



Strategic Ties: Formation and Effects of Long-Term Exchange Relations

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In a nutshell...

- **Well-known:** repeated interactions facilitate cooperation of rational and purely self-interested actors in social dilemmas
 - => *Effects* of long-term exchange relations
- **Hence,** rational and purely self-interested actors have incentives to invest in establishing and maintaining repeated interactions
 - => *Formation* of long-term exchange relations
 - 'Formation' is not well-studied
- **New contribution:** integrated model of 'formation and effects'
 - We assume strategic rationality with respect to both 'formation' and 'effects'
- **Note:** this is an exercise in theory formation and formal modeling, including testable predictions; empirical test on To Do-list

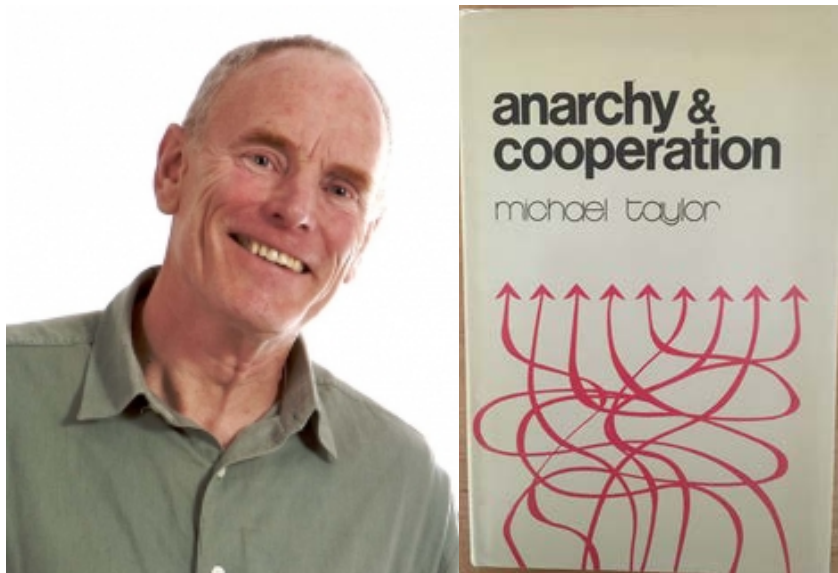
Effects of long-term exchange relations

- Effects of repeated interactions on behavior in social dilemmas
- **Social dilemmas** : \approx
 - Cooperation is beneficial (Pareto-optimal) for the actors involved
 - Cooperation is not an equilibrium outcome of 'one shot'-interactions (such as 'spot exchange')
 - Examples: PD, Trust Game, Investment Game, Public Good Game,...
- Repeated interactions => conditional cooperation (\approx Tit for Tat-like behavior) can be equilibrium behavior ('cooperation of rational egoists')

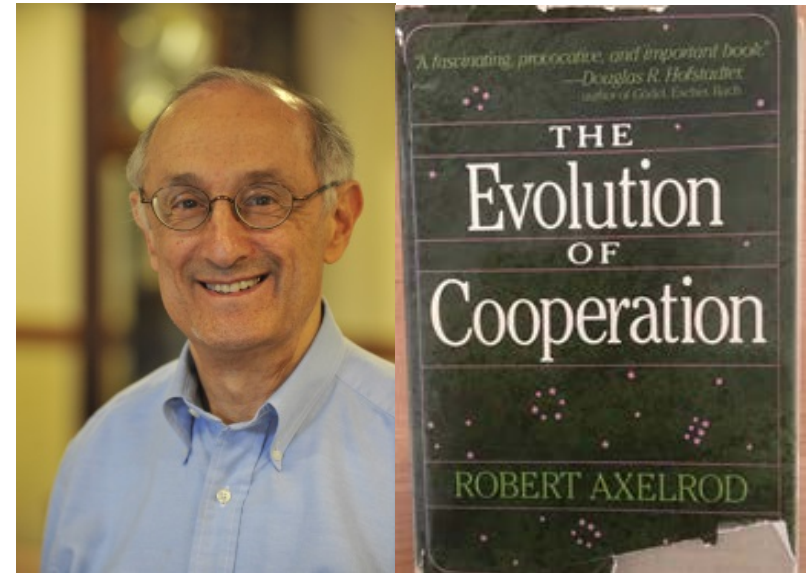
Effects of long-term exchange relations

- **Conditional cooperation of rational egoists in repeated social dilemmas: early contributions in political science**

1976



1984



Effects of long-term exchange relations

- Conditional cooperation of rational egoists in repeated social dilemmas: early contributions in sociology

1982



Thomas Voss

RATIONAL ACTORS AND SOCIAL INSTITUTIONS: THE CASE OF THE
ORGANIC EMERGENCE OF NORMS

Introduction

One of the most promising branches of the structural-individualistic program in sociology is the economic approach to social phenomena. It rests on the idea that individual behavior under social conditions and its collective consequences should be explained with explicit recourse to the behavioral assumption of rational action ¹⁾ (as elaborated in utility and game theory). The success of

1986

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Die Sozialstruktur der Kooperation rationaler Egoisten*
Zur „utilitaristischen“ Erklärung sozialer Ordnung

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Zusammenfassung: Soziale Situationen strategischer Interdependenz, in denen kooperatives Verhalten für nicht durch externe Instanzen eingeschränkte, rationale und egoistische Akteure zwar vorteilhaft, jedoch schwierig zu erreichen ist, treten in vielen Zusammenhängen auf. Klassisches Beispiel ist Hobbes' Problem der sozialen Ordnung. Weitere zentrale Beispiele sind bestimmte wirtschaftliche und „soziale“ Austauschbeziehungen oder solidarisches Verhalten in Gruppen. Im ersten Teil des Beitrags werden „problematische“ Situationen dieser Art und die bei ihrer

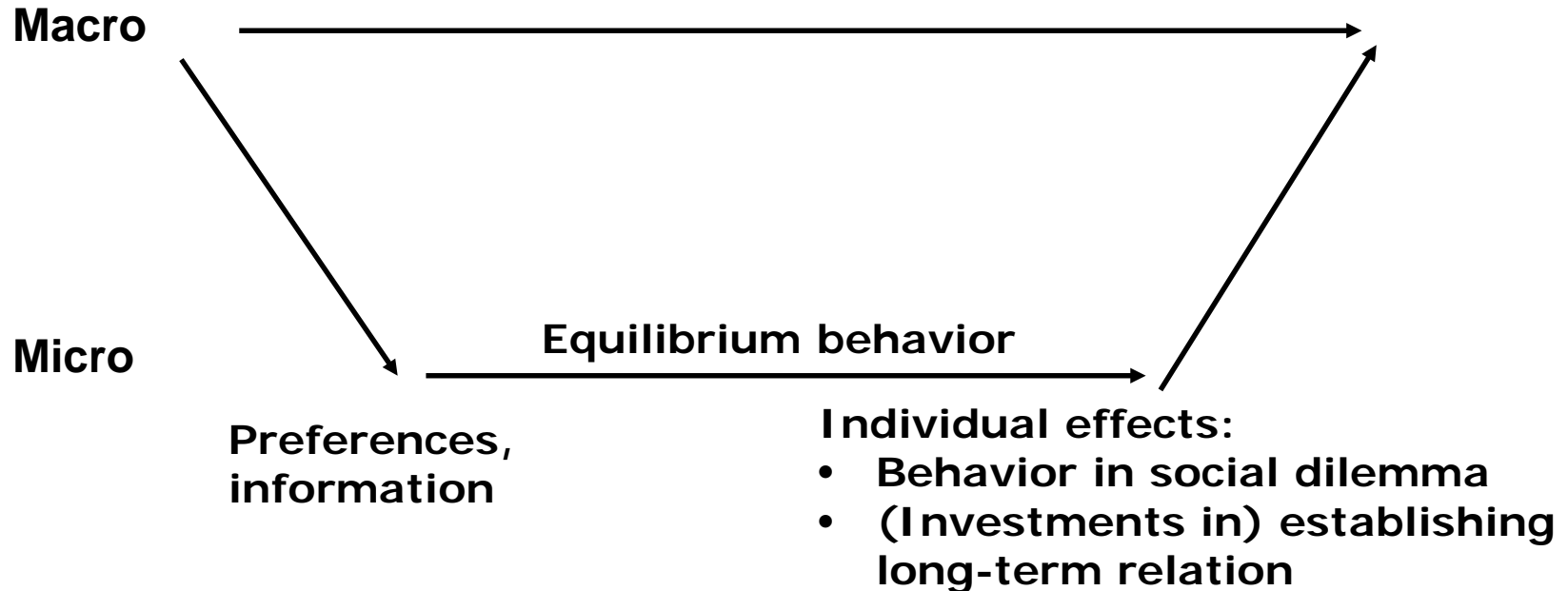
Formation of long-term exchange relations

- At times, actors can engage, possibly at cost, in establishing, maintaining or severing relations (ties) with others
- Effects of long-term relations & opportunities to establish and maintain such relations → incentives to invest (e.g., investments in alternatives to spot exchange)
- Modeling these features → Long-term relations are endogenous

Summary of the approach in terms of Coleman's diagram

Macro conditions: social dilemma;
opportunities for establishing
long-term relation

Macro outcomes:
• long-term relation;
• Pareto-(sub)optimality



Research strategy: "to import the economist's principle of rational action for use in the analysis of social systems proper, including but not limited to economic systems, and to do so without discarding social organization in the process" (Coleman 1988: S97)

Coleman on 'social organization'

- Coleman's research strategy: "to import the economist's principle of rational action for use in the analysis of social systems proper, including but not limited to economic systems, and to do so without discarding social organization in the process" (Coleman 1988: S97)
- In our case, 'social organization' refers to 'tie formation' and thus to market structure as an *outcome* of rational action, rather than exclusively a *macro-condition* for individual behavior

Related research

- Dynamics of networks and behavior (e.g., Raub, Buskens & Frey 2013 *The Rationality of Social Structure, Social Networks*)
 - Integrated model of formation and effects of networks (rather than dyadic relations)
- Empirical work
 - Experimental study on the emergence of exchange structures: Kollock *AJS* 1994
 - Related work in economic sociology using survey data: DiMaggio & Louch *ASR* 1998
 - As often happens, economists picked up the topic: Brown, Falk & Fehr *Econometrica* 2004 on mitigating principal-agent problems in employer-employee interactions

Remainder of the presentation

- **Model assumptions**
- **Implications of the model**
- **Testable predictions**
- **Discussion**
 - **Commitment-feature of strategic ties**
 - **Generalizations**
 - **Summary**

Model assumptions

- ***'Simple cases first'***: a model using the Prisoner's Dilemma (PD) as an example for a social dilemma
- **Afterwards: generalizations**

Prisoner's Dilemma

		Actor 2	
		Cooperation C_2	Defection D_2
Actor 1	Cooperation C_1	R, R	S, T
	Defection D_1	T, S	P, P

$$S < P < R < T$$

Mutual defection: unique equilibrium

Mutual cooperation: Pareto-improvement compared to mutual defection and Pareto-optimal but not an equilibrium

PD as a model for two sided incentive problems in economic exchange (Hardin 1982): e.g., seller has an incentive to sell a bad good for the price of a good one; buyer has an incentive to delay payment

Embedding the PD in a repeated game Γ

- Consider a game Γ with rounds $t = 0, 1, 2, \dots$
- Depending on what happens in $t = 0$, game Γ continues either as a subgame Γ^{tie} or as a subgame $\Gamma^{stranger}$
- Subgame Γ^{tie} : indefinitely often repeated PD between actors 1 and 2 in rounds 1, 2, ...
- Subgame $\Gamma^{stranger}$:
 - Round 1: actors 1 and 2 play the PD with each other
 - Rounds 2, 3, ...: two series of one-shot PDs
 - Actor 1 plays PD with actors 1(2), 1(3), ...
 - Actor 2 plays PD with actors 2(2), 2(3), ...
 - No information exchange between actors in $\Gamma^{stranger}$
 - *Note:* long-lived actors 1, 2 and short-lived actors $i(2), i(3), \dots$ in $\Gamma^{stranger}$

Strategic tie formation

- Round 0 of Γ : actors 1 and 2 can choose between playing subgame Γ^{tie} or subgame $\Gamma^{stranger}$, i.e., they can establish a long-term exchange relation in which they play repeated PDs with each other
- Total costs of tie formation: τ
- Simple sharing institution for costs of tie formation:
 - Each actor can invest $\tau/2$ in tie formation
 - Actors 1 and 2 decide simultaneously and independently on own investment
 - Tie is formed (= subgame Γ^{tie} is played) iff each actor invests; otherwise, no tie formation (= subgame $\Gamma^{stranger}$ is played)
 - An actor willing to invest does not lose investment if tie is not formed
 - *Note:* these are the standard assumptions on 'two-sided link formation with shared costs of link'

Further assumptions on Γ

- After round 0 and before round 1, each actor is informed on the other actor's decision in round 0
- Round 1 is always played after round 0; after each round $t = 1, 2, \dots$, the next round $t+1$ is played with constant probability w ($0 < w < 1$)
- (Expected) payoff for $\Gamma =$ costs in round 0 + discounted sum of payoffs in rounds 1, 2, ...
- No noise: information – if available – is correct
- Structure of Γ is common knowledge
- Γ is a noncooperative game

Examples from economic exchange

- PDs in rounds 1, 2,...: economic transactions with incentive problems (due to, e.g., information asymmetries, incomplete contracts,...)
- Subgame $\Gamma^{stranger}$: actors 1 and 2 have one-shot transactions with different partners
- Round 0: actors 1 and 2 can establish a long-term exchange relation (formally: entering subgame Γ^{tie}) through, e.g., an agreement for repeated transactions, a joint venture, entering a long-term employment relation...

Analysis of the model: implications

Analytical approach

- We derive conditions for subgame perfect equilibria (spe) of Γ
 - **Specifically:** conditions for spe such that strategic tie is formed in round 0, while actors subsequently cooperate in each round 1, 2, ... of subgame Γ^{tie}
 - Focus on spe's in trigger strategies
 - Backwards induction:
 - Step 1: analyze subgames $\Gamma^{stranger}$ and Γ^{tie}
 - *Note:* analysis of Γ^{tie} : *effects* of tie formation
 - Step 2: derive conditions such that tie *formation* in round 0 is on the spe-path
- => Integrated model of 'formation and effects'
- **Additional result:** specification of value of strategic tie and net gain of tie formation

Effects of strategic ties: equilibria of subgames $\Gamma^{stranger}$ and Γ^{tie}

- **Proposition 1 – Defection without tie formation:** equilibrium behavior in subgame $\Gamma^{stranger}$ implies that all actors defect in all PDs in all rounds 1, 2,...
- **Proposition 2 – Cooperation after tie formation:** subgame Γ^{tie} has an spe such that actors 1 and 2 cooperate throughout all rounds 1, 2,... iff

$$w \geq TEMP := (T - R) / (T - P)$$

- **Note:**
 - Proposition 2 is on *effects* of strategic ties
 - **TEMP:** measure for size of cooperation problem
 - $0 < TEMP < 1$

Details on subgame $\Gamma^{stranger}$

- **Proposition 1 – Defection without tie formation:** equilibrium behavior in subgame $\Gamma^{stranger}$ implies that all actors defect in all PDs in all rounds 1, 2,...
- **Note:** the important feature of $\Gamma^{stranger}$ is not that each actor i plays the PD only once with j and with each actor $i(2), i(3), \dots$. Also, no need to assume that information exchange between actors involved in $\Gamma^{stranger}$ is completely excluded. Only important feature: cooperation is not supported by game-theoretic equilibrium behavior in $\Gamma^{stranger}$ and equilibrium behavior implies that actors defect throughout all rounds 1, 2, ... in $\Gamma^{stranger}$. Our assumptions on the structure of $\Gamma^{stranger}$ do ensure this for the subgame and keep the model simple

Conditional cooperation in Γ^{tie} I

- We derive conditions for an spe such that actors cooperate conditionally:
 - Actor i cooperates (and thus rewards cooperation of j) as long as i has no information on a defection
 - Actor i defects (and thus punishes defection of j) as soon as i has information on a defection
- Most severe punishment for defection: i cooperates *never* again → trigger strategy
- Conditions for trigger strategy equilibrium are necessary and sufficient conditions for spe such that actors cooperate throughout Γ^{tie}
- Assumption for empirical applications: cooperation is more likely when the conditions for a trigger strategy equilibrium are less restrictive (Buskens & Raub 2013; Dal Bó & Fréchette 2018)

Conditional cooperation in Γ^{tie} II

- **Proposition 2 – Cooperation after tie formation:** subgame Γ^{tie} has an spe such that actors 1 and 2 cooperate throughout all rounds 1, 2,... iff

$$w \geq TEMP := (T - R) / (T - P)$$

- **Note:** this is the standard condition for spe in indefinitely repeated PD. Under this condition, if i uses trigger strategy, j 's payoff from any defection is not larger than his payoff from always cooperating

Tie formation

Proposition 3 – Investments in strategic tie:
 Γ has an spe such that actors 1 and 2 invest in tie formation in round 0 and subsequently cooperate in all rounds 1, 2,... iff

$$(1) \quad w \geq TEMP$$

and

$$(2) \quad \tau \leq 2(R - P) / (1 - w)$$

Note: (1) implies cooperation on spe-path in Γ^{tie} ; (2) implies individual costs of tie formation are small enough (not larger than value of tie)

Value of strategic tie and net gain of tie formation

Proposition 4 – Value of strategic tie and net gain of tie formation:

Assume

- (1) equilibrium behavior in subgame $\Gamma^{stranger}$**
- (2) cooperation in all rounds 1, 2, ... of subgame Γ^{tie} iff cooperation is on spe-path**
- (3) $w \geq TEMP$**

Then:

$$\text{value of strategic tie} = (R - P) / (1 - w) > 0$$

$$\text{net gain of tie formation} = (R - P) / (1 - w) - \tau / 2 \geq 0$$

for each actor i ($i = 1, 2$)

Note: under assumptions (1)–(3), equilibrium payoffs are $R / (1 - w)$ in Γ^{tie} and $P / (1 - w)$ in $\Gamma^{stranger}$

Testable predictions

Predictions for experimental tests

Predictions based on main assumption 'equilibrium behavior':

- Scenario $w < TEMP$ ('large cooperation problems')
 - Likelihood of tie formation: small
 - Effects of costs τ on tie formation: small
 - Likelihood of cooperation in rounds 1, 2,...: small
 - Effects of tie formation on subsequent cooperation: small
- Scenario $w \geq TEMP$ ('small cooperation problems')
 - Effects of costs τ on tie formation: negative and large
 - Effects of tie formation on subsequent cooperation: positive and large

Predictions for experimental tests: comment

Note that the model allows for a rigorous test of rational choice assumptions:

- Predictions on *effects of tie formation* on cooperation are the standard case of predictions on reactions to incentives
- Predictions on *tie formation itself* address the further question whether actors behave as if they anticipate on the effects of tie formation and form ties with these effects 'in mind'

(Similar arguments in related contexts: Prendergast 1999; Batenburg, Raub & Snijders 2003)

Experimental research: further suggestions

- Compare two scenarios for mitigating cooperation problems in transactions and exchange:
 - Scenario 1: subjects can mitigate cooperation problems by investing in *strategic ties*
 - Scenario 2: subjects, at costs, can secure *external enforcement* for agreements on behavior in one-shot interactions
- One can easily derive and test predictions for conditions such that rational actors would prefer investing in strategic ties or would prefer investing in external enforcement

Discussion

Commitment-feature of tie formation

- Through strategic tie formation, actor Ego voluntarily ensures that s/he suffers from own future costs of own defection, since Alter can punish Ego's defection in future interactions in subgame Γ^{tie}
- Thus, Ego voluntarily reduces own incentives for defection: 'binding one's own hands'
- In this sense, investing in strategic tie can be a 'credible commitment' to cooperate
- This can induce Alter to cooperate likewise
- Compare: 'hostage posting' as a mechanism of cooperation
- Related research: e.g., Schelling, Williamson, own work, Diekmann/Gambetta/Przepiorka...

Generalizations of the model

Model can be generalized in various directions:

- Other social dilemma games
- Other institutions for (sharing the) costs of tie formation
- Games with incomplete information

Generalizations: other social dilemma games

The model can be easily generalized, with results analogous to the PD-example, to indefinitely repeated games with trigger strategy equilibria (Friedman 1986)

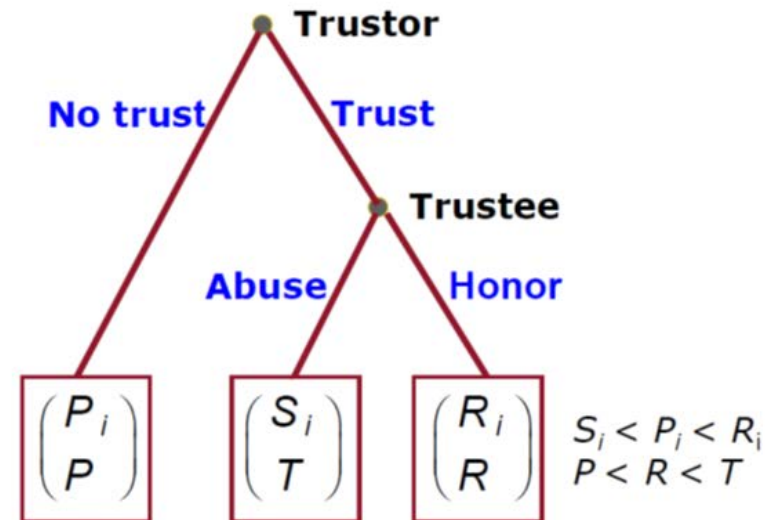
=> This includes social dilemma games with 2 as well as $n > 2$ actors (for example, Trust Game, Investment Game, Public Goods Game)

Trust Game and tie formation as a commitment of the trustee

Consider a variant of the repeated game Γ with

- standard Trust Game played in rounds 1, 2, ...
- $w \geq TEMP := (T - R) / (T - P)$
- $\tau \leq (R - P) / (1 - w)$
- only trustee can invest in tie formation: tie formation as one-sided commitment of the actor with incentive for opportunistic behavior

=> Γ has spe such that trustee invests and trust is placed and honored in all subsequent rounds



Generalizations: other institutions for costs of tie formation

- Our model includes a simple sharing institution for costs of tie formation: 'two-sided link formation with shared costs of link'
- Implications of other assumptions on institutions for costs of tie formation can be analyzed as well
- Institutional design issue – strategic tie formation as collective good: an actor who did not contribute to the costs of tie formation could likewise benefit from the tie => design institution so that opportunities and incentives for free riding are mitigated
 - *Note: 'two-sided link formation with shared costs of link' does avoid opportunities and incentives for free riding*

Tie formation as a collective good problem

- Long-term relation with repeated interactions as a collective good: actor i benefits from tie formation even if i did not contribute to costs of tie formation

=> Institutional design problem: rules for allocating costs of tie formation so that collective good problem is mitigated

- Examples
 - 'Two-sided link formation with shared costs of link' avoids the collective good problem: tie formation presupposes that each actor contributes and actor who invests can't be 'exploited'
 - Another rule: actor 1 and actor 2 decide simultaneously and independently about their individual investment; each actor can either invest τ or can decide not to invest; tie is formed if and only if at least one actor decides to invest; each actor who decides to invest, has to pay τ , irrespective of the other actor's choice in round 0 => bargaining problem: each actor prefers that the other actor invests

Generalizations: games with incomplete information

- Our model: indefinitely repeated game with complete information
 - = > Exclusive effect of tie formation: opportunities to sanction actors' present behavior in future interactions ('control')
- Finitely repeated game with incomplete information – effects of tie formation:
 - Sanction opportunities ('control')
 - Opportunities to infer unobservable characteristics of the partner from information on behavior in past interactions ('learning', 'signaling')
 - *Note:* analysis doable for PD and TG but far from trivial for many other social dilemma games

Equilibrium selection problem for Γ

- Under various institutions for allocating the costs of tie formation, the repeated game Γ always has an equilibrium such that actors do not invest in tie formation and subsequently defect throughout all rounds $1, 2, \dots$

=> Equilibrium selection problem not only for the subgame Γ^{tie} but also for Γ itself

=> Payoff dominance arguments needed not only with respect to conditional cooperation as a solution of Γ^{tie} but also with respect to strategic tie formation in round 0 and conditional cooperation in all subsequent rounds as a solution of Γ itself: actors tacitly coordinate on the equilibrium that makes them better off

Summary

- **Integrated model of formation and effects of strategic ties such as long-term exchange relations**
 - **Model with full strategic rationality with respect to both formation and effects of ties**
- **'Value of strategic tie' and 'net gain of tie formation' are implications of the model and are precisely defined**
- ***Note:* investment in tie formation as a voluntary 'commitment' that induces mutual cooperation**
- **Testable implications on formation and effects of ties**

Two remarks on macro-implications

1. Assuming sufficiently low costs of tie formation, market structure differs depending on whether or not exchange is associated with incentives for opportunistic behavior: 'spot exchange' versus long-term exchange relations (cf. Kollock 1994 and Coleman's 1988 remark on accounting for 'social organization' in rational choice models)
2. Effects of tie formation on inequality: strategic tie $i-j$ excludes other actors k from exchanges and can thus increase inequality (cf. Frey & Van de Rijt 2016)

Thanks for your attention!

Reference

- Raub, W., V. Buskens & V. Frey (2018) Strategic Ties: Formation and Effects of Long-Term Exchange Relations, *mimeo*, Utrecht University
(available upon request, email to w.raub@uu.nl)

Related work

- Raub, W., V. Buskens & V. Frey (2013) The Rationality of Social Structure: Cooperation in Social Dilemmas through Investments in and Returns on Social Capital, *Social Networks* 35: 720-732
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