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Equilibrium Selection

as a matter of norms and beliefs

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Game Theory and observed behavior

Is there a connection?

- „Naive“ applications reveal fundamental differences!
- Is there any connection at all? Analytical Sociology: No!
- Amendments (wide psychological version)
  - Norms (social preferences) instead of egoism
  - Beliefs instead of complete information
  - Error or imprecision

  are sometimes rather successful!

E.g. Quantal response equilibria (McKelvey&Palfrey, 1995) with social preferences

Additional Complication(?)

Multiple Equilibria

- 2x2 games often have three equilibria
- The 4x2 games discussed below have up to 31 equilibria
- Can players coordinate on one of the equilibria?
- If yes: Which one is played?
- If no: ?

Normative approaches to equilibrium selection

- Pay-off dominance (if applicable)
- Risk dominance (different definitions)
- Global games (noise → 0)
- Quantal response equilibria (impresision → 0)
- Harsanyi-Selten theory
- ….

Always – often – sometimes: unique selection

Is „unique“ desirable for a behavioral approach?

Behavioral Theory of Equilibrium Section

Non- existent (?)

Requirements?

General Hypothesis

Behavior is based on three main requirements:

- Consistency (best replies, equilibria)
- Efficiency (social product maximizing strategies)
- Fairness (qualitative or quantitative equality)

However, people are prone to

- Error

as random deviations and non-justified beliefs.

Evidence for each of these behavioral traits from economic experiments!

Specific Hypothesis

Behavior is an **equilibrium strategy** either from

- the **most efficient** equilibrium

or

- the **most efficient among the fair** equilibria

[Fairness= binary concept :

Equilibria are either fair or unfair]

But ….

Plus Error!

Concerning

- Equilibrium (non-equilibrium heuristics)
- Maximum (second best)
- Implementation (probability of deviation)

Practical Hypothesis

Players belong to different populations

- PE1 play most efficient equilibrium
- PE2 play second most efficient equilibrium
- PF1 play most efficient among the fair equilibria
- PF2 play second most efficient among the fair equ.
- P… use simple heuristics

In addition:

Small random deviations from all strategies

The

Practical Hypothesis

defines a **strict frame** with some degrees of freedom,

in particular concerning

- Definition of fairness
- Heuristics

Experiments:

- Binary Threshold Public Good games
- 4 players
- 2 strategies (contribute with costs = ci

  or not with costs =0)
- Public good produced if ≥**k** players contribute

  Public good provides benefits Gi, otherwise 0

In the positive frame:

k=1 is the Volunteer‘s Dilemma (Diekmann, 1985)

k=4 is the Stag Hunt Game (Rousseau, 1762)

Experimental design

- 4 treatments x 4 games
- Games with k=1,2,3,4
- Treatments S+, S-, A, B

In **S+** two kinds of players with **positive** ci and Gi and ci/Gi=0.4

In **S-** all players as in S+ but with **negative** ci and Gi

In **A** all players with **positive** costs and benefits and cost/benefit ratios = (0.225, 0.25, 0.275, 0.3)

In **B** all players with **positive** costs and benefits and cost/benefit ratios = (0.1, 0.2, 0.3, 0.4)

Experimental design

- Sessions with 8 players (two games with 4 players)
- In every session 4x8 periods (repetitions of games)
- Same k in 8 consecutive periods, random order of k
- Stranger design (in every period radom allocation)

- S+, S- with 10 sessions each in Frankfurt/Oder
- A with 6 (12) sessions in Frankfurt (Berlin)
- B with 10 (6) sessions in Frankfurt (Berlin)

Number of equilibria

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Threshold k	1	2	3	4
# pure str. equ.	4	7	5	2
# compl. mixed equ.	≤ 1	≤ 2*	≤ 2*	≤ 1
# pure/mixed equ.	≤10	≤ 24	≤ 24	≤ 6

Definition of fair equilibria
- Symmetric equilibria
- Completely mixed equilibria

Hypothetical populations

- PE1 play most efficient equilibrium
- PE2 play second most efficient equilibrium
- PF1 play most efficient among the fair equilibria
- PF2 play second most efficient among the fair equ.
- P1 contribute always (always fair, equ.* for k=4)
- P0 contribute never (always fair, equ.* for k=2,3,4)

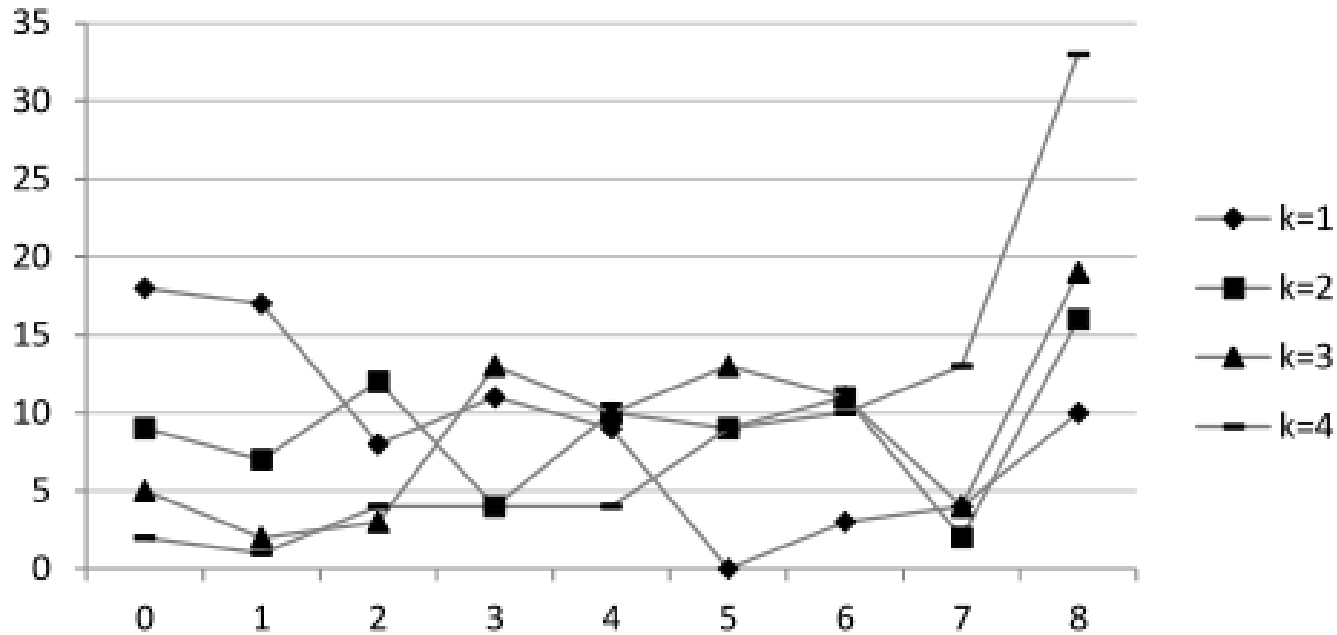


Figure 1: Frequency distribution of individual contribution frequencies (ICFs) in treatment S+. k= threshold. For every k, 8 decisions by 80 individuals.

These do not seem to be binomial distributions !

No unique equilibrium selection!

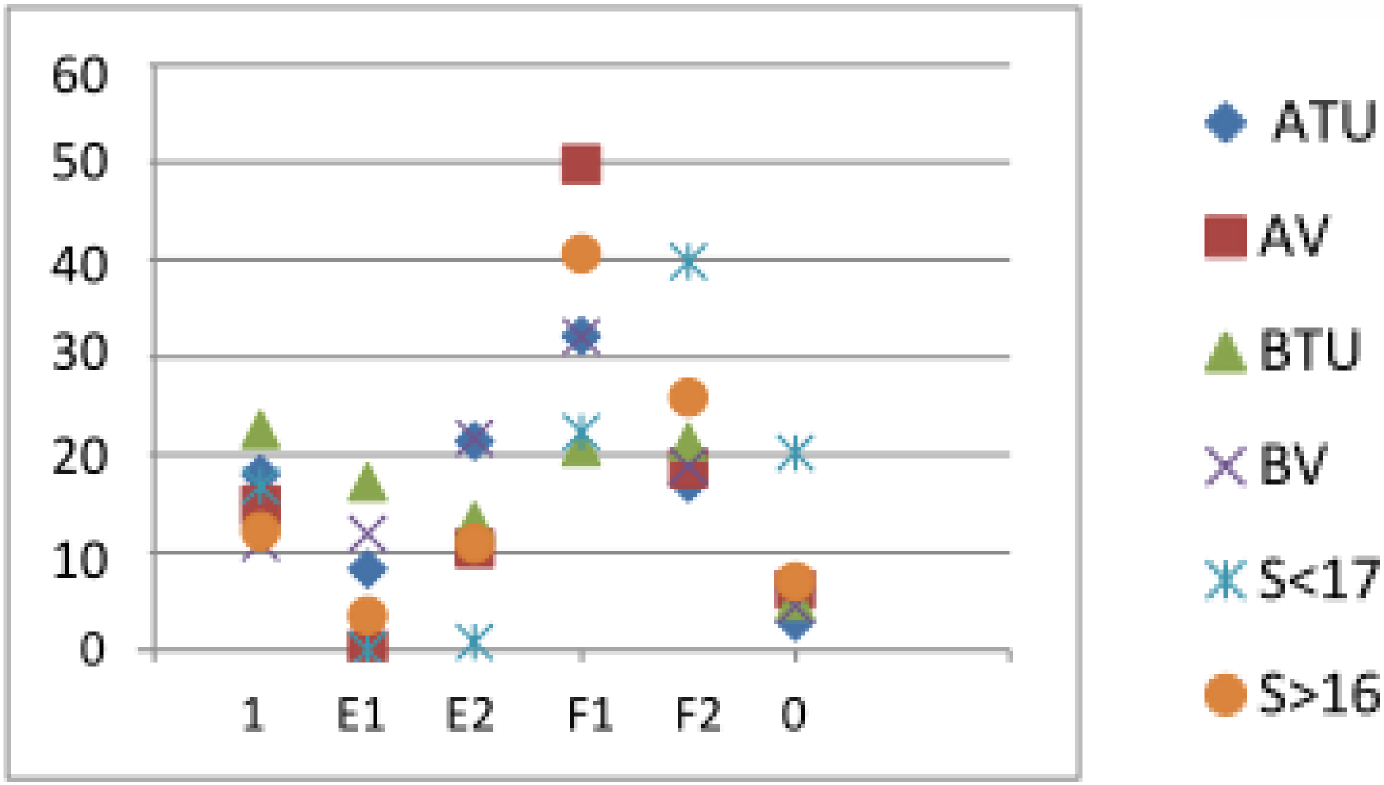
Parameters to be estimated

- Population shares for
  P1, PE1, PE2, PF1, PF2, P0
- Warm glow parameters
  varying with cost/benefit ratios ci/Gi
- One deviation probability

- 7 Parameters in S+ and S-
- 10 parameters in A and B

		Minimum χ^2			Minimum χ_r^2		Maximum Likelihood			
Data	N	χ^2	$p(\chi^2)$	-logL	χ_r^2	$p(\chi_r^2)$	χ^2	$p(\chi^2)$	-logL	-logL/N
S+/S- per<17	320	171.0	0.002	712.1	24.7	0.479	216.4	$<10^{-6}$	700.8	2.190
S+/S- per>16	320	146.1	0.060	602.9	38.6	0.040	174.2	0.001	595.2	1.860
S+/S- all	640	190.8	$<10^{-4}$	1342.5	22.1	0.683	248.8	$<10^{-9}$	1329.5	2.077
A_{TU}	384	121.0	0.405	610.5	24.4	0.328	134.5	0.142	604.5	1.574
A_V	192	141.9	0.066	350.9	24.8	0.304	177.3	0.003	347.6	1.810
$A_{TU}+A_V$	576	181.7	10^{-4}	986.7	32.4	0.070	208.5	$<10^{-6}$	980.0	1.701
B_{TU}	192	124.2	0.300	291.0	18.6	0.667	368.3	0	279.2	1.454
B_V	320	122.0	0.382	549.3	20.6	0.546	143.4	0.056	544.4	1.701
$B_{TU}+B_V$	512	135.5	0.129	841.3	24.4	0.328	162.6	0.004	834.3	1.629

Table 4: Minimum Chi-square and Maximum likelihood estimation of the finite mixture model with six data sets under *HypThresh*.



Estimated population shares (%)

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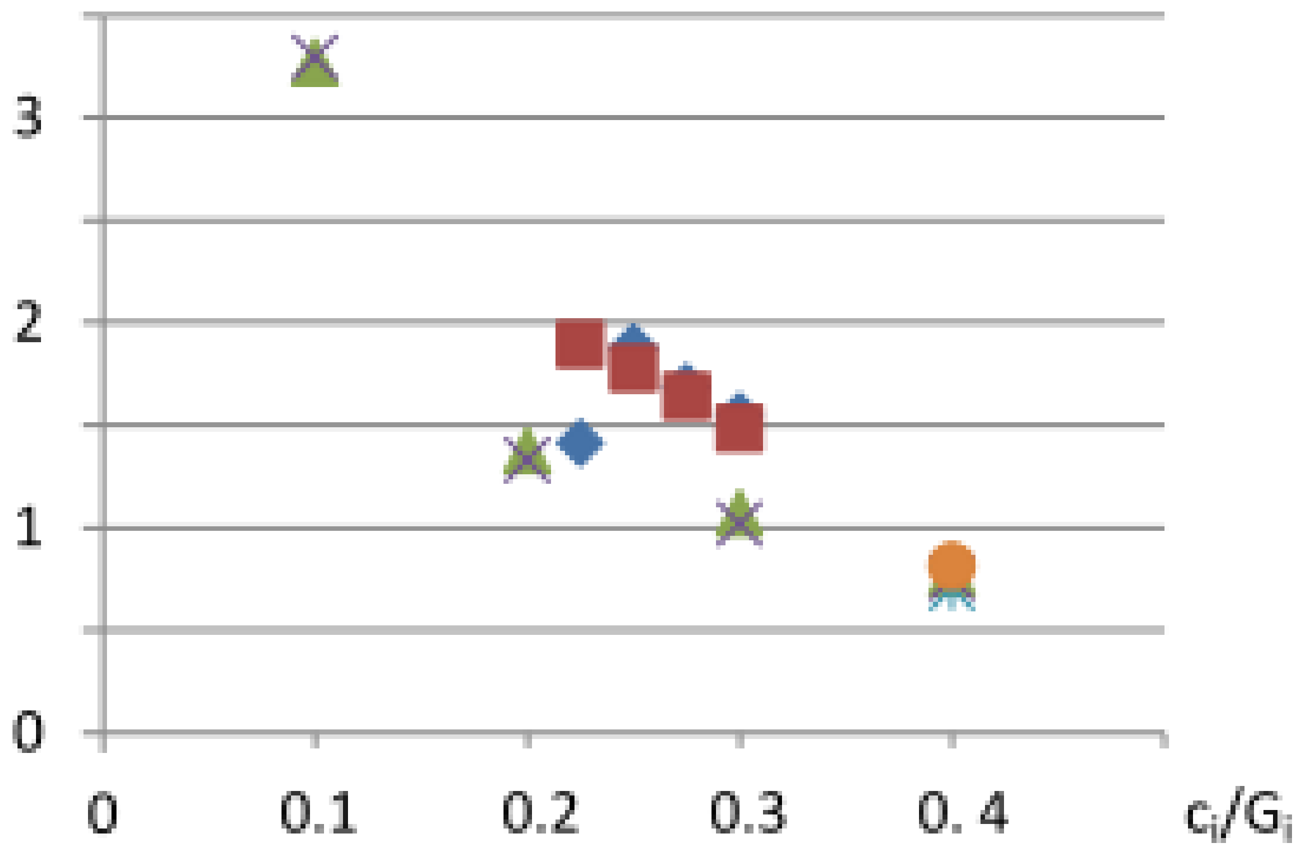

Estimated warm glow parameters

(additional utility from contributing)

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Performance of Equ. Select. hypothesis

where applicable (static behavior, same subject pool)

- Not rejected in chi-square tests
- Same population shares for k=1,2,3,4 (and S+/S-)
- warm glow parameters varying only with ci/Gi

But remaining treatment effect:

- Different population shares in S+/S-, A, and B

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Open questions

- Explanation of remaining treatment effects
- Application to other classes of games
- Populations and personal characteristics
- Extension to dynamic behavior (learning)

Thank you for your attention!

In spite of the good fit, ….

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Fundamental problem in **repeated** games: Why stick to equilibria which are not played by all others? Possible answers:

- People have detected the „right thing“ and they stick to it, independent of what others do

  (Cooper, 1996,rep. PD, 12% always coop.)
- There is no advantage from changing one‘s strategy
- Deviationed from mixed strategy equilibria are difficult to detect