

In Search of Stars: Efficiency, Equity and the Dynamics of Network Formation.

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University of Amsterdam

work in progress

Introduction & Motivation

- Networks play important role in real life
 - labor markets
 - the world wide web
 - co-authorships
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- Our study ← adds realism → people are different
 - create focalness? weaken inequity? strengthen efficiency?

Theoretical model

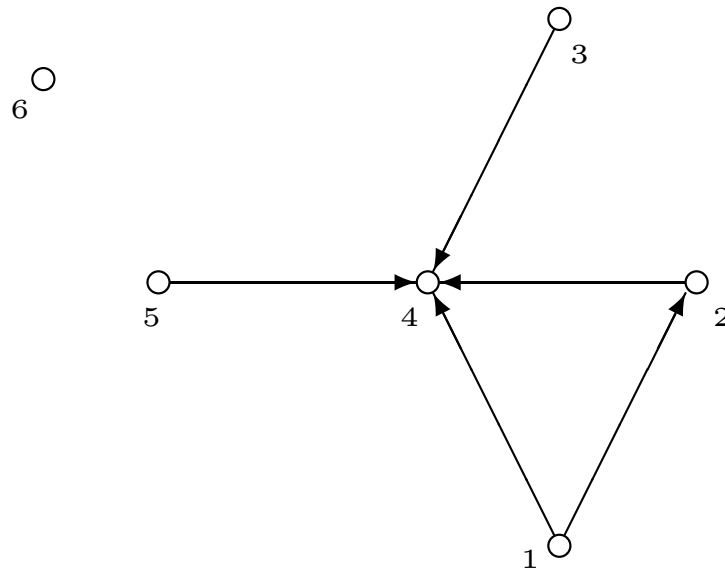
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 - linking agent bears linking cost
 - benefits accrue to any linked agents, directly and indirectly

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Example - A network with six agents

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$$\pi_i(g) = \sum_{j \in N} \Phi(v_j, d(i, j; g)) - \mu_i(g)c_i.$$

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- $\Phi(v_j, d(i, j; g))$... benefit to i from j at distance $d(i, j; g)$;
decay \rightarrow Φ decreases with $d(\cdot)$
- $\mu_i(g)$... number of links maintained by i
 c_i ... marginal cost of i of maintaining a link

Experimental design

- fixed groups of size six 30 rounds

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	marginal linking cost				value to neighbors		
normal agent	24				16		
low cost agent	7				16		
high value agent	24				32		
decay if distance	0	1	2	3	4	∞	
normal or low cost agent	16	12	9	7	5	0	
high value agent	32	24	18	14	10	0	

Experimental design & procedures

- **Treatments:** distribution of types & information about types

distribution of types	full information	limited informat
6 normal	BI (7)	-
5 normal + 1 low cost	CI (6)	CN (6)
5 normal + 1 high value	VI (4)	VN (6)
4 normal + 1 low cost + 1 high value	CVI (4)	CVN (6)

Number of independent observations (groups) in parentheses.

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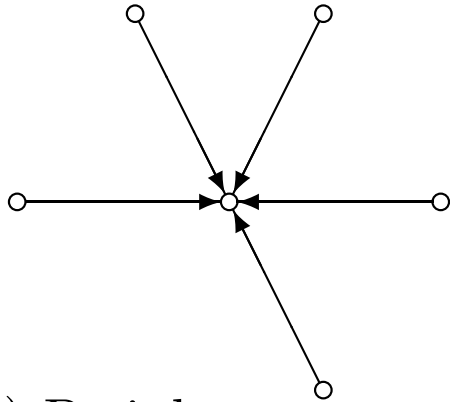
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- **Full** information → types & network structure
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- Computerized sessions at CREED (31 groups) and CalTech (8 groups); many thanks to Jos Theelen for the great program
- Average earnings: € 15,- to € 27,- (45 to 90 minutes)

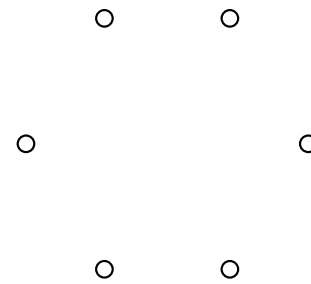
Theoretical predictions

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- **Strict Nash networks in BI:**



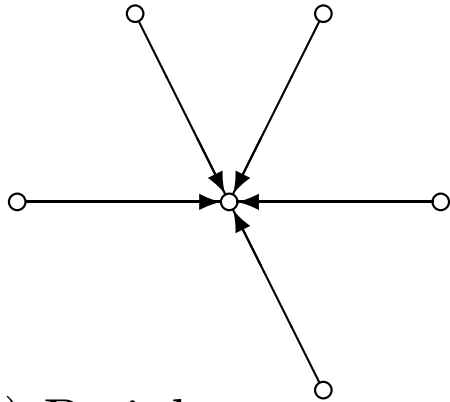
(a) Periphery-sponsored star



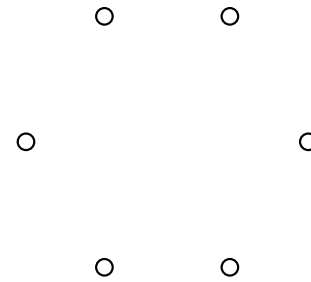
(b) Empty network

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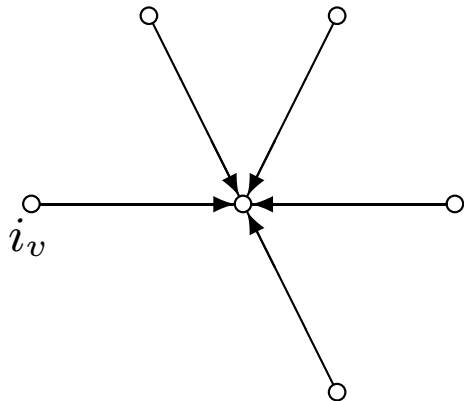


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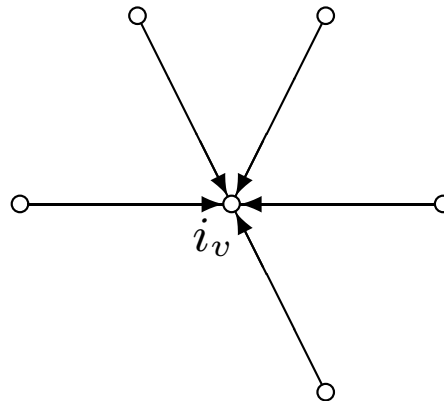


(b) Empty network

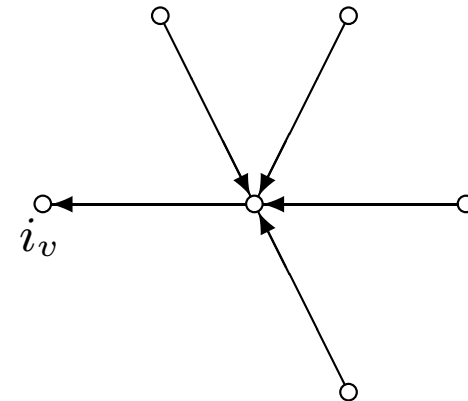
- **Strict Nash networks in VI:**



(a) Periphery-sponsored star



(b) periphery-sponsored star,
high value agent i_v as center

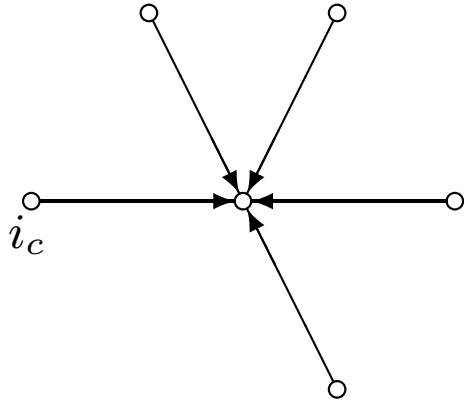


(c) star with center
sponsoring a link with i_v
otherwise periphery-sponsored

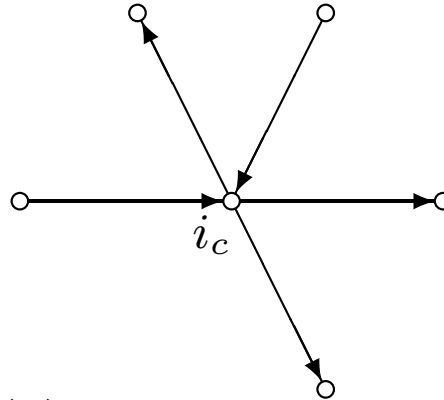
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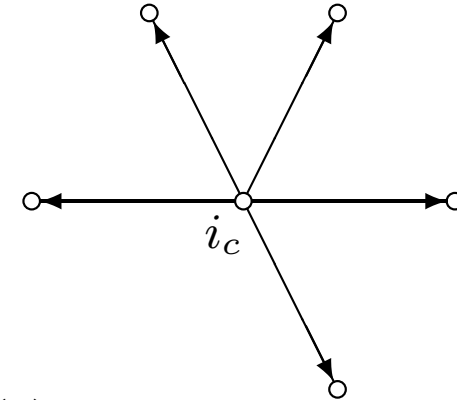
- **Strict Nash networks in CI:**



(a) Periphery-sponsored star



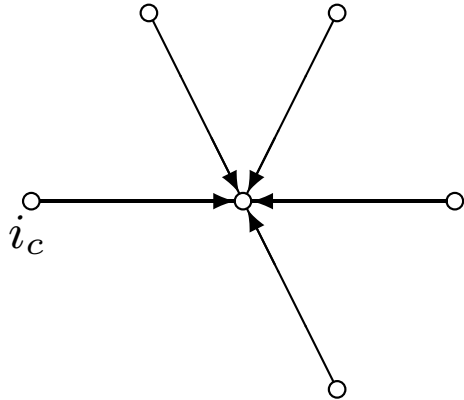
(b) star, with low cost agent i_c as center



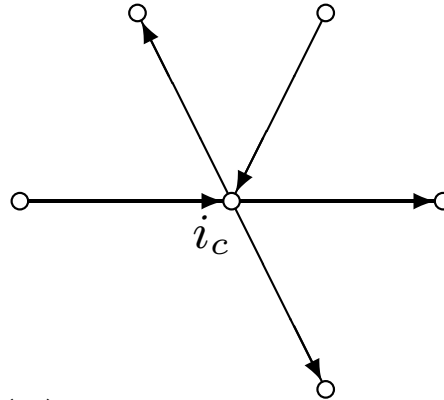
(c) center sponsored star with i_c as center

Theoretical predictions

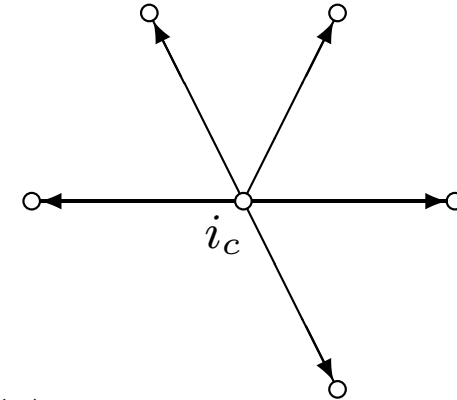
- **Strict Nash networks in CI:**



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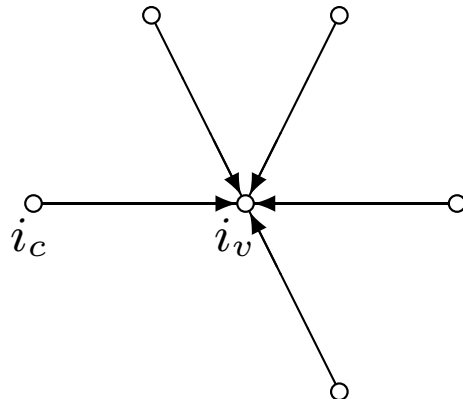


(b) star, with low cost agent i_c as center

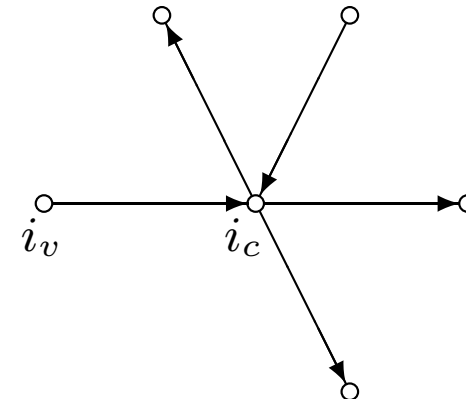


(c) center sponsored star with i_c as center

- **Strict Nash networks in CVI:**



(a) periphery-sponsored star, high value agent i_v as center



(b) star with low cost agent i_c in the center

Theoretical predictions

- **Efficient networks**

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In BI: All star networks

In CI & CN: Center sponsored star with i_c in the center

In VI & VN: All star networks with i_v in the center

In CVI & CVN: Center sponsored star with i_c in the center

Theoretical predictions

- **Efficient networks**

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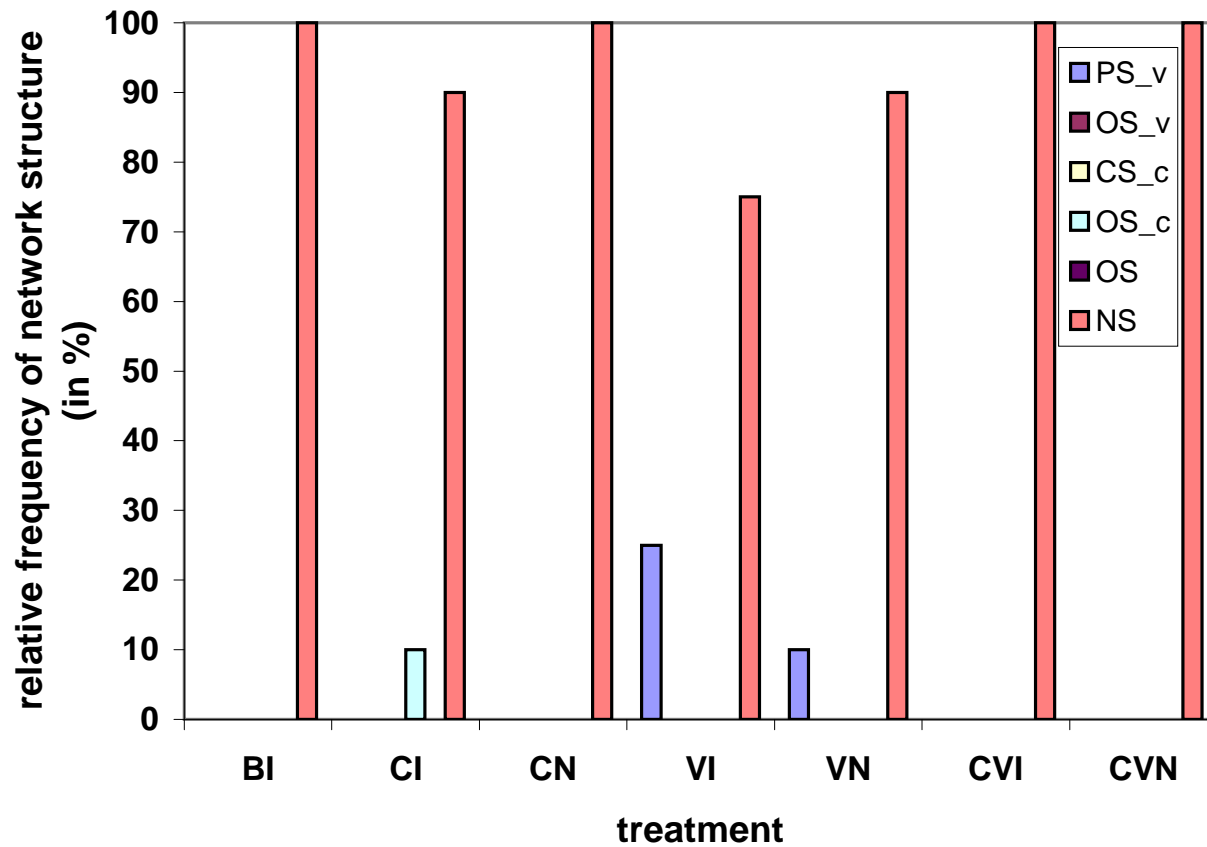
Hence, **efficient networks are also stars.**

Results - Network structures and its dynamics

- Network structures across the first five rounds

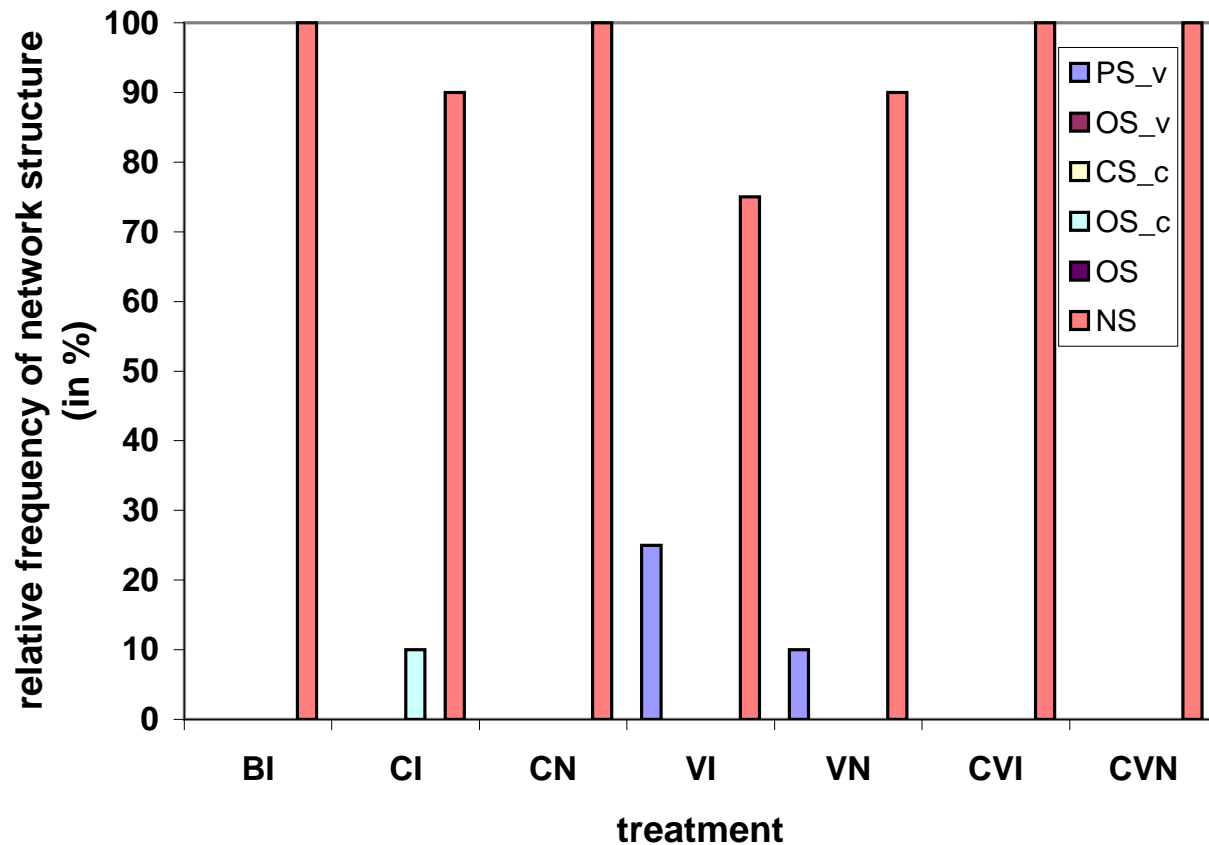
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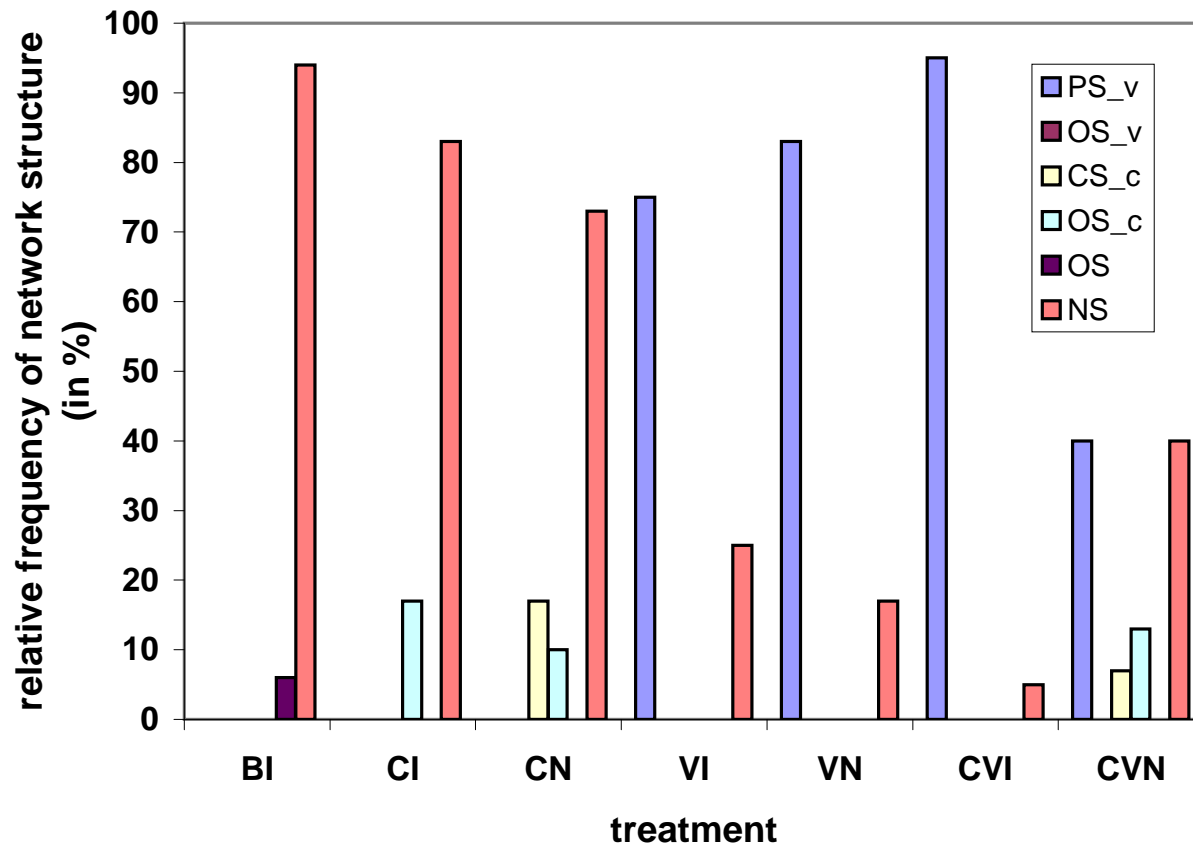
In early rounds stars are not prominent in any treatment.

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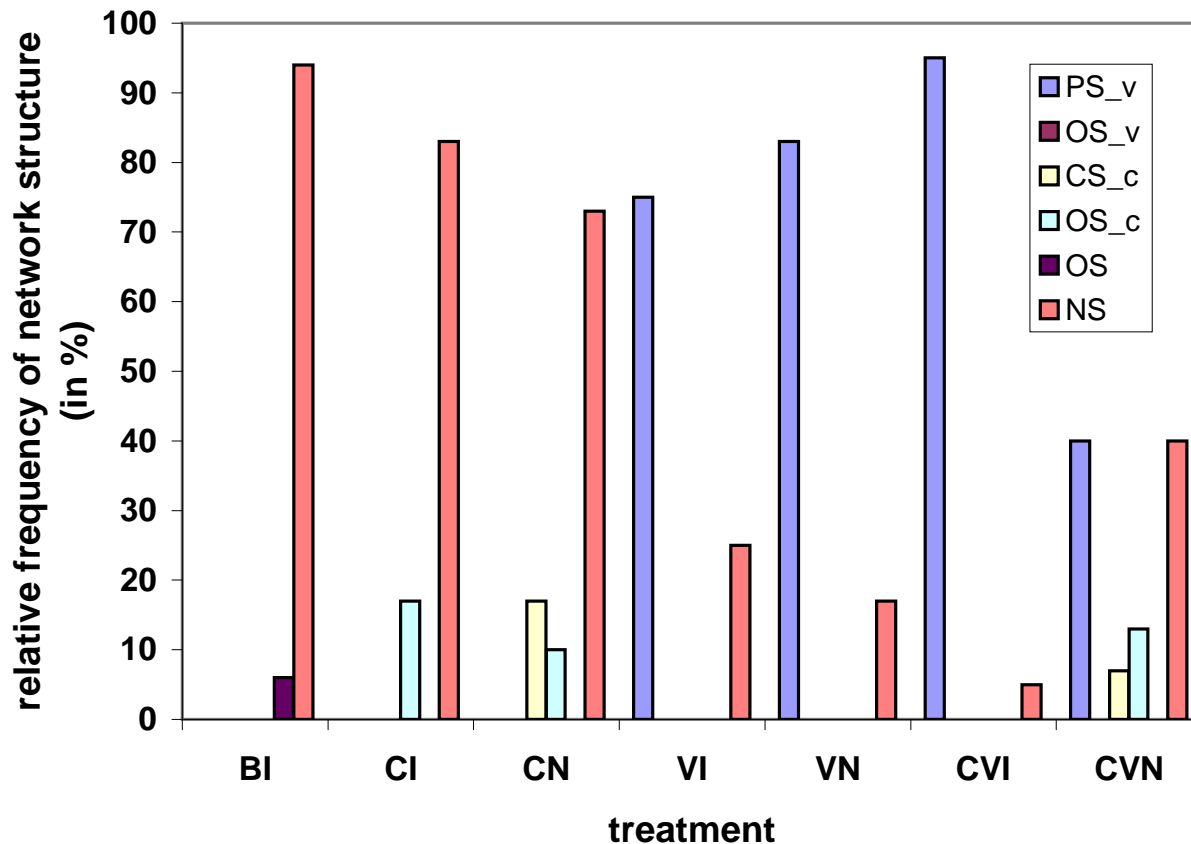
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In BI stars are virtually absent.

In CI and CN stars are very rare. If there are stars then the low cost agent appears in the center.

In VI, VN, and CVI periphery sponsored stars with i_v in the center are the most frequent networks.

In CVN periphery sponsored stars with i_v in the center also appear but less frequently.

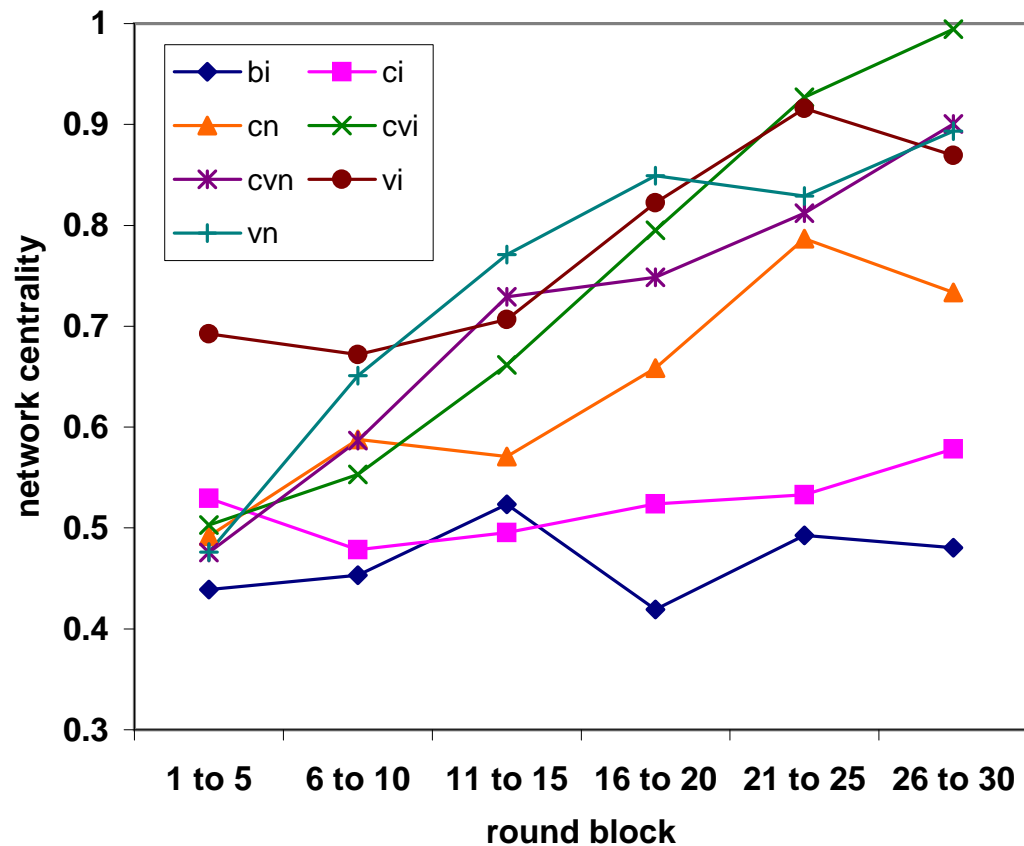
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ZERO iff all agents are equally central (complete network); **ONE** iff one agent dominates the network (STAR)

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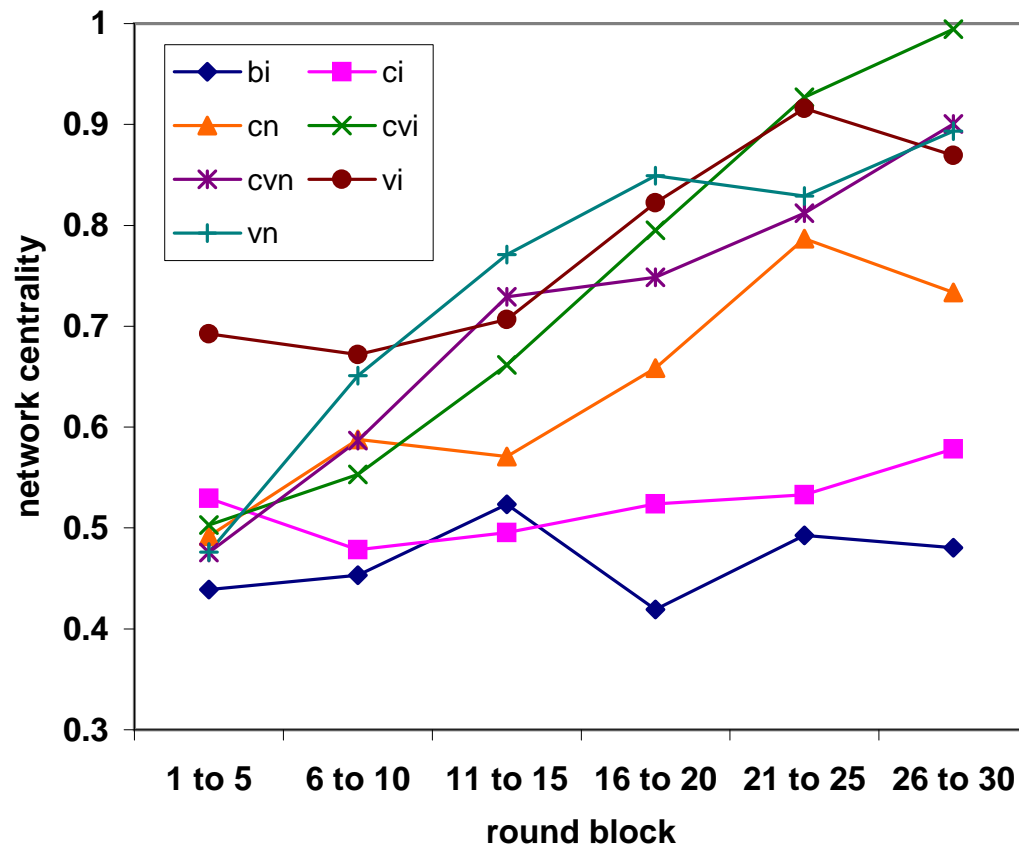
ZERO iff all agents are equally central (complete network); **ONE** iff one agent dominates the network (STAR)

In the first few rounds, network centrality is similar in all treatments, except VI where it is somewhat larger.

Over time network centrality increases in all treatments except BI and CI.

Networks with a high value agent tend to end up with a higher centrality.

Spearman’s ρ significantly positive except for BI & CI

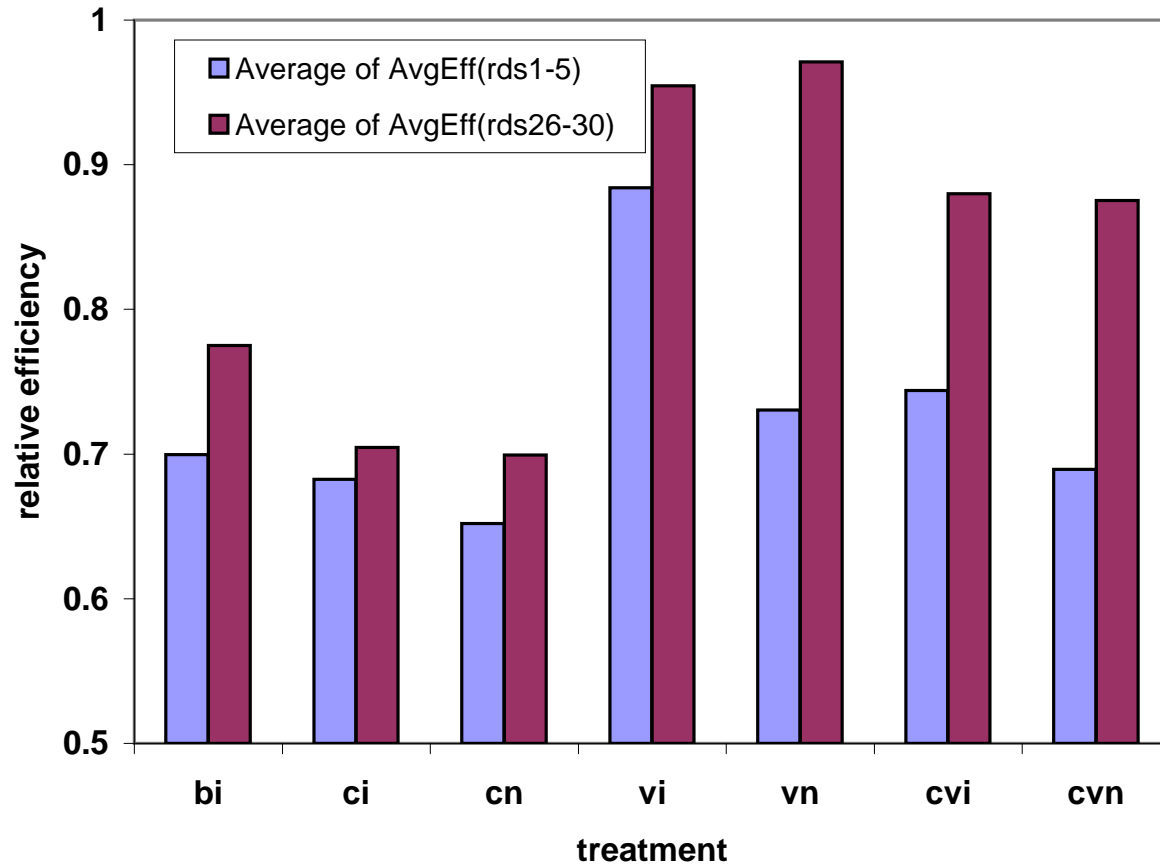


Results - Efficiency

- Efficiency: measured as actual total payoff relative to total payoff in efficient network structure

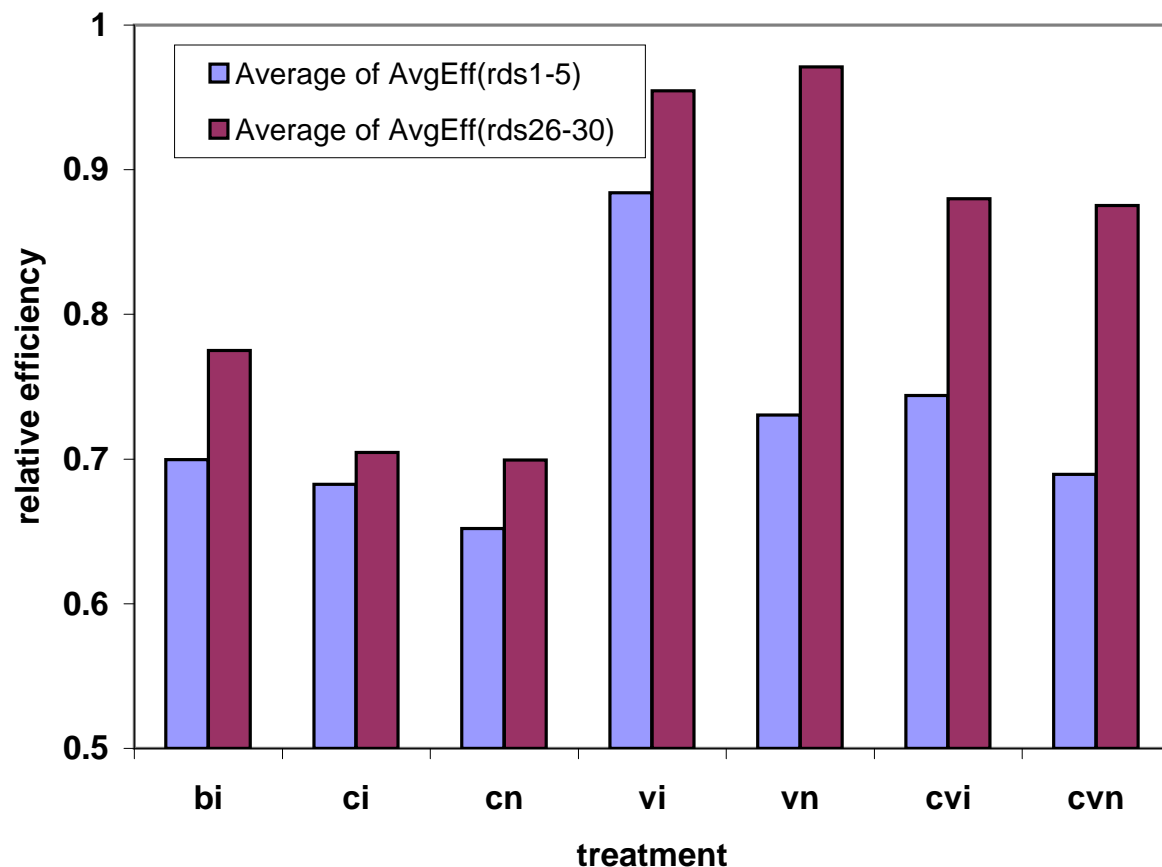
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In BI, CI, and CN relative efficiency of networks is rather low at the beginning and stays so across rounds.

In VI, VN, CVI, and CVN, in contrast, relative efficiency of the network structure significantly increases over time.

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- Inequity and network structures

Define a measure for experienced inequity, EIE , for those who ‘have to do the work’; inspired by Fehr & Schmidt (1999)

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network structure & inequity

In BI $PS \rightarrow EIE(n \text{ who links}) = -20\%$

In VI $PS_v \rightarrow EIE(n \text{ who links}) = -9\%$

In CI $CS_c \rightarrow EIE(c \text{ who links}) = -42\%$

$PS_c \rightarrow EIE(c \text{ who links}) = -20\%$

In CVI $PS_v \rightarrow EIE(n \text{ who links}) = -15\%$

$\rightarrow EIE(c \text{ who links}) = +3\%$

$CS_c \rightarrow EIE(c \text{ who links}) = -21\%$

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	network structure & inequity	in last five rounds
In BI	$PS \rightarrow EIE(n \text{ who links}) = -20\%$	PS is never formed
In VI	$PS_v \rightarrow EIE(n \text{ who links}) = -9\%$	PS_v forms in 75% of all cases
In CI	$CS_c \rightarrow EIE(c \text{ who links}) = -42\%$	CS_c is never formed
	$PS_c \rightarrow EIE(c \text{ who links}) = -20\%$	PS_c is never formed
In CVI	$PS_v \rightarrow EIE(n \text{ who links}) = -15\%$	PS_v forms in 95% of all cases
	$\rightarrow EIE(c \text{ who links}) = +3\%$	
	$CS_c \rightarrow EIE(c \text{ who links}) = -21\%$	CS_c is never formed

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- Strong learning dynamics in the heterogeneous treatments
- Focalness matters but is alone not able to help to solve the coordination problem
- There seems to be a role for inequity aversion