Enhancing the efficacy of the Paris Agreement: More frequent commitments promote cooperation, ratcheting does not

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joint work with **Axel Ockenfels**[c,d,e] and **Bodo Sturm**[f,b]

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Paris agreement
UNFCCC (2015)

> Global action plan to limit global warming to well below 2°C

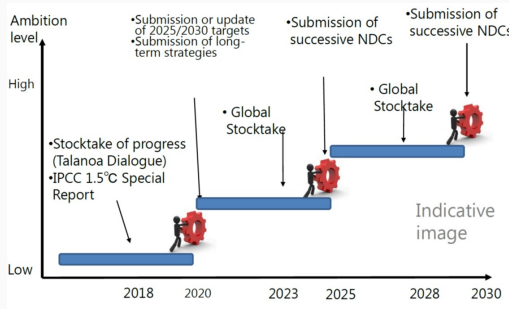❷ **Nationally determined contributions**
Falkner (2016)

> **Pros**: Eased entry into force

> **Cons**: Contributions fall short of achieving the 2°C target!

❷ **Ratchet-up mechanism**
UNFCCC (2015, Article 4)

> Gradually increase parties' contributions over time

> Achieve the 2°C target

What does the ratchet-up mechanism do?

Source: IGES

'As nationally determined contributions to the global
response to climate change, all Parties are to undertake
and communicate efforts [...] the efforts of all Parties
will present progression over time [...]'
UNFCCC (2015, Article 4.3)

Why does the ratchet-up mechanism need an update?

UNEP (2021) ...

> Contributions are still too low to reach the 2°C target figures ...

Charness et al. (2011)...

> Agents strategically restrict their true capacity, because they anticipate that higher levels of output will be met with increased obligations more lit ...

Gallier & Sturm (2021), Alt et al. (2023)

> Ratchet-up mechanism increases agents' risk of being free ridden and decreases contributions to a public good results ...

> Collective minimum contributions promote contributions, only if binding results ...

How to update the ratchet-up mechanism?

'I hope we come out with a very good framework.
Whether it's five years (or) less, I can't tell you
today. [...] But I definitely believe it should be
as short as we can.' John Kerry

⊙ **Policy proposal**
  › Carattini & Löschel (2021): Making parties **update and review their NDCs more frequently**, e.g., every year rather than on the current five-year schedule

⊙ **Prior**
  › Schelling (1960): Small and more frequent commitments could limit the risk of being free ridden, establish trust, and foster cooperation

Many small vs. few big contribution decisions
Do agents contribute more to a public good if they can make *many small* instead of a *few big* contribution decisions?

> **Voluntary contribution mechanism**: Freely decide upon their contributions to the public good

> **Ratchet-up mechanism**: Each contribution to the public good at least as high as in the previous round

Public goods game, w/ `details`

> multiple rounds & multiple decisions per round:

5x1 vs. *5x5*

> voluntary contribution & ratchet-up mechanism:

BASE vs. *RAT*

Simulations `details`

Even *low* contributions in the beginning of *5x5* could lead to cumulative contributions that are higher than in *5x1*, if ...

> *enough* agents are conditional cooperative

> *enough* agents are willing to lead by example

Experimental results `details`

> Contributions in *5x5* are higher than in *5x1*, in *BASE* & *RAT*

w/ multiple rounds & multiple decisions per round

> - n identical individuals, $i \in \{1, \ldots, n\}$
> - In each round $t \in \{1, \ldots, T\}$
>   > - i receives an endowment: w
>   > - i makes $d \in \{1, \ldots, D\}$ contribution decisions: $g_{i,t,d}$
> - At the end of each round t
>   > - i´s cumulative contributions: $g_{i,t} = \sum_{d=1}^{D} g_{i,t,d}$
>   > - Public good provision level: $G_t = \sum_{j=1}^{n} g_{j,t}$
>   > - Payoff:
>
> $$\pi_{i,t}(w - g_{i,t}, G_t) = w - g_{i,t} + 0.5 * G_t$$

Treatment	Mechanism		Setting	
	Voluntary contributions	**Ratchet-up**	**5x1**	**5x5**
BASE 5x1	✚	✖	✚	✖
BASE 5x5	✚	✖	✖	✚
RAT 5x1	✖	✚	✚	✖
RAT 5x5	✖	✚	✖	✚

Experimental design | VCM

BASE 5x1

> w/ $t = 5$ rounds & $d = 1$ decision per round

> w/ voluntary contribution mechanism

⮕ Players can freely decide upon their contributions

> $0 \leq g_{i,t} \leq w$

BASE 5x5

> w/ $t = 5$ rounds & $d = 5$ decisions per round

> w/ voluntary contribution mechanisms

⮕ Players can freely decide upon their contributions

> $d = 1 : 0 \leq g_{i,t,1} \leq w$

> $d > 1 : 0 \leq g_{i,t,d} \leq w - \sum_{d=1}^{d-1} g_{i,t,d}$

RAT 5x1

> w/ $t = 5$ rounds & $d = 1$ decision per round

> w/ ratchet-up mechanism

↪ Each contribution per round at least as high as the previous

   > $t = 1$, like *BASE 5x1*
   > BUT $t > 1$, $g_{i,t-1} \leq g_{i,t} \leq w$

RAT 5x5

> w/ $t = 5$ rounds & $d = 5$ decisions per round

> w/ ratchet-up mechanism

↪ Each contribution per round at least as high as the previous

   > $t = 1$, like *BASE 5x5*
   > BUT $t > 1$,
      > $d = 1 : g_{i,t-1} \leq g_{i,t,1} \leq w$ and
      > $d > 1 : 0 \leq g_{i,t,d} \leq w - \sum_{d=1}^{d-1} g_{i,t,d}$

Experimental procedure

Laboratory, software & data collection

> - Cologne Laboratory for Economic Research
>   - Nov. 22 – Jan. 23
> - o-tree for programming & orsee for recruiting
> - Online visually monitored sessions
> - All in all, 368 participants </> pwr

Routine

> - Registration & certification: Ethics Committee of the Faculty of Economic and Social Sciences at University of Cologne
> - Partner matching
> - Sessions: $\approx$ 1 hour
> - Exchange rate: 60 ECU $=$ 1 Euro
> - Average payoff of $\approx$ 13 Euro (incl. 1 Euro show-up fee)

Hypothetical agents w/ three robust **behavioral patterns**:

- 👤 **Defectors** (Isaac et al. 1984 ...)
  Some agents selfishly defect

- 👤 **Conditional cooperators** (Fischbacher et al. 2001 ...)
  Some agents are willing to cooperate but only as long as others do

- 👤 **Heterogeneity** (Gächter et al. 2012 ...)
  Some agents are willing to lead by example

Simulated contributions in t:

$$g_{i,t} = \beta \bar{g}_{-i,t-1} + (1-\beta)g_{i,t-1}$$

where

> Contributions in $t-1$: $g_{i,t-1}$
> Others' average contributions in $t-1$: $\bar{g}_{-i,t-1}$

> **w/ some agents are willing to lead by example**:
> > Defectors: $g_{i,t} = 0 \ \forall t$
> > Heterogeneous contributors: $g_{i,1} = \texttt{runif}\{0, w\}$

> **w/ some agents are conditional cooperative**:
> > Being free ridden: $\beta = 1 \Rightarrow g_{i,t} = \bar{g}_{-i,t-1}$
> > Free riding: $\beta = 0.5 \Rightarrow g_{i,t} = 0.5(\bar{g}_{-i,t-1} + g_{i,t-1})$

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5x1: BASE vs. RAT
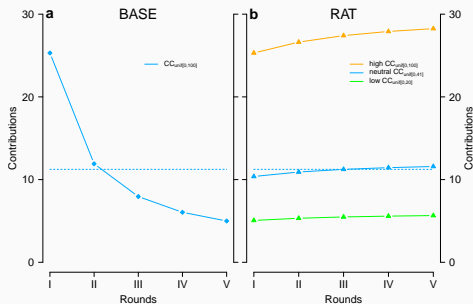
> Ratcheting can foster cooperation, if initial contributions are not *too* low
> Gallier & Sturm (2021): low initial contributions w/ ratcheting

Prior 1. Ratcheting reduces cooperation, b/c of the limited flexibility to respond to uncooperative agents </> obs # 2

5x1 vs. 5x5: BASE and RAT
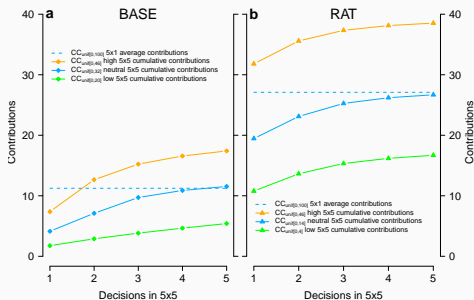
> More frequent interactions can foster cooperation, if initial contributions are not *too* low
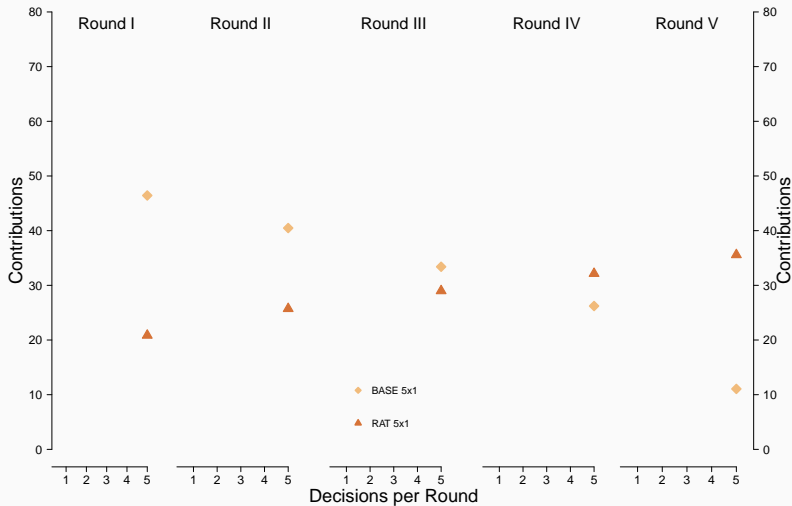> Schelling (1960): Build cooperation gradually

Prior 2. More frequent interactions increase cooperation, b/c of the reduced vulnerability against uncooperative behavior `</> obs # 3`
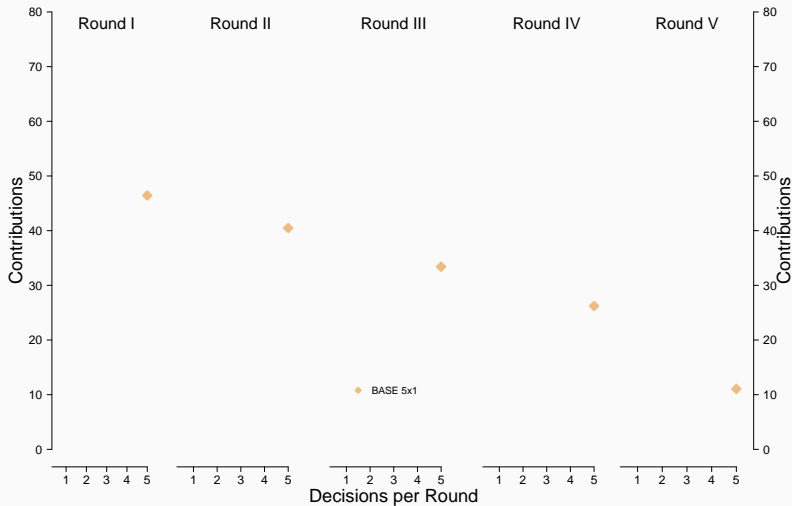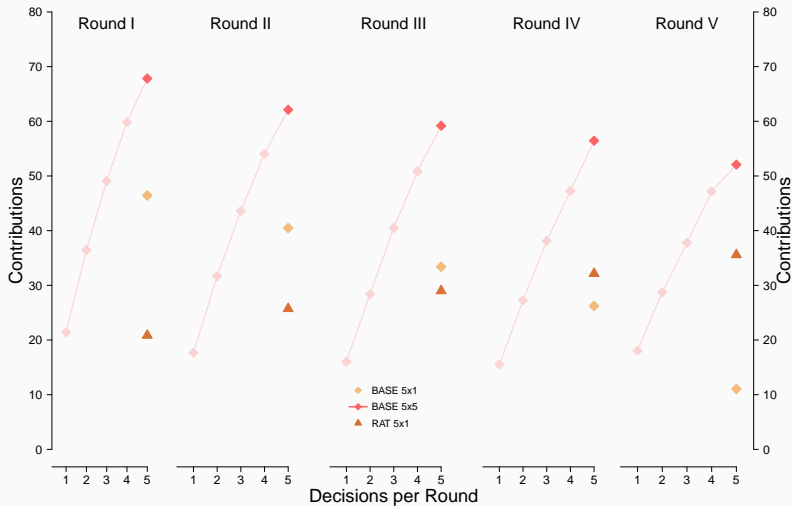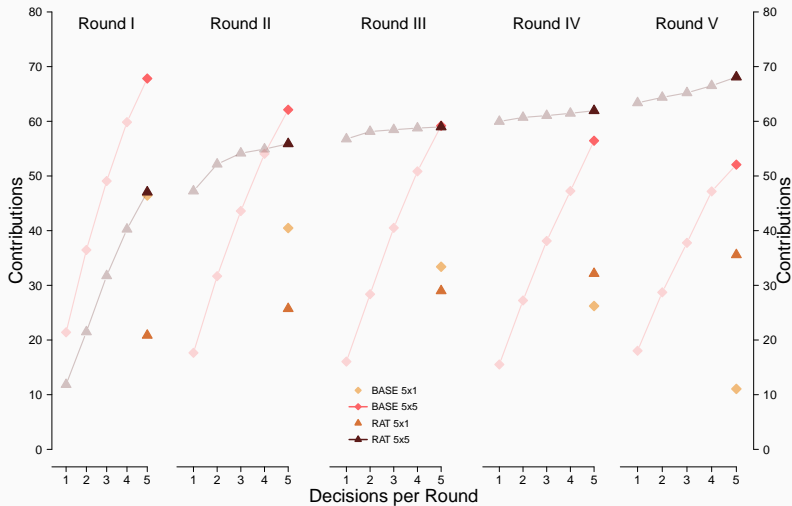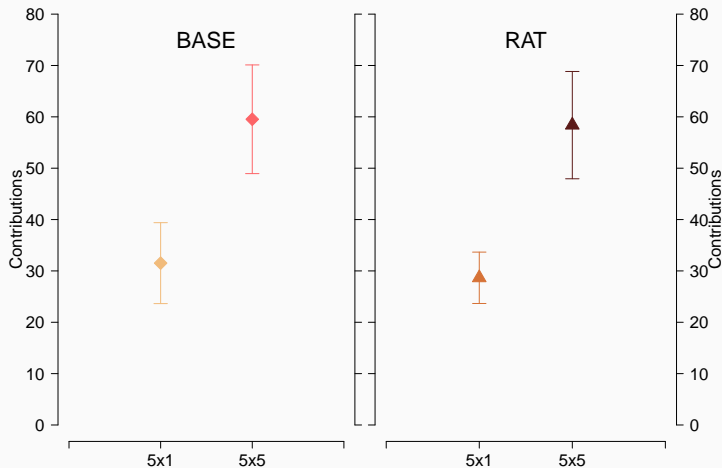
Obs 1. Contributions in *5x5* are higher than in *5x1*, both in *BASE* (p-value < 0.001) and *RAT* (p-value < 0.001)
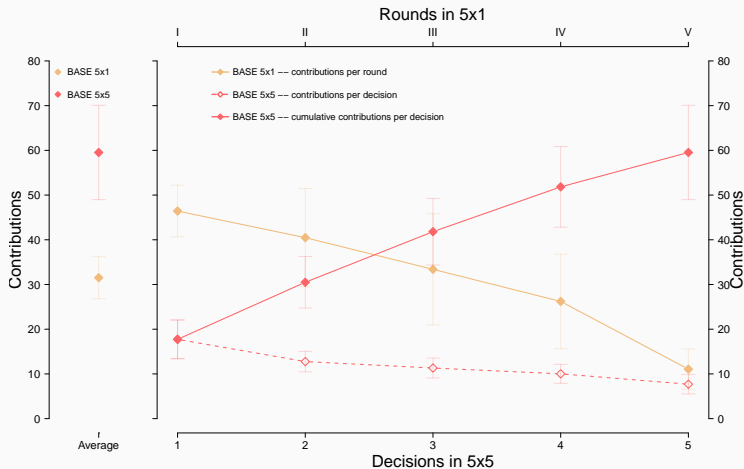
Obs 2. In *5x5*, contributions start *low* (*p*-value < 0.001) but decrease *less* (*p*-value < 0.001) `</> sim # 1`
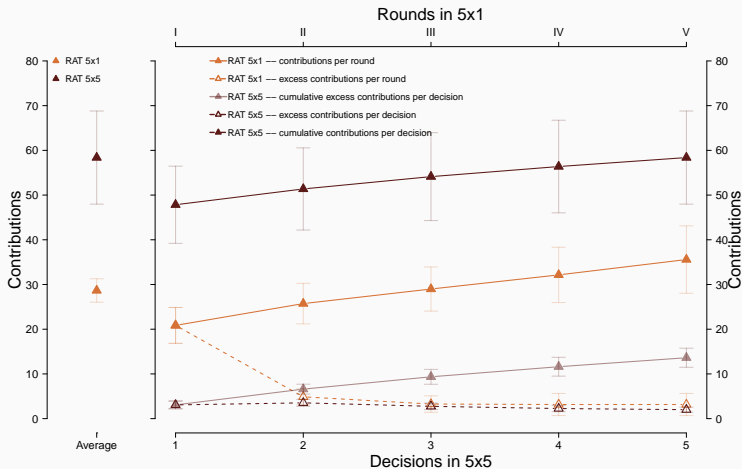
Obs 3. In *5x5*, excess contributions start *low* (*p*-value < 0.001) but decrease less (*p*-value < 0.001) `</> sim # 2`

Extent of exploitation
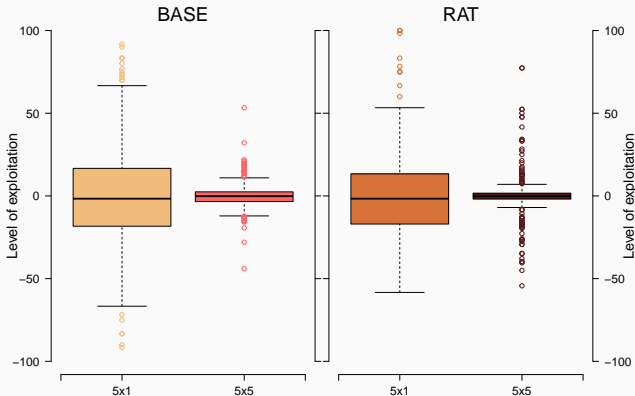
Obs 4. Extent of exploitation is higher in *5x1* than in *5x5*

Effect of exploitation
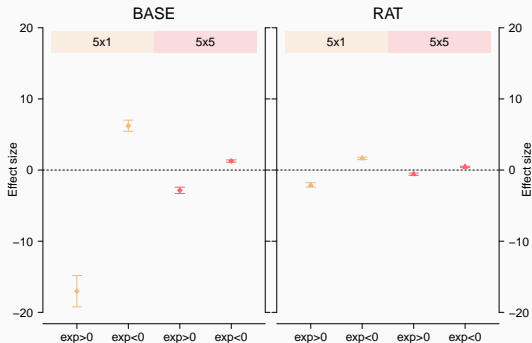
Obs. 5a. Drop after being free ridden exceeds lift after free riding

Obs. 5b. Effects in *5x5* are less pronounced than in *5x1*

Conclusion

Public goods game w/

> multiple rounds & multiple decisions per round: *5x1* vs. *5x5*

> voluntary contributions & ratchet-up: *BASE* vs. *RAT*

Simulation & experimental results

> Contributions in *RAT* are not higher than in *BASE*, in *5x1* and *5x5*

> > *RAT* heightens the risk of exploitation, deterring cooperation

> Contributions in *5x5* are higher than in *5x1*, in *BASE* & *RAT*

> > *5x5* diminishes the risk of exploitation, encouraging cooperation

'[...] trust and reciprocity are mutually reinforcing [...] a decrease in either can generate a downward cascade leading to little or no cooperation [...]' Poteete, Janssen, and Ostrom (2010)

Architecture of climate negotiations

> Status quo: Climate negotiations rely on unilateral nationally determined contributions

> Update: Amendments allow to change how reciprocity is operationalized to cultivate trust and promote cooperation

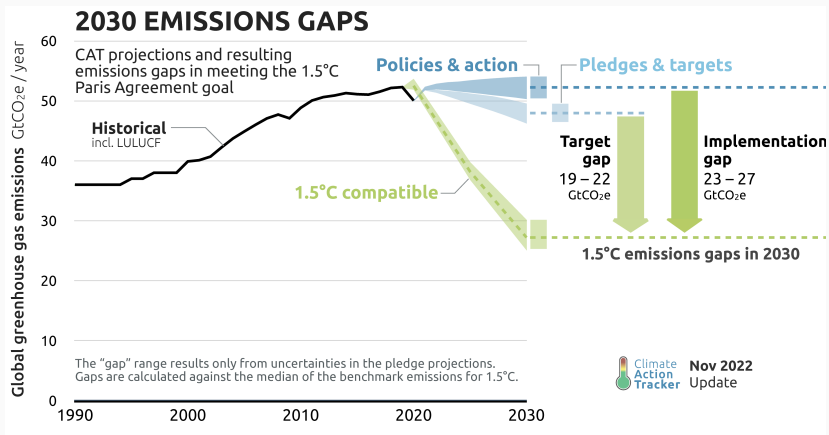> Strategic advantage: Shift towards more frequent interactions

Thank you!

If you have questions or comments, please let me know

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🌐 https://cgallier.github.io/

Appendix

2030 EMISSIONS GAPS

Global greenhouse gas emissions GtCO₂e / year

CAT projections and resulting emissions gaps in meeting the 1.5°C Paris Agreement goal

Policies & action

Pledges & targets

Historical
incl. LULUCF

1.5°C compatible

Target gap
19 − 22
GtCO₂e

Implementation gap
23 − 27
GtCO₂e

1.5°C emissions gaps in 2030

The "gap" range results only from uncertainties in the pledge projections.
Gaps are calculated against the median of the benchmark emissions for 1.5°C.
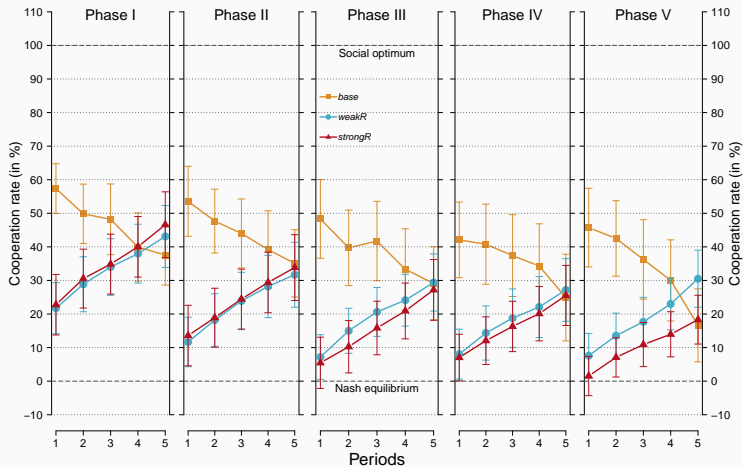
Climate Action Tracker

Nov 2022
Update

back

Amano & Ohashi (2018)
❯ Firms (Japanese televisions) strategically hold back on energy efficiency to be able to continue to sell less efficient products for the foreseeable future
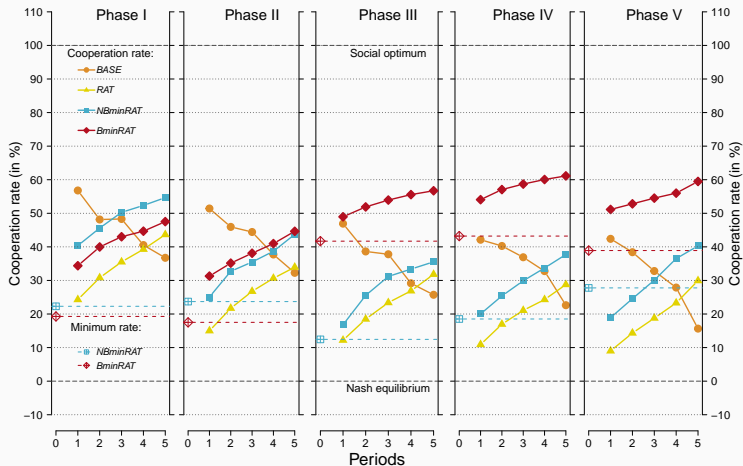
back

back

Schelling (1960)

```
[...] if the contribution is divided into consecutive
  small contributions, each can try the other's good
faith for a small price. [...] no one need risk more
        than one small contribution at a time.
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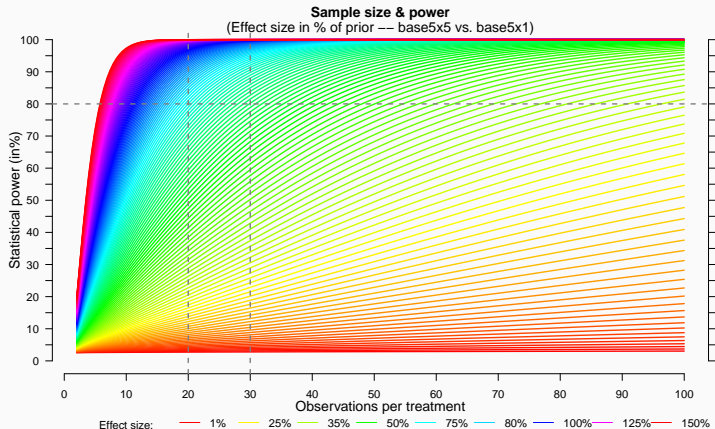
Duffy et al. (2006)

> Contributions to a public good are larger in a dynamic
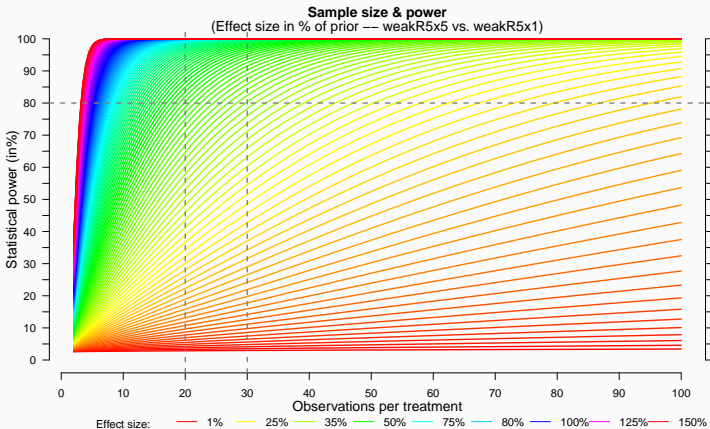> multi-round game than in a one-shot game

Dorsey (1992), Kurzban et al. (2001)

> If contributions can be constantly revised, ratcheting increases
> contributions to a public good

back

BASE 5x5 vs. BASE 5x1

Sample size & power
(Effect size in % of prior –– base5x5 vs. base5x1)

Effect size: —— 1% —— 25% —— 35% —— 50% —— 75% —— 80% —— 100% —— 125% —— 150%

RAT 5x5 vs. RAT 5x1

Sample size & power
(Effect size in % of prior — weakR5x5 vs. weakR5x1)

THIS IS THE END!