LMU LUDWIG-MAXIMILIANS-UNIVERSITÄT MÜNCHEN

MAY 12, 2025

REAL LIFE GAMES:
HOW GAME THEORY SHAPES HUMAN DECISIONS

GAME THEORY

THE ULTIMATUM GAME & PARETO OPTIMALITY

Adrian Haret
a.haret@lmu.de

Shall we play another game?

The Ultimatum Game

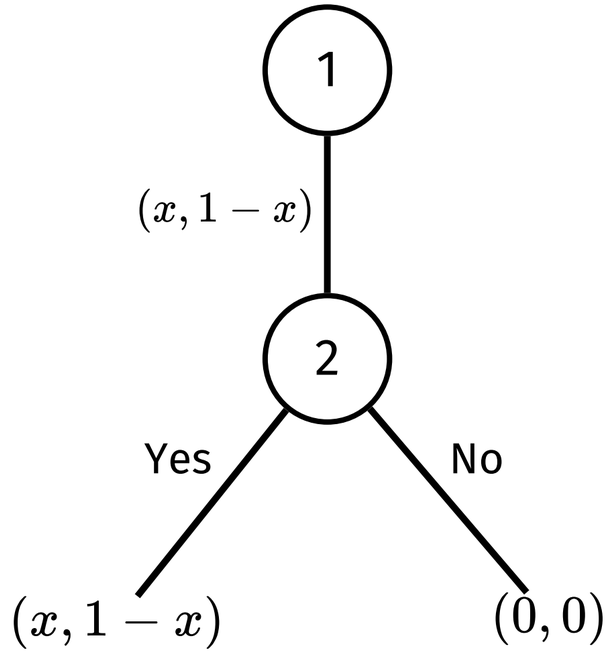
Player 1 has an endowment.

They propose a split with Player 2.

If Player 2 accepts, they divide the money according to the proposed split.

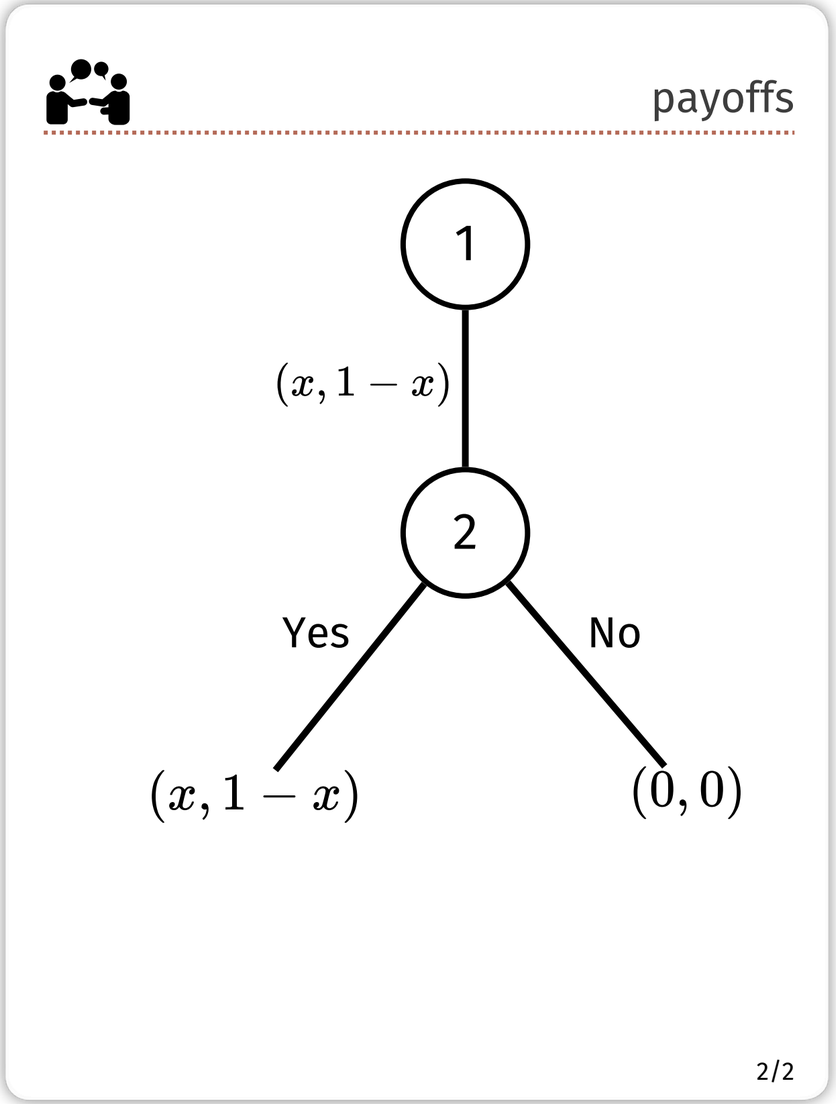
If Player 2 rejects, they both get nothing.

payoffs



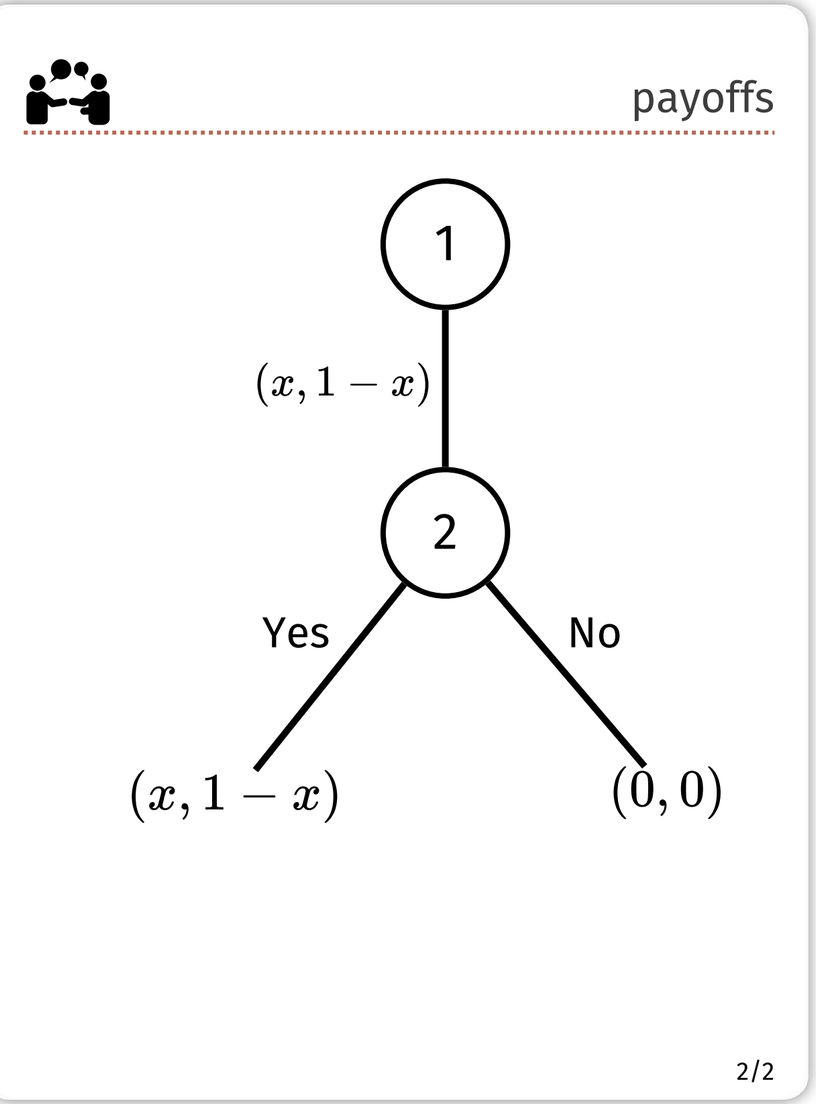
How do we think through this?

Player 2, as a self-interested agent, should accept any split where they get more than 0.



Player 2, as a self-interested agent, should accept any split where they get more than 0.

Knowing this, Player 1 will offer the smallest possible amount to Player 2, and keep the difference.



What about Nash equilibria?

What about Nash equilibria? Let’s look at a simplified version of the game.

The Ultimatum Game

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They propose a split with Player 2.

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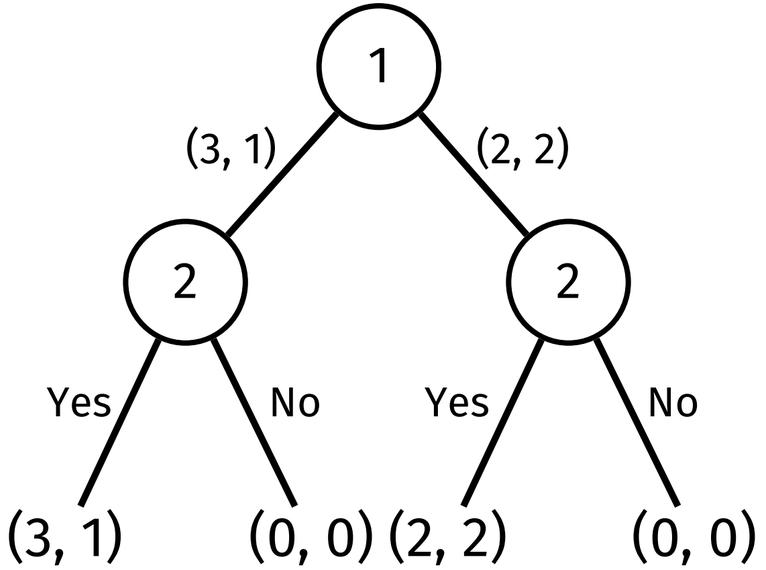
Let’s say the endowment is 4, and consider two possible splits.

payoffs



When we switch to the table view, we get more states.

Subtle, but important: Player 2's actions are the moves it would make at *every* choice node of the tree. Even if the game doesn't reach that node.

payoffs

	Yes, Yes	Yes, No	No, Yes	No, No
(3, 1)	$3, 1$	$3, 1$	$0, 0$	$0, 0$
(2, 2)	$2, 2$	$0, 0$	$2, 2$	$0, 0$

pure Nash equilibria

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Note that the Nash equilibria reflect this.

payoffs

	Yes, Yes	Yes, No	No, Yes	No, No
(3, 1)	3, 1	3, 1	0, 0	0, 0
(2, 2)	2, 2	0, 0	2, 2	0, 0

pure Nash equilibria

(3, 1), (Yes, Yes)
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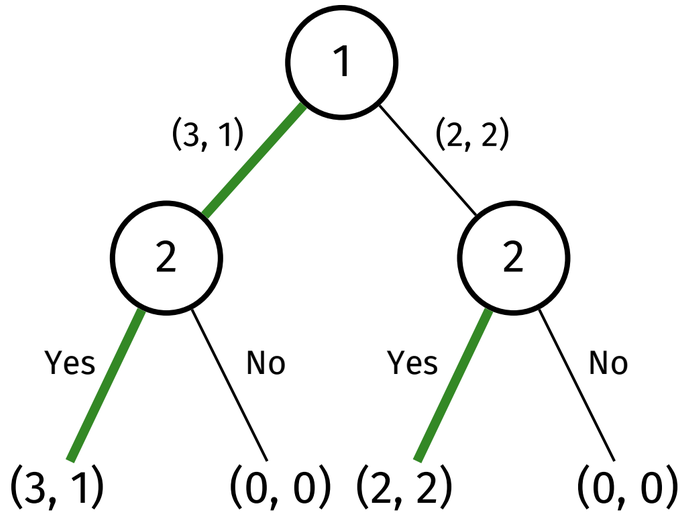
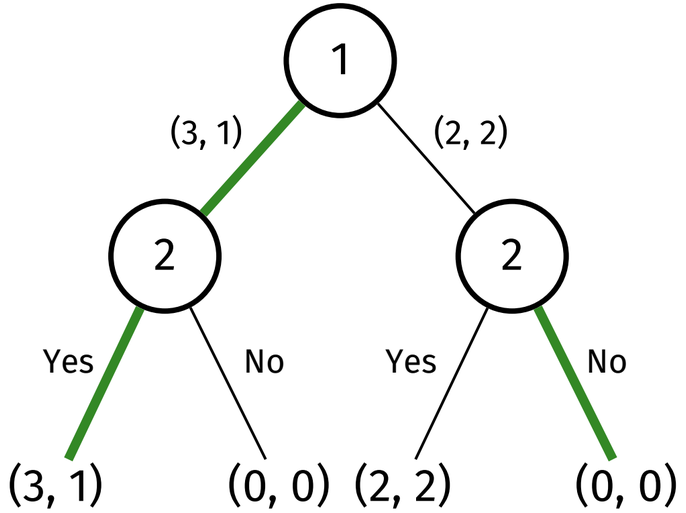
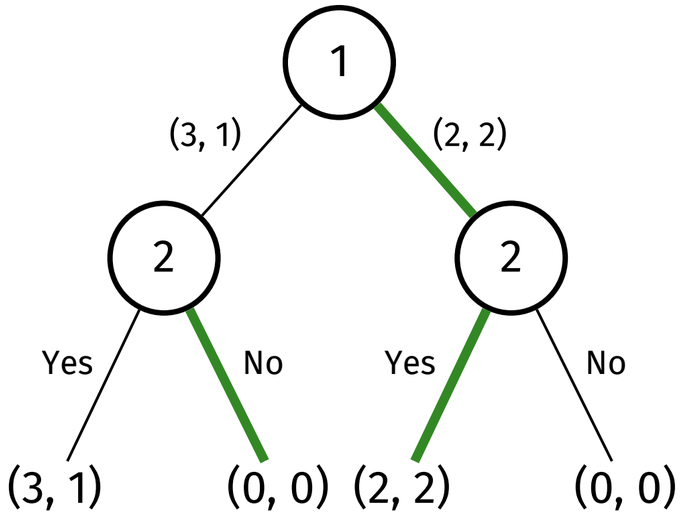
PURE NASH EQUILIBRIA FOR ULTIMATUM GAME







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The profile ((2, 2), (No, Yes)) is an equilibrium *because* Player 2 commits to refusing a (3, 1) split, *if* it occurs.

This is like a threat that Player 2 makes.

payoffs

	Yes, Yes	Yes, No	No, Yes	No, No
(3, 1)	3, 1	3, 1	0, 0	0, 0
(2, 2)	2, 2	0, 0	2, 2	0, 0

pure Nash equilibria

(3, 1), (Yes, Yes)
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The profile ((2, 2), (No, Yes)) is an equilibrium *because* Player 2 commits to refusing a (3, 1) split, *if* it occurs.

This is like a threat that Player 2 makes.

Though we might wonder whether such a threat is credible.

payoffs

	Yes, Yes	Yes, No	No, Yes	No, No
(3, 1)	3, 1	3, 1	0, 0	0, 0
(2, 2)	2, 2	0, 0	2, 2	0, 0

pure Nash equilibria

(3, 1), (Yes, Yes)
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The strongest rationality assumption* is that Player 2's threat (or commitment) is not credible.

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The strongest rationality assumption* is that Player 2's threat (or commitment) is not credible. In other words, that they will never leave money on the table. This narrows down the set of equilibria.

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THE ULTIMATUM GAME IN EXPERIMENTS

Interestingly, in experiments people do not behave according to this prediction.

Early experiments found that Proposers offered, on average, around 40% - 50% of the total amount.

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Interestingly, Responders were willing to pay a cost to punish unfair splits: offers below 20-30% of the total sum were frequently rejected.

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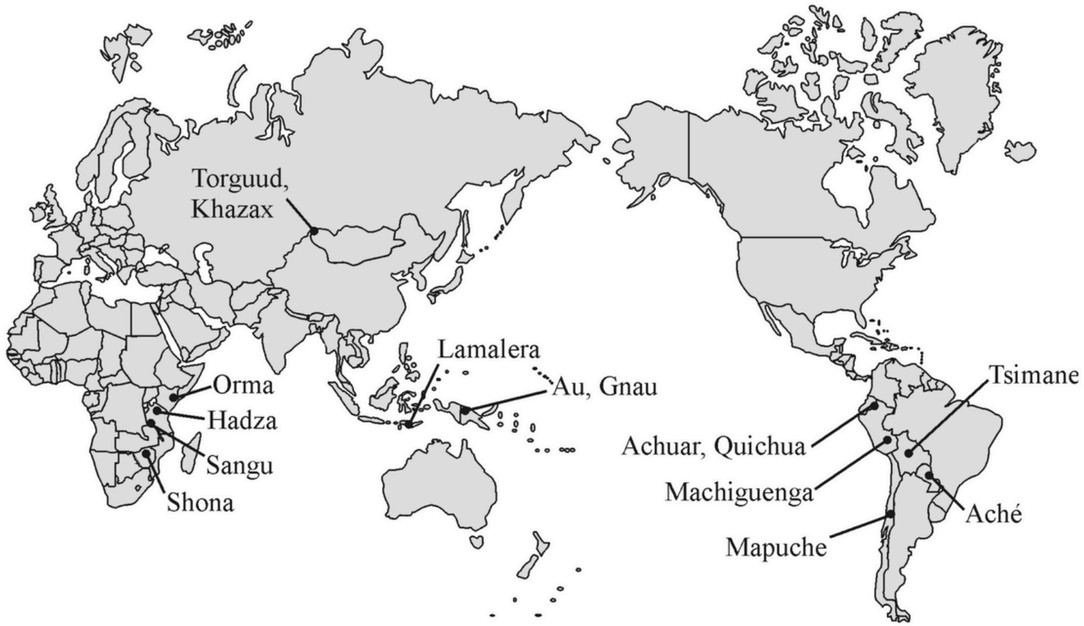
CROSS-CULTURAL VARIATION

Joe Henrich and colleagues tested out people in 15 communities across the world.



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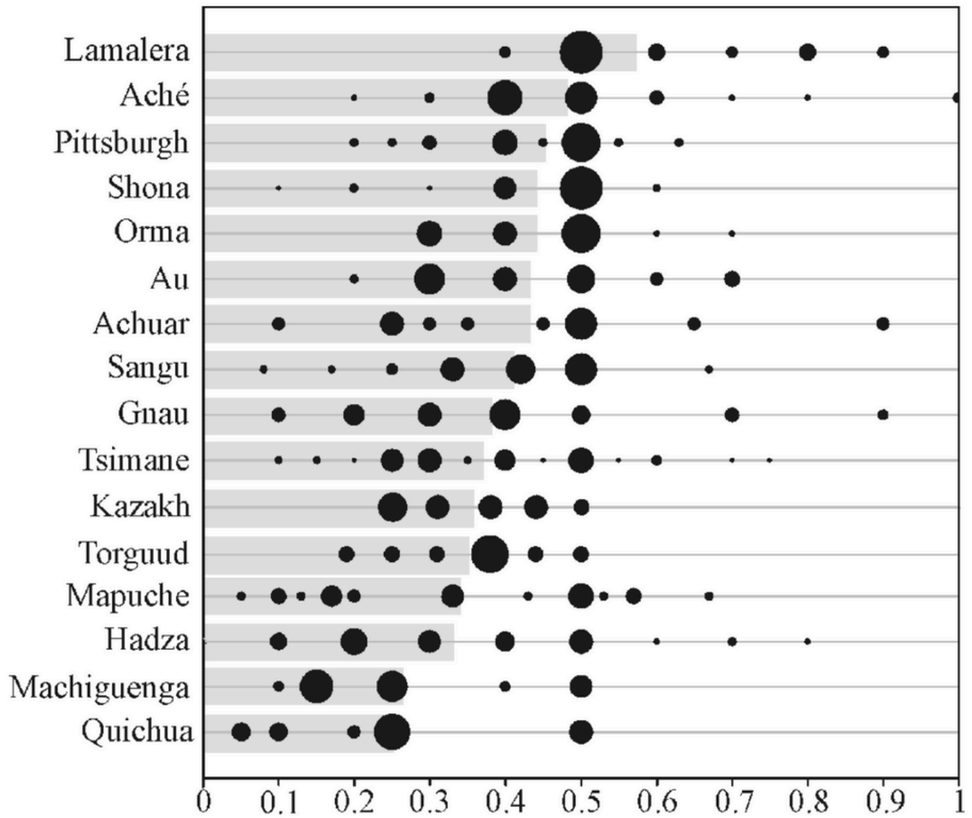

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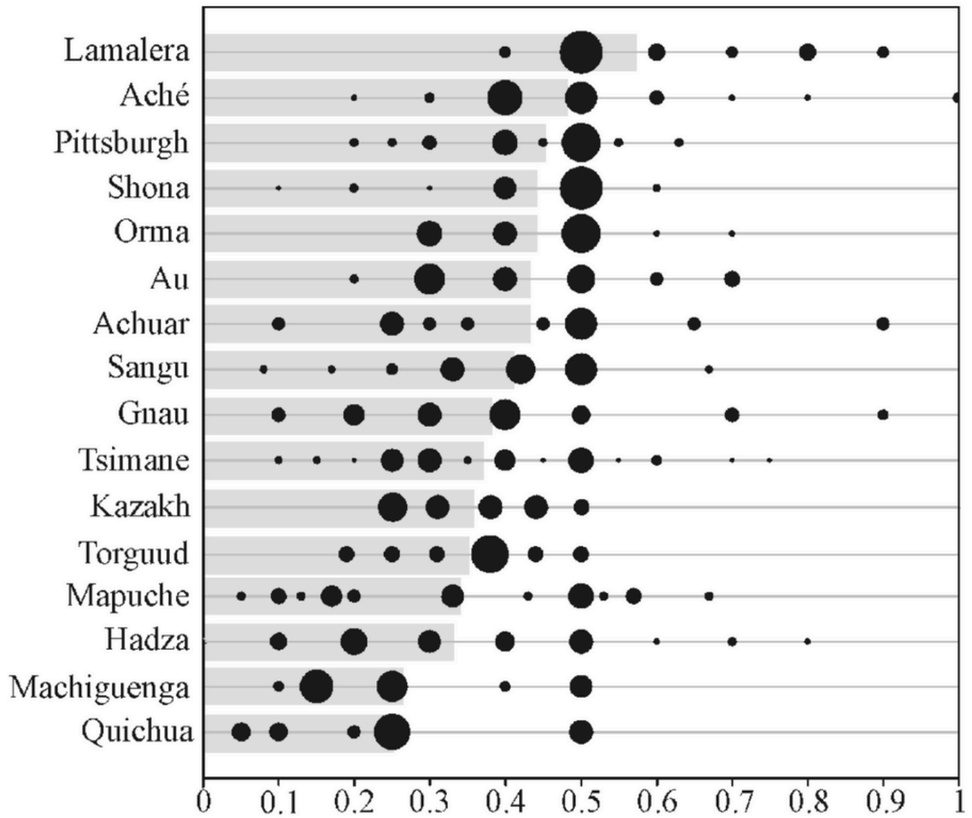

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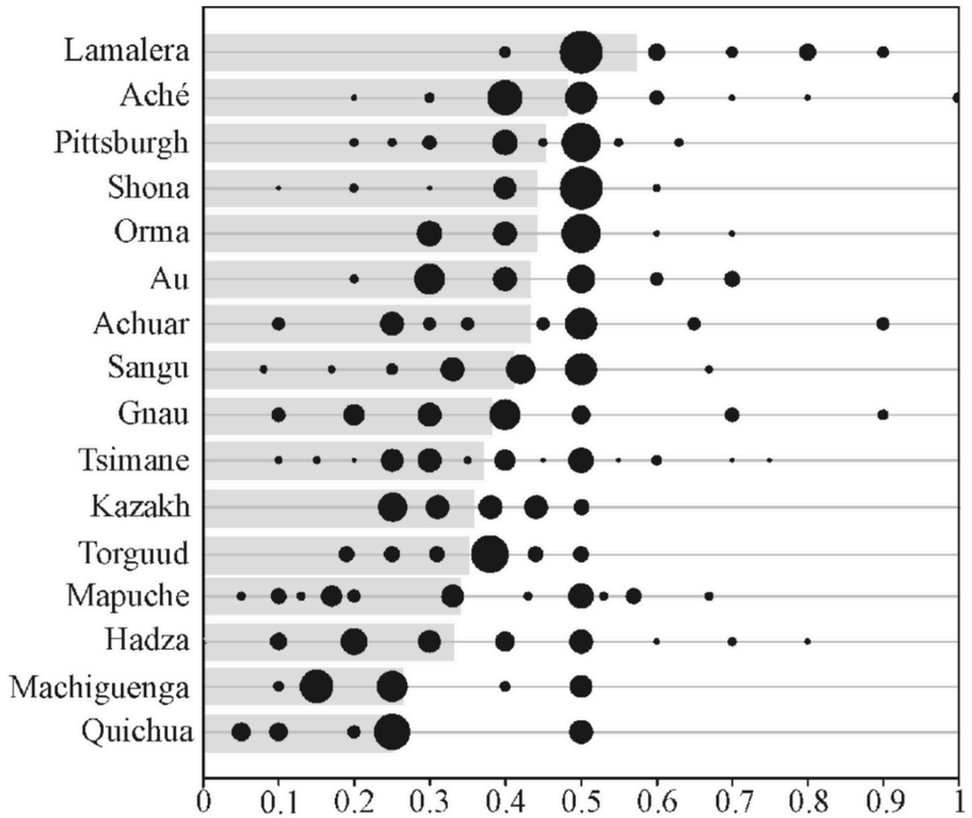
Societies with more cooperative labor (e.g., group fishing or hunting) tend to offer and expect fairer splits. Market integration also matters.



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Interestingly, in some societies hyper-fair splits were commonly rejected, seemingly because they were interpreted as obligations to reciprocate.

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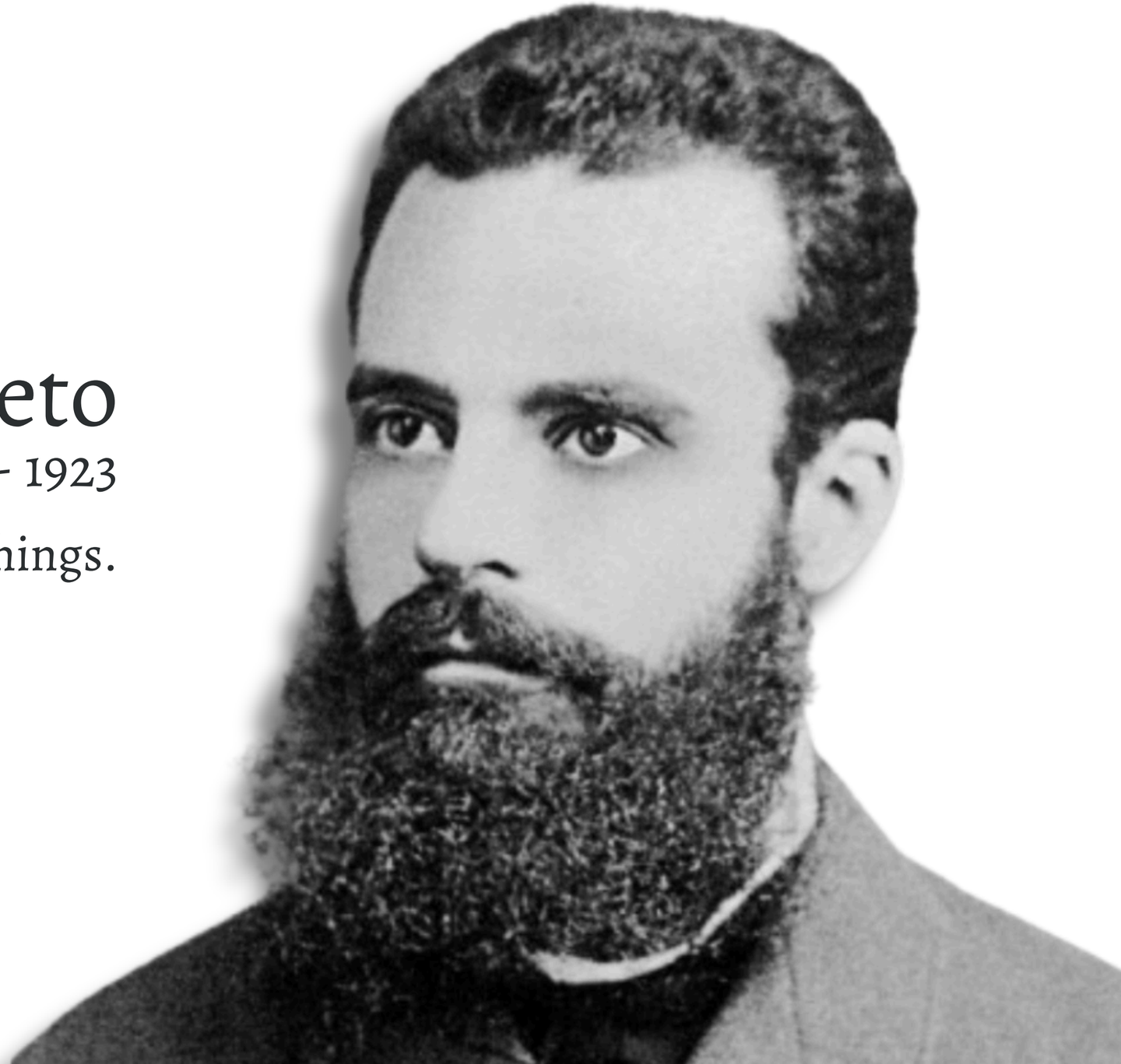
In social dilemmas there's something weird about the equilibria: everyone hates them, and would prefer a different outcome.

Vilfredo Pareto

1848 - 1923

Mathematician and many other things.



VILFREDO PARETO

How about we look at outcomes where people are (jointly) as well-off as they can be.

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In a Pareto optimal outcome no one can be made better off without making someone else worse off.

PARETO DOMINATION & OPTIMALITY

DEFINITION (PARETO DOMINATION)

A strategy profile s *Pareto dominates* strategy profile s' if:

(i) $u_i(\boldsymbol{s}) \geq u_i(\boldsymbol{s}')$, for every agent i, and

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DEFINITION (PARETO OPTIMALITY)

A strategy profile s is *Pareto optimal* if there is no (other) strategy profile s' that Pareto dominates s.

PARETO OPTIMALITY INTUITION

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Just that the pie is distributed equally.

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If a sum of 4 is distributed among two players, then (2, 1) is dominated by (2, 2) and by (3, 1).

But (2, 2) and (3, 1) are both Pareto optimal.

PARETO OPTIMALITY IN THE PRISONER'S DILEMMA

What dominates what in the Prisoner's Dilemma?

payoff table

	Cooperate	Defect
Cooperate	-20, -20	-100, 0
Defect	0, -100	-50, -50

pure Nash equilibria

- ✗ (Cooperate, Cooperate)
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Pareto optimal outcomes

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(Defect, Defect) is Pareto dominated by (Cooperate, Cooperate).

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Everything else is optimal.

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PARETO OPTIMALITY IN THE PRISONER'S DILEMMA

What dominates what in the Prisoner's Dilemma?

(Defect, Defect) is Pareto dominated by (Cooperate, Cooperate).

Everything else is optimal.

Everything *but* the Nash equilibrium is Pareto optimal!

payoff table

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pure Nash equilibria

- ✗ (Cooperate, Cooperate)
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Pareto optimal outcomes

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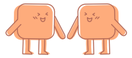
PARETO OPTIMALITY IN THE TRUST GAME

What dominates what in the Trust Game?



payoff table

	Keep	Share
Keep	$1, 1$	$1, 1$
Invest	$0, 4$	$2, 2$

pure Nash equilibria

(Keep, Keep)

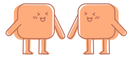
Pareto optimal outcomes

PARETO OPTIMALITY IN THE TRUST GAME

What dominates what in the Trust Game?

(Keep, Keep) and (Keep, Share) are dominated by (Invest, Share).

(Invest, Keep) and (Invest, Share) are not dominated by anything.



payoff table

	Keep	Share
Keep	1, 1	1, 1
Invest	0, 4	2, 2

pure Nash equilibria

(Keep, Keep)

Pareto optimal outcomes

(Invest, Keep)

(Invest, Share)

All these games are examples of *social dilemmas*.

SOCIAL DILEMMAS

DEFINITION

A *social dilemma* is a situation in which individual incentives are at odds with group incentives. Individual rationality leads members of a group to an outcome that is suboptimal.

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SOCIAL DILEMMAS

DEFINITION

A *social dilemma* is a situation in which individual incentives are at odds with group incentives. Individual rationality leads members of a group to an outcome that is suboptimal.

More formally, a social dilemma is a game in which the equilibria are Pareto dominated by some other outcome.

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Social dilemmas show up a lot.

Social dilemmas show up a lot. They're the reason we can't have nice things.

LANCE ARMSTRONG

Sports people face a social dilemma when deciding whether to take performance enhancing drugs.

Schneier, B. (2006, August 10). Drugs: Sports' Prisoner's Dilemma. *Wired*.

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JON HAIDT

Social media use is similar: it makes teens miserable, but everyone is locked in for fear of missing out.

Haidt, J. (2024). *The Anxious Generation: How the Great Rewiring of Childhood Is Causing an Epidemic of Mental Illness*. Penguin Books.

Can’t we just expect that players will gravitate towards a Pareto-optimal outcome?

PARETO IS FRAGILE

Supposing players end up in a situation where both cooperate, they each have a strong incentive to defect.

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PARETO IS FRAGILE

Supposing players end up in a situation where both cooperate, they each have a strong incentive to defect.

Pareto-optimal outcomes may not survive, in the long run.

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Nash equilibria are not necessarily *good*.

Nash equilibria are not necessarily *good*. They're just hard to escape, if end up in them.