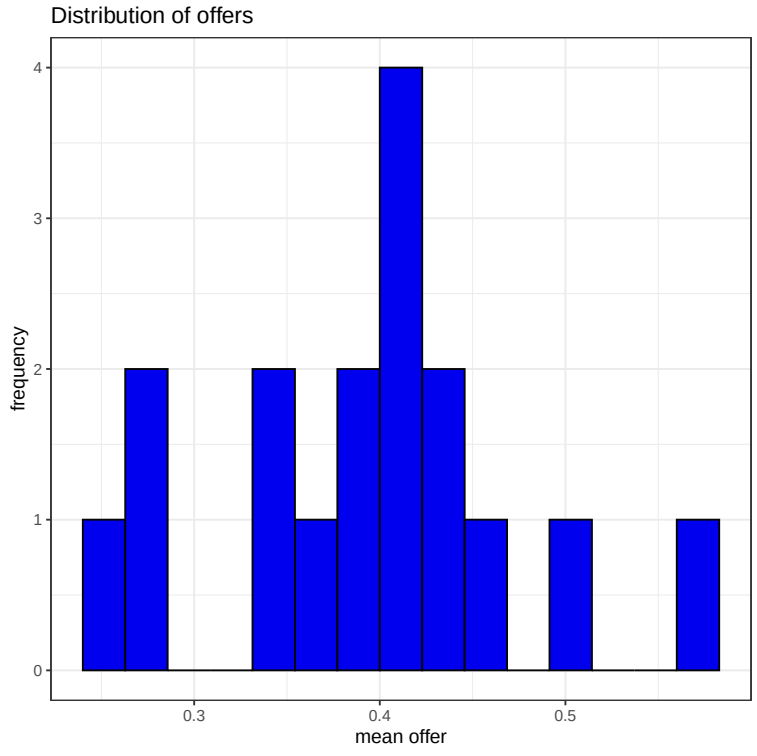
Table: Source: Henrich et al. (2005)

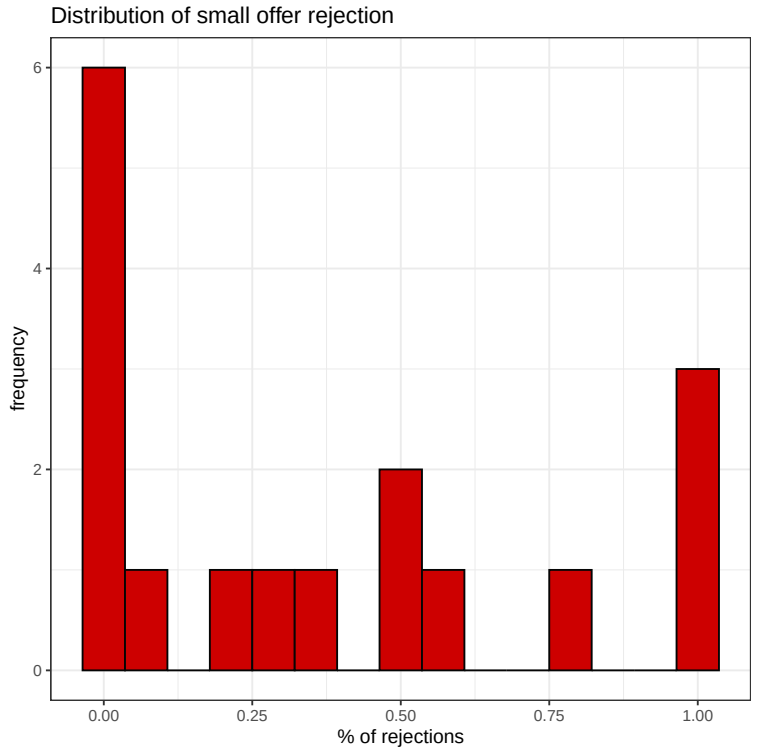
The ultimatum game in small-scale societies: things to notice

- Large variation in offers
- Multimodal distribution of offers
- Large variation of rejection rates

Experimental evidence for the ultimatum game

- Mean offer and rejection rates of the ultimatum game in small scale societies





The ultimatum game in small-scale societies: lessons learnt

- Local customs important: Au, Gnau (PNG) Large offers, large rejection rates: avoid obligation
- Importance of cooperation in production (see Lamerara)
- Importance of market integration
- cooperation in production + market integration can explain 88% of variation in offers
- evidence of huge importance of cultural factors in the way we interact strategically!

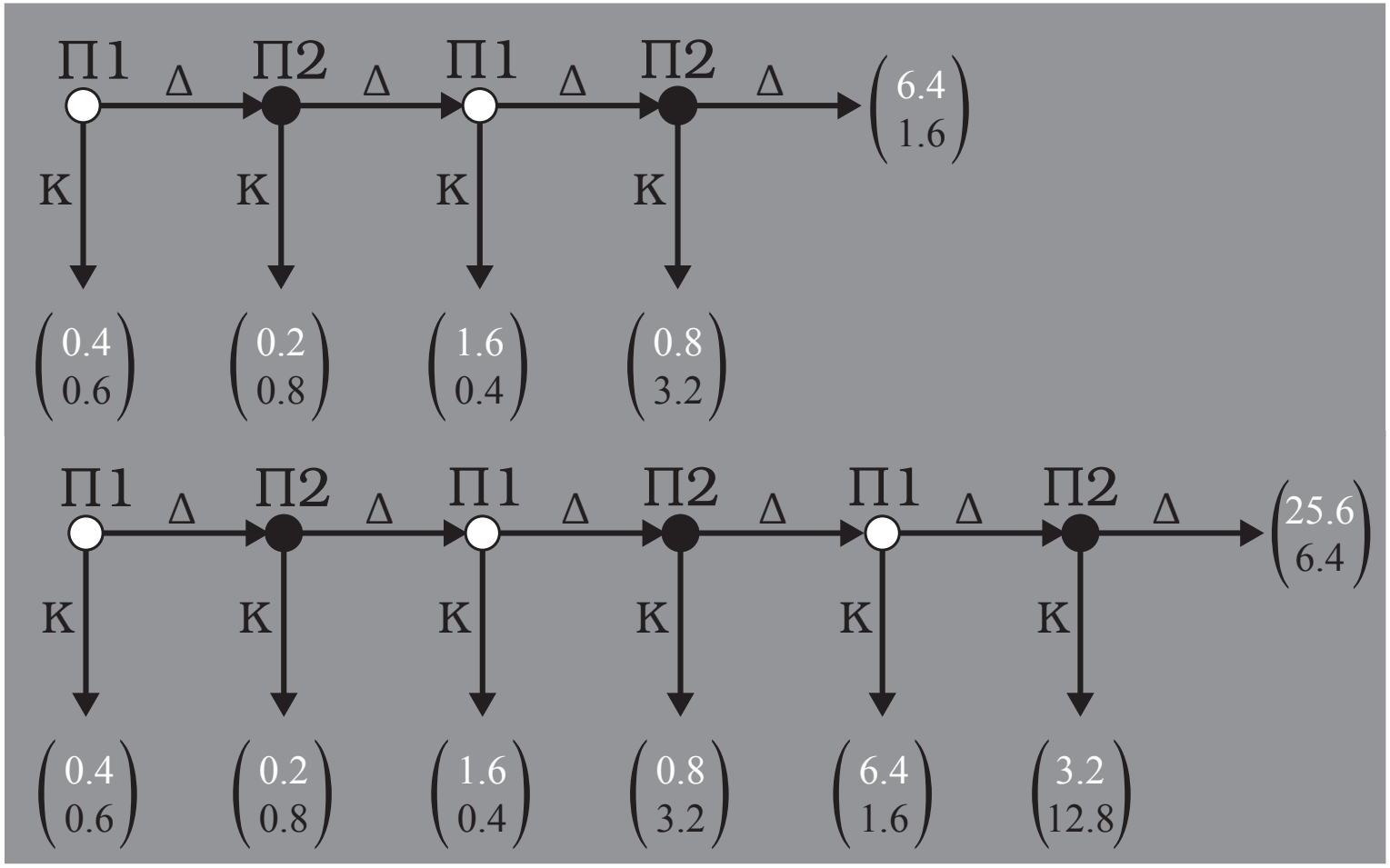
Lessons from the centipede game

- Should we trust backwards induction and rationality in multi-stage games?
- How does this matter in negotiations?
- How confident are we that we should always call other party's bluffs?
- Let's see how players fared in experiments of the centipede game

Lessons from the centipede game

- One of the first experimental studies of the predictions of dynamic game theory of how the centiped game should be played was undertaken by McKelvey and Palfrey (1992)
- In Passadena College of the California Institute of Technology, they organised repeated sessions of the centipede game with 5 or 7 nodes (why not 100?)
- The games are given below

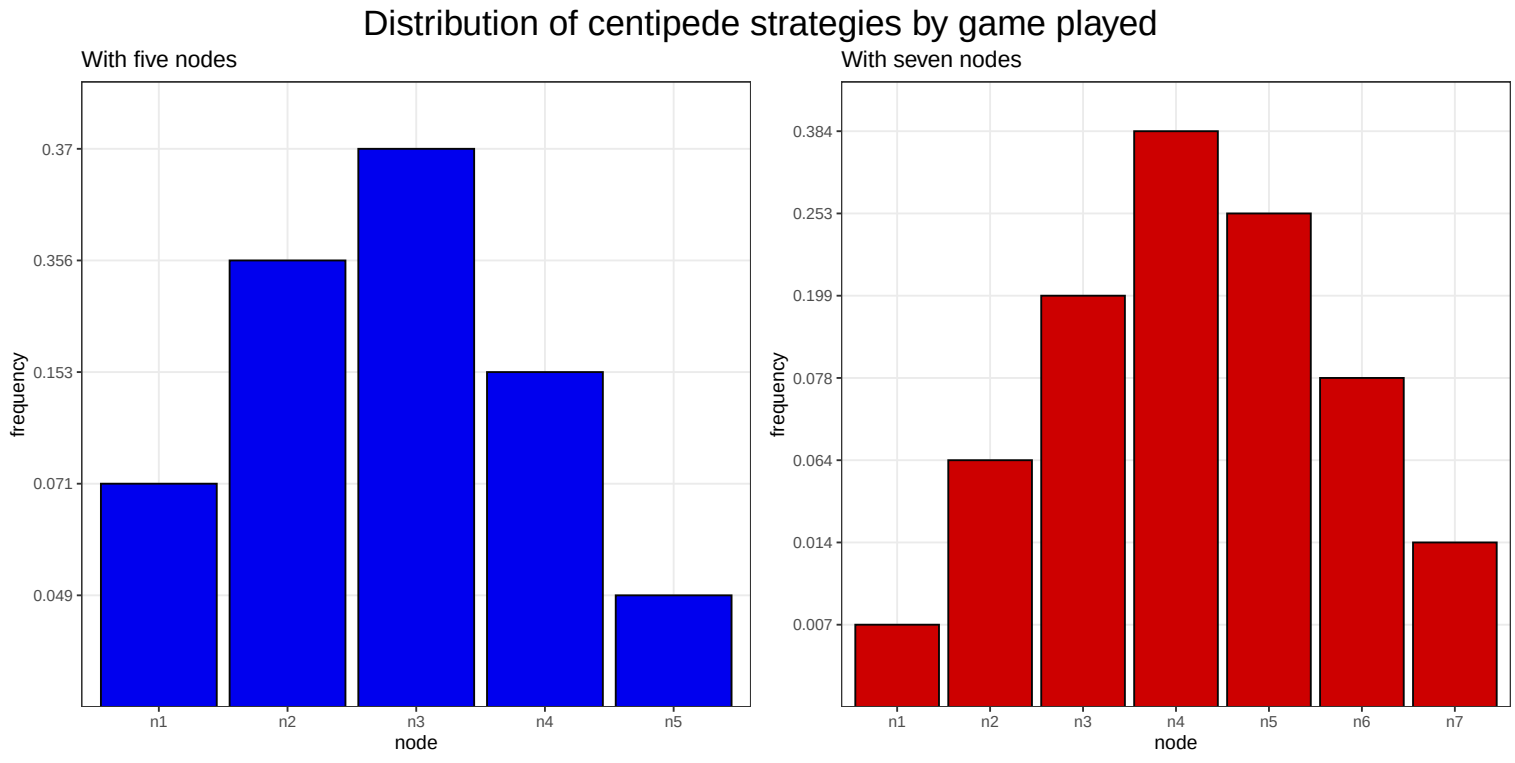
McKelvey and Palfrey's (1992) centipede game



Lessons from the centipede game

- How did McKelvey and Palfrey's (1992) students play the game?
- If there is a lesson to be drawn from McKelvey and Palfrey's (1992) experiment is that the vast majority of games ended neither at the first node (as game theory would predict), nor at the last node (which would maximise total social surplus)
- Below we give a graph of the distribution of strategies for the two variants of the game

McKelvey and Palfrey's (1992) centipede game



Lessons from the centipede game

- What can we make of McKelvey and Palfrey's (1992) analysis?
- Are players irrational?
- Possibly rationality is one of many contributing factors in agents' behaviour. Another could be altruism
- Or people are just stupid?

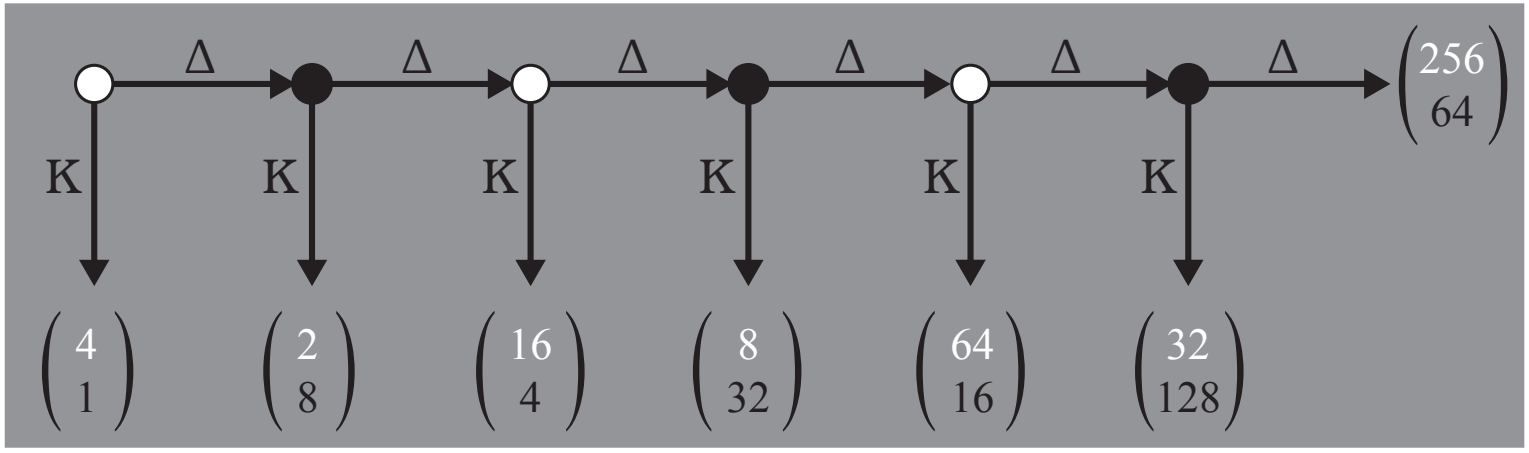
Lessons from the centipede game

- Another explanation says that people have bounded rationality and can't see the endgame when they are in the first node
- However as they approach the end, they start realising that it is in their interest strategically to pull of and the exit before they reach the final node
- McKelvey and Palfrey (1992) give another explanation: if there is a small percentage of altruism, then people might play mixed strategies (play randomly). 5% altruists could explain the observed outcomes

Lessons from the centipede game

- A more recent paper sheds more light pointing towards the bounded rationality explanation
- Palacios-Huerta & Oscar Volij (2009) came up with a brilliant idea to test whether more sophisticated players' play will come closer to game theoretic predictions:
- Palacios-Huerta & Oscar Volij (2009) present a variation of the 5-node game presented above, however the payoffs are multiplied by 10. Let's see the game Palacios-Huerta & Oscar Volij (2009) developed:

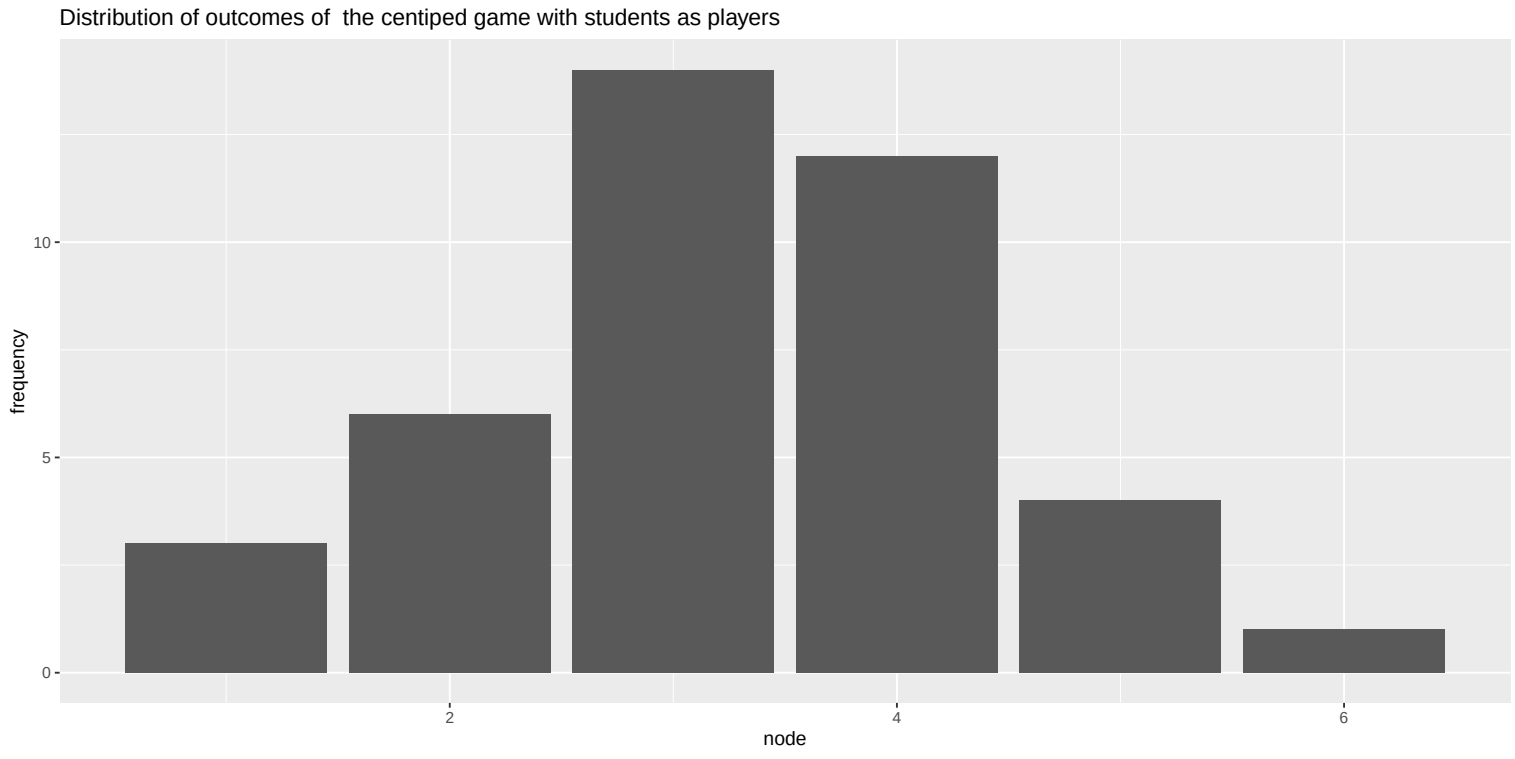
Testing effects of sophistication: Palacios-Huerta & Oscar Volij (2009)



Lessons from the centipede game

- The innovation of Palacios-Huerta & Oscar Volij (2009) had to do with their choice of players:
- As in previous experiments of the centipede game, they also used students as their base. Students capture the educated part of the population without perfect foresight
- However the centipede game requires players who can see variants of game plays and pick the best outcome. Just like chess
- Hence Palacios-Huerta & Oscar Volij (2009) organised 2 stages of the game including chess players of varying abilities: from competitive chess players to Grand Masters
- Two stages: in the first stage the two groups played separately: students against students and chess players against chess players

How students played



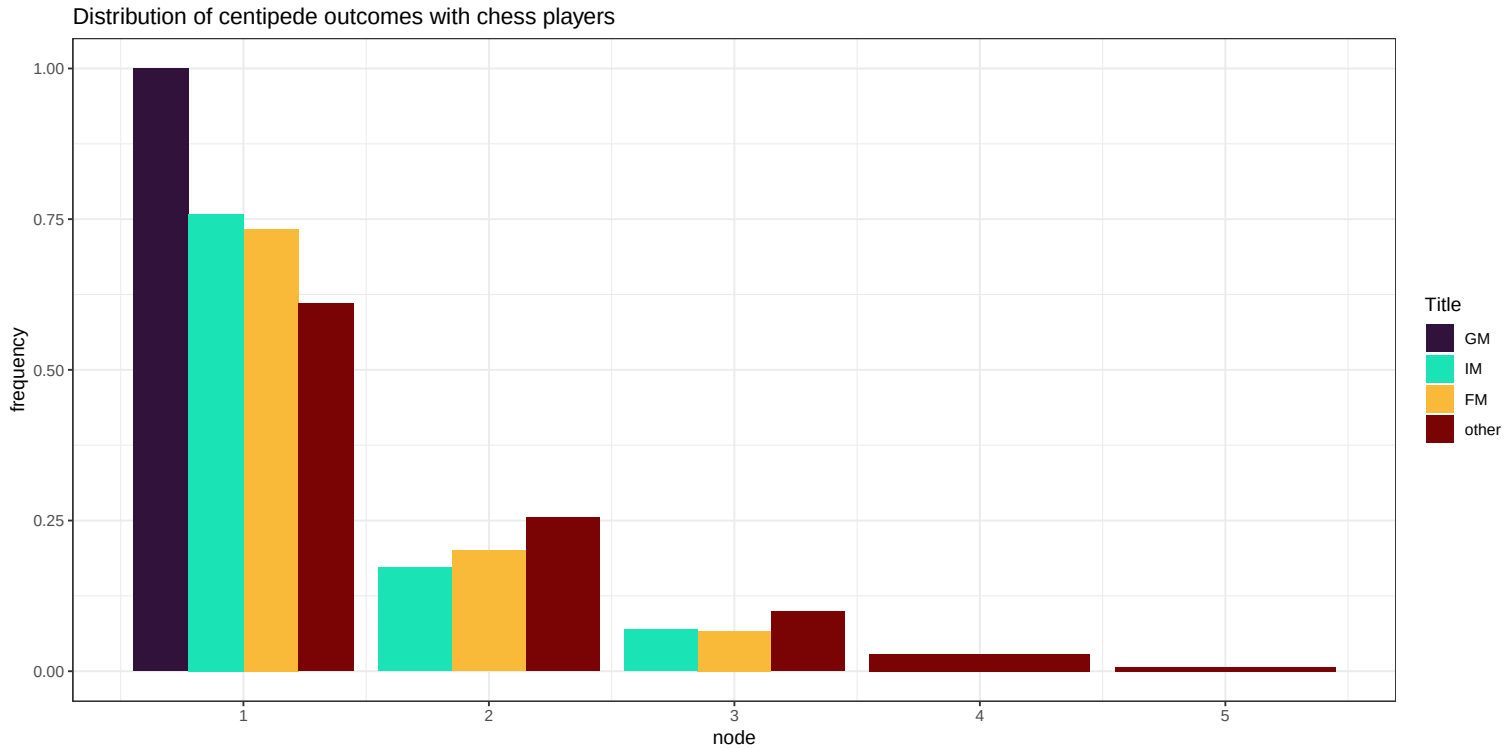
- Students seem to behave as recorded in previous studies

Lessons from the centipede game

- In the second stage students were matched against chess players of various abilities
- The titles of chess players (in descending order of ability):
  1. Grandmaster - GM
  2. International Master - IM
  3. Federation Master - FM
  4. Unrated

How students played

- Let's see how the various categories of chess players played the game:



How chess players played

- Grandmasters all ended the game at the first node!!!
- Most other chess players exited very soon as theory predicts. The ones who delayed most were lower-level chess-players
- In the second round: In the lab, chess players were much closer to the theoretical prediction than students
- In repeated rounds all chess players converged to the SPNE by the 5th iteration of the game
- Students played as usual: only 3% converged to the SPNE
- When students played against chess players, the proportion of those who played SPNE in the first round was 10 times higher than when they played against students!
- In the last round 70% students played the SPNE

Lessons learned from Palacios-Huerta & Oscar Volij (2009)

- Lesson learned: deviations from rational, self-interested play can be due to variety of reasons: one major, now documented reason is players' inability to calculate optimal play
- What does this say about negotiations?
- Be very prepared. Study the other party extensively
  - how sophisticated are they?
  - are they likely to solve all stages of the negotiating process backwardly?
  - might they have cognitive or behavioural biases?
  - how can you incorporate for these in your strategy?

References I

- Andersen, Steffen, Seda Ertaç, Uri Gneezy, Moshe Hoffman, and John A. List. 2011. ”Stakes Matter in Ultimatum Games.” American Economic Review, 101 (7): 3427-39
- Cameron, Lisa A, 1999. ”Raising the Stakes in the Ultimatum Game: Experimental Evidence from Indonesia,” Economic Inquiry, Western Economic Association International, vol. 37(1), pages 47-59, January.
- Henrich, Joseph, et al. “In Search of Homo Economicus: Behavioral Experiments in 15 Small-Scale Societies.” The American Economic Review, vol. 91, no. 2, 2001, pp. 73–78
- Henrich J, Boyd R, Bowles S, et al. “Economic man” in cross-cultural perspective: Behavioral experiments in 15 small-scale societies. Behavioral and Brain Sciences. 2005;28(6):795-815.

References II

- McKelvey, R. D., & Palfrey, T. R. (1992). An Experimental Study of the Centipede Game. Econometrica, 60(4), 803–836.
- Munier, B., Zaharia, C. High Stakes and Acceptance Behavior in Ultimatum Bargaining:. Theory and Decision 53, 187–207 (2002)
- Palacios-Huerta, Ignacio, and Oscar Volij. 2009. ”Field Centipedes.” American Economic Review, 99 (4): 1619-35.
- Slonim, R., & Roth, A. E. (1998). Learning in High Stakes Ultimatum Games: An Experiment in the Slovak Republic. Econometrica, 66(3), 569–596
- Munier, B., Zaharia, C. High Stakes and Acceptance Behavior in Ultimatum Bargaining:. Theory and Decision 53, 187–207 (2002)