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Voting and transfer payments in a threshold public goods game

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Motivation

Reward-based Crowdfunding

- Community (or firm) needs a certain amount of money (**threshold value**) to fund a project (e.g., a new school building).
- Members of community (or potential customers) may prefer the realization of this project (**public good**, but possibly excludable).
- Certain websites (e.g., kickstarter.com) allow the collection of (refundable) donation **pledges** in exchange for rewards depending on the contributed amount (**transfer payment**).
- Possibility of **repeated interaction** if community wants to finance additional projects.

Threshold public goods game with refund

Choice of parameters (basic model)

- 4 players, endowment e of 30 ExCU (2 ExCU = 1 Euro)
- Individual contributions q_i from 0.00 CU to 10.00 CU (2 decimal places)
- Total contribution Q up to 40 CU
- Penalty x for missing the threshold (16 CU): 25 ExCU

Marginal costs of contribution

- 2 low-cost players: $c_L = 1 \frac{ExCU}{CU}$
- 2 high-cost players: $c_H = 3 \frac{ExCU}{CU}$

Individual payoff (player i)

$$\pi_i = \begin{cases} 30 \text{ ExCU} - c_i q_i & Q \geq 16 \text{ CU} \\ 5 \text{ ExCU} & Q < 16 \text{ CU} \end{cases}$$

Refund if threshold is missed!

Nash eq. (basic model):

- $Q = 0$ CU (Status Quo)
- $Q = 16$ CU (Social Optimum)
- $0 \text{ CU} < Q < 10 \text{ CU}$

Selection criteria for Nash eq. of threshold PGs

Problem

- Large number of Nash equilibria makes coordination difficult.

Selection criteria

- Welfare-maximizing equilibrium (welfmax)
- Equal-payoff equilibrium with highest welfare (eqpay)
- Equal-contribution equilibrium with highest welfare (eqcont)

	q_H	q_L	π_H	π_L	Π
welfmax	0 CU	8 CU	30 ExCU	22 ExCU	104 ExCU
eqpay	2 CU	6 CU	24 ExCU	24 ExCU	96 ExCU
eqcont	4 CU	4 CU	18 ExCU	26 ExCU	88 ExCU

In the basic model (one-shot game), no equilibrium is both welfare-maximizing (welfmax) and equal-payoff (eqpay)!

Transfer payments

- **Idea:** Ex post transfers can redistribute payoffs to achieve an outcome that maximizes welfare and has equal payoff:

	q_H	q_L	π_H	π_L
welfmax	0 CU	8 CU	30 ExCU	22 ExCU
welfmax&eqpay	0 CU	8 CU	26 ExCU	26 ExCU

- **Problem:** No incentive to pay transfers in one-shot game

- **Solution 1:** Repeated game → SPNE with "welfmax&eqpay" in all rounds but last (Example: reward-based crowdfunding)

- **Solution 2:** Unanimous vote on contributions and transfers at the same time (Example: committee of potential funders)

Research Questions

- Are transfer payments used for **redistribution** in welfare-maximizing outcomes (to achieve equal payoffs)?
- Do transfer payments affect **total contributions**?
- Are **voluntary** (ex-post) transfers employed in a **repeated game**…?
- …or does this require a **collective** effort, i.e., a **vote** on contributions and transfers?

Results from the literature

Transfer payments in public-good games

- No (known) studies with zero-sum transfers in **threshold** PGs.

- Use of punishment/reward in **linear PGs**
  - **Punishment** increases cooperation (and contributions).
    (Fehr & Gächter, 2000; Chauduri, 2011; many others…).
  - **Rewards (zero-sum transfers)** also increase contributions, but with higher group earnings than punishment. Rewards appear to **decrease in later rounds.**
    (Walker & Halloran, 2004; Gürerk, Irlenbusch, Rockenbach, 2006; Sefton, Shupp, Walker, 2007; Sutter, Haigner, Kocher, 2010)

- Comparison to our design:
  - Punishments/rewards are intended to **reciprocate behavior.**
  - Our transfer payments (“rewards”) are intended to **reduce payoff inequalities**.

Repeated Game, No Transfer

Idea

- Basic game is played **repeatedly.**
- Players learn to coordinate contributions on threshold.

Procedure

Q-Q-Q-Q-Q-Q-Q-Q-Q-Q

- Repeated voluntary contributions & threshold events (Q)
- Partner design with full information on past contributions & payoffs
- 10 rounds, only 1 random round paid

Repeated Game & Transfer

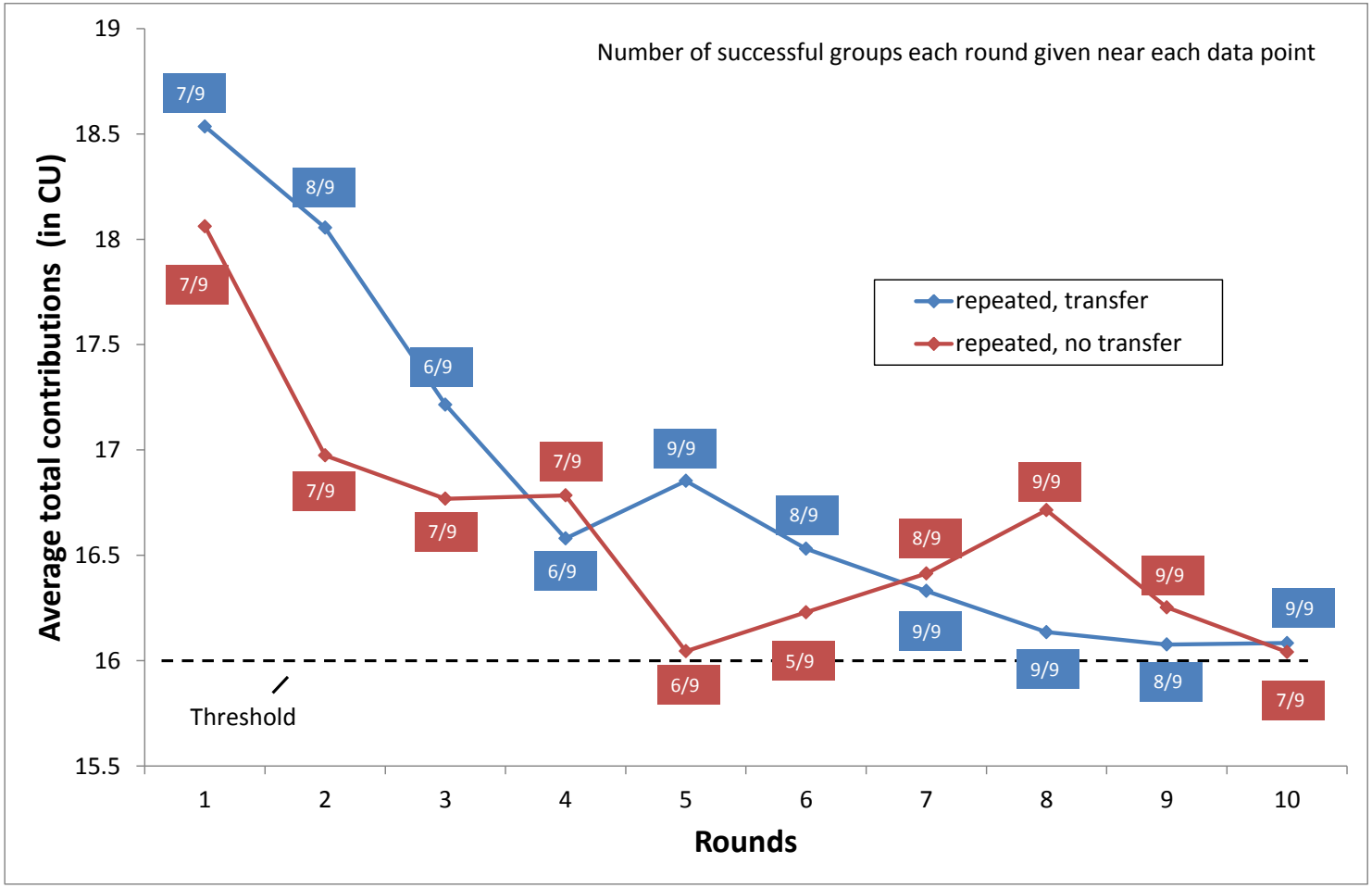
Idea

- Basic game is played **repeatedly.**
- Players learn to coordinate contributions on threshold.
- Efficient outcomes are maintained with transfer mechanism.

Procedure

Q-T-Q-T-Q-T-Q-T-Q-T-Q-T-Q-T-Q-T-Q-T-Q-T

- Repeated voluntary contributions & threshold events (Q)
- Partner design with full information on past contributions & payoffs
- Transfer option each round after contributions are known
- Each high-cost player can give part of earnings as transfer to each low-cost players in two separate transfer payments.
- If the threshold is not reached, no transfers are possible.
- 10 rounds, only 1 random round paid



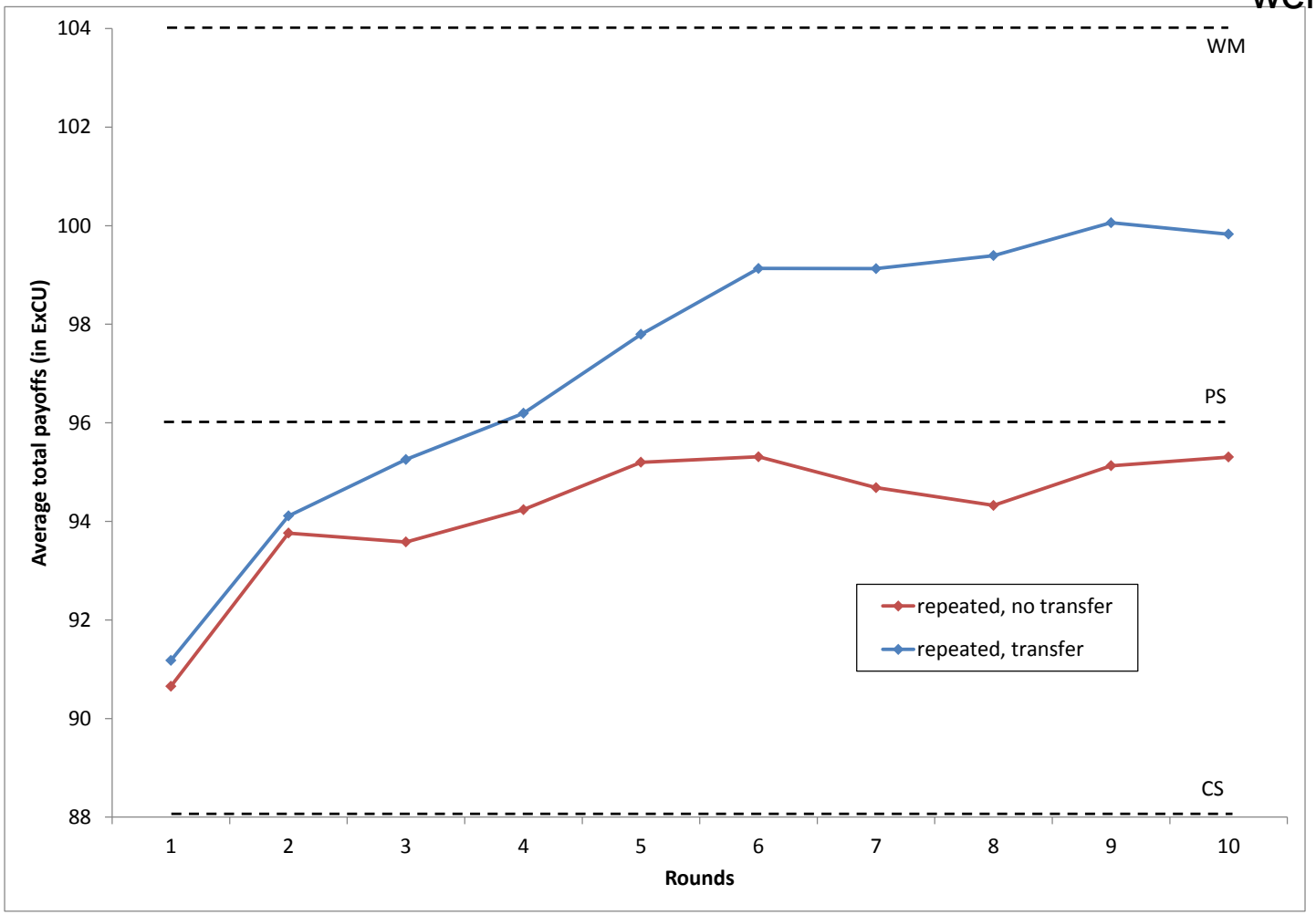
Total contributions of successful groups in repeated game

In each round of the treatments, the majority of groups manages to reach the threshold.

Total contributions in successful groups decrease over time, no treatment differences.

Total success rates: no transfer - 72/90 (80%) transfer - 79/90 (87.8%)

welfmax



eqpay

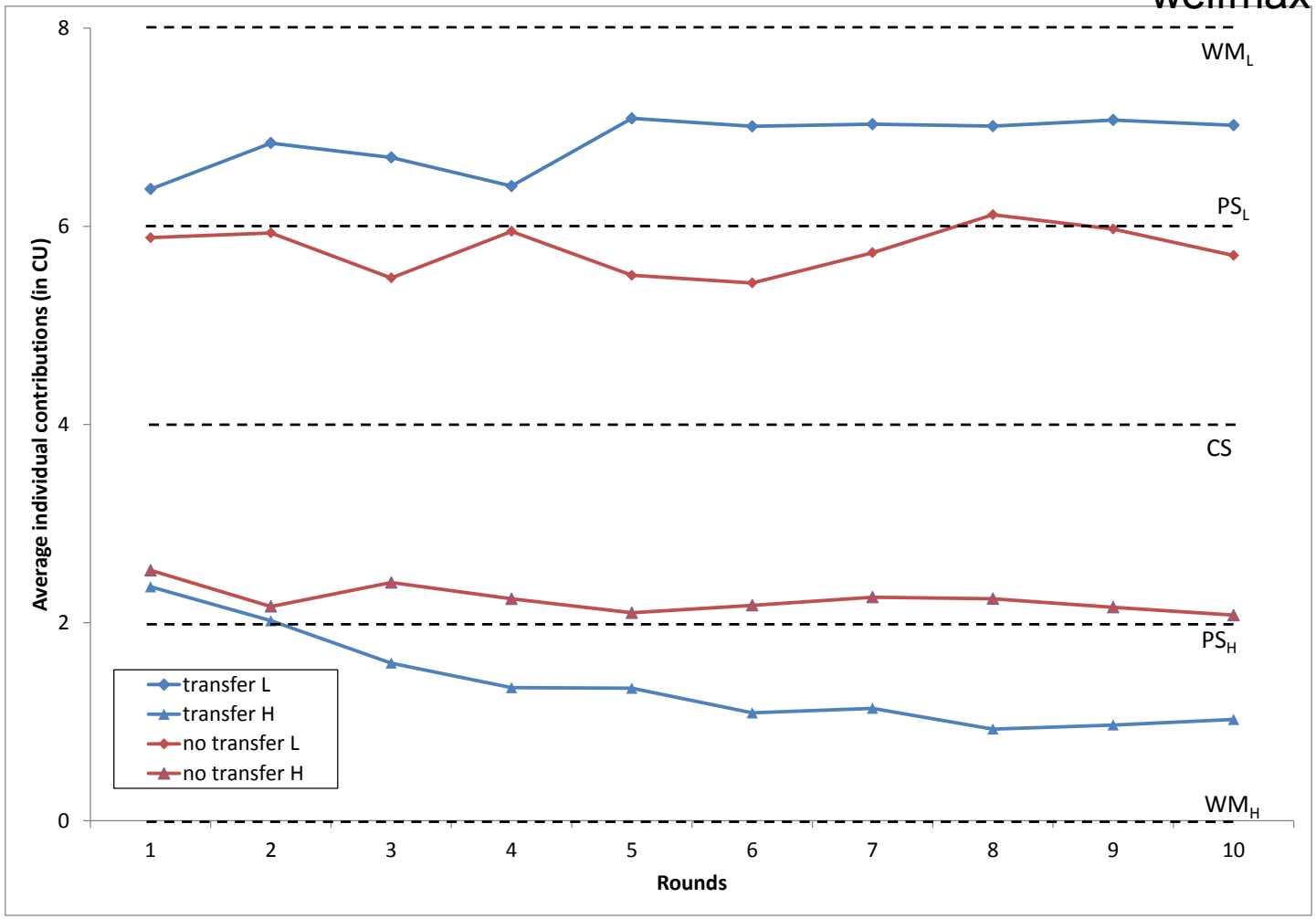
eqcont

Average total payoffs in successful groups

Average total payoffs increase over time.

Groups without transfer payments approach the equal-payoff outcome of 96 ExCU.

Transfer payments can increase social welfare.



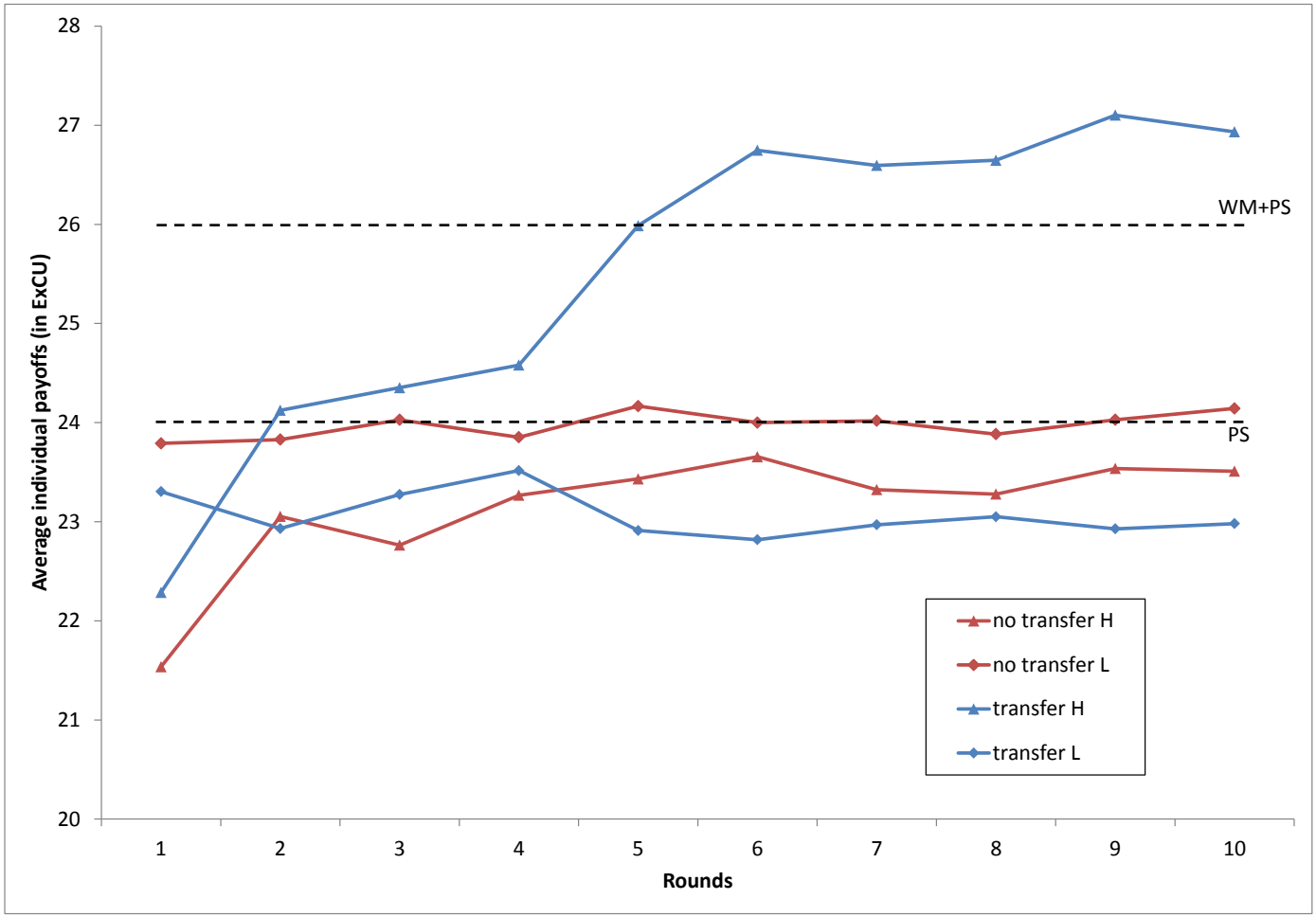
Average individual contributions in repeated game by cost type

In the repeated game, players of both cost types (H and L)…

…tend to equal-payoff outcomes without transfers…

…and approach welfare-maximizing outcomes with transfers.

Both types clearly avoid the equal-contribution outcome.

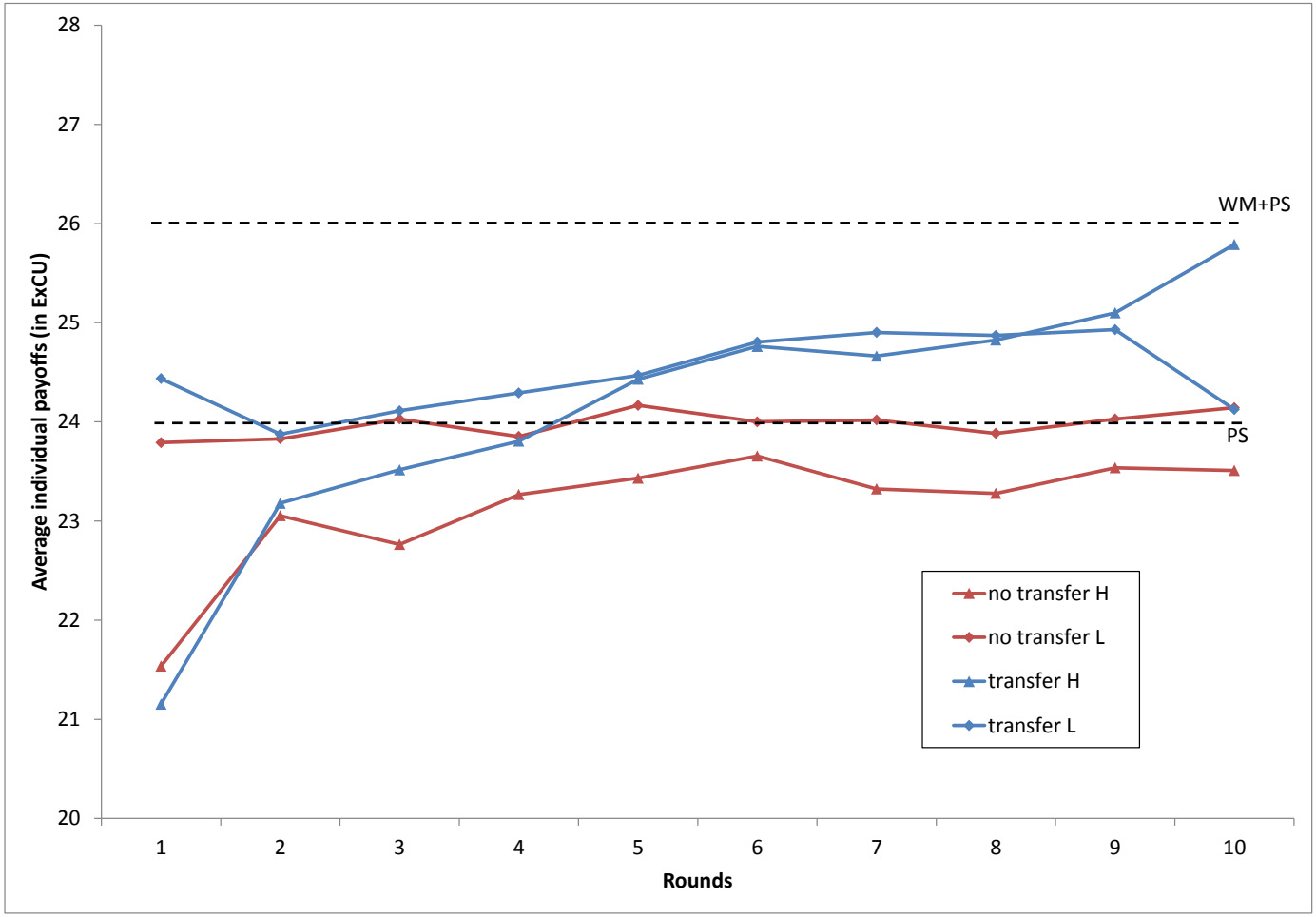


welfmax&
eqpay

eqpay
(not welfmax)

Average individual payoffs ex transfers in repeated game by cost type (only successful groups)

After a few rounds, high-cost players in transfer treatment receive a far higher payoff before transfers…



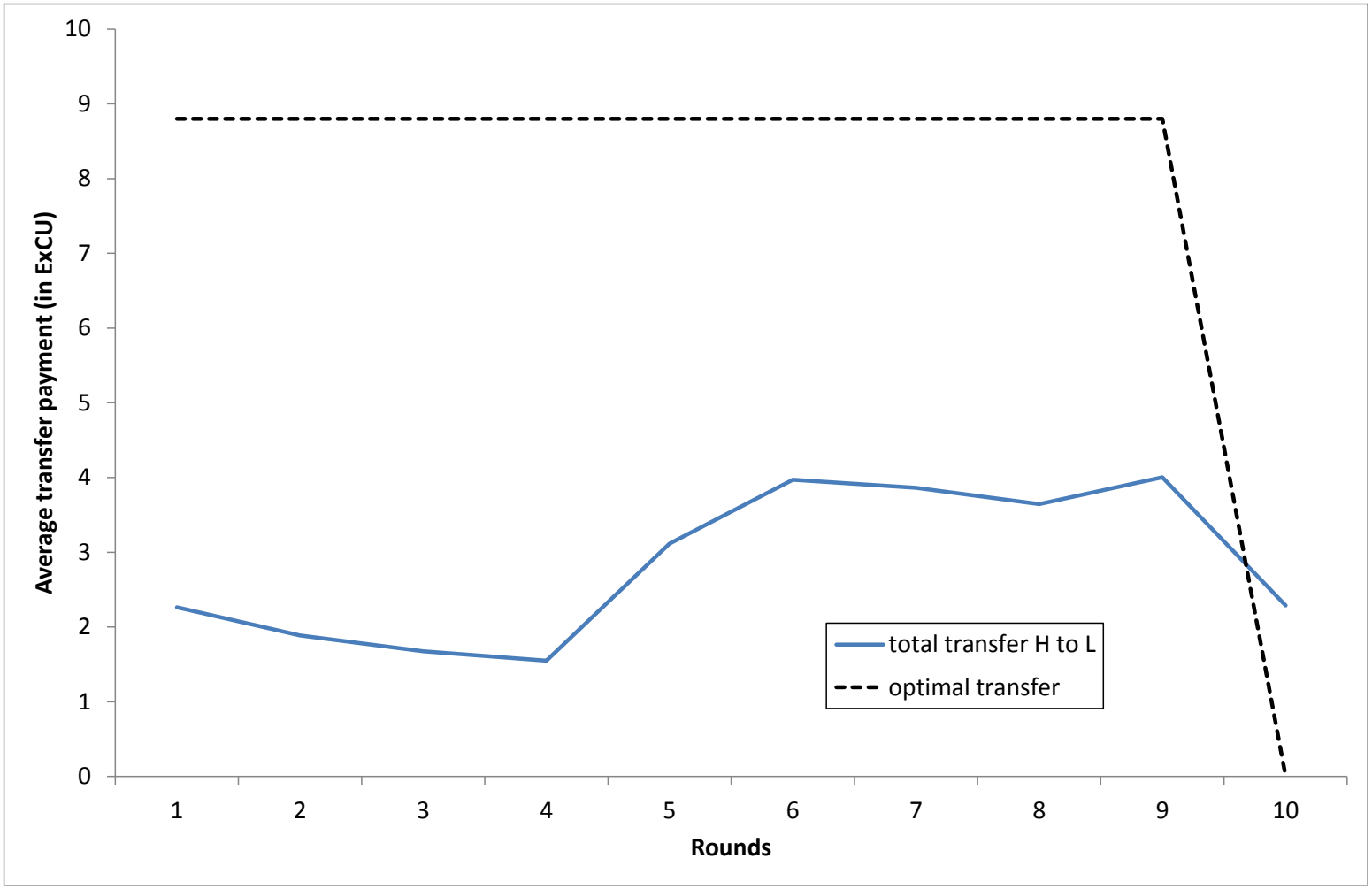
welfmax& eqpay

eqpay (not welfmax)

Average individual payoffs cum transfers in repeated game by cost type (only successful groups)

…but pass some of it along to their low-cost partners.

Groups in both treatments try to equalize payoffs, but payoff levels with transfers are higher for both player types. However, high-cost players benefit more from transfers.



Average transfers paid (H to L) in repeated game (only succ. gr.)

Transfer payments increase in later rounds, but are far below the theoretical optimum (of 8.8 ExCU).

Transfer payments decrease again in the final round, but are still positive on average.

Research Questions & Answers

- **Are transfer payments used for redistribution in welfare-maximizing outcomes (to achieve equal payoffs)?**
  YES (but not often efficiently)

- **Do transfer payments affect total contributions?**
  NO

- **Are voluntary (ex-post) transfers employed in a repeated game …?**
  YES (but this requires some learning)

- **…or does this require a collective effort, i.e., a vote on contributions and transfers?**
  MAYBE. In any case, a (binding unanimous) vote is more efficient than voluntary contributions and also works in one-time situations.

Thanks for your attention!

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