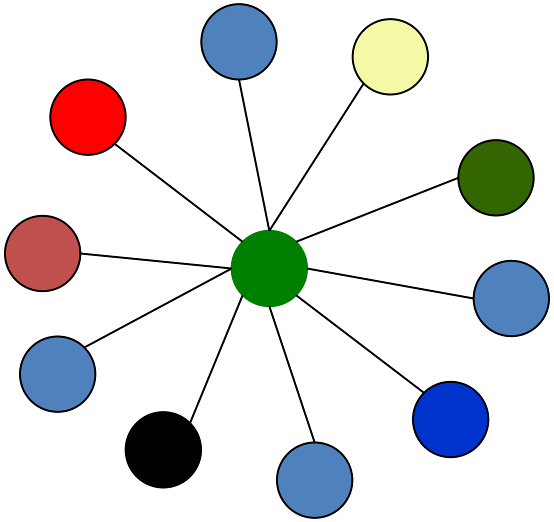
Economics of Networks III



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Communities in society

- We study interaction between communities with conflicting views on norms, e.g., language, dress, hospitality, food and diet.
- Diversity is valued but at the same time it is also viewed as a major social challenge.
- **Aim:** understand mechanisms that shape conformism vs diversity.

Case for diversity

- Valued: diversity respects individual preferences and values. This is important in itself in a liberal society. Diversity brings variety and that may have value in itself.
- Diversity may also have instrumental value as it potentially brings different perspectives into play and that may facilitate best practice across a range of societal contexts.

Challenges to diversity

- Challenge: contemporary politics in many parts of the world.
- Brexit is at least partly driven by recent immigration and a fear of further large scale immigration.
- Immigrant ghettos in European cities are viewed as a social and economic problem.
- Traditional argument: communities choose segregation over integration.

In this lecture

- We study coordination problem with many individuals.
- Individuals gain payoffs by coordinating with others.
- There are two actions and individuals differ on preferred action.
- A battle of sexes in a group setting..
- Question: when will a minority conform with the majority or and when will it go its own separate way?

Background

- Coordination problems: Schelling (1960), Gauthier (1972).
- Anderlini and Ianni (1996), Blume (1993), Ellison (1993), Goyal and Janssen (1997): interaction structure matters for coordination.
- Early work with simple networks: lattices and rings.
- Goyal and Vega-Redondo (2005) Jackson and Watts (2002): players choose *networks* and then play a coordination game.
- Advani and Reich (2015), Ellwardt et al. (2016): introduce heterogeneous preferences.

Framework: Social Coordination with Heterogenous Preferences

- Two types of individuals and two actions
- Everyone prefers to coordinate on same action
- Type A prefers action *a*, type B prefers action *b*
- Individuals choose actions simultaneously
- Two settings: exogenous interaction vs. choose links and action
- Question: what are the mechanisms that facilitate conformism and diversity?

Model

Goyal, Hernandez, Martinez, Moisan, Munoz, Sanchez 2017

- Players: $N = \{1, 2, \ldots, n\}$ with $n \geq 3$.
- Two types: $\theta_i \in \{a, b\}$.
- Two stage game: first choose link proposals and then choose actions.
- First stage: every player proposes links to everyone else. Links are binary, $g_{ij} \in \{0, 1\}$.
- Define $\bar{g_{ij}} = g_{ij} g_{ji}$. Set of undirected networks is $\overline{g}$.
- Second stage: every player i chooses action $x_i : \overline{g} \rightarrow \{a, b\}$.
- Neighbours: $N_i(\overline{g}) = \{j \in N : \overline{g}_{ij} = 1\}$.

Model

- Following Ellwardt et al (2016), the payoff to player i from $\mathbf{s} = (x, g) = (x_1, .., x_n, g_1, ..., g_n)$:

$$u_i(\theta_i, x, \overline{g}) = \lambda^{\theta_i}_{x_i(\overline{g})}(1 + \sum_{j \in N_i(\overline{g})} I_{\{x_i(\overline{g}) = x_j(\overline{g})\}}) - |N_i(\overline{g})|k \quad (1)$$

  $I_{x_j = x_i}$ = indicator function for i's neighbour j who choose same action as i.

- $\lambda^{\theta_i}_{x_i(\overline{g})} = \alpha$ if $x_i(\overline{g}) = \theta_i$; $\lambda^{\theta_i}_{x_i(\overline{g})} = \beta$ if $x_i(\overline{g}) \neq \theta_i$.
- Assume $\alpha > \beta$ and $k \in \mathbb{R}$. Interesting case: $\beta > k$

Proposition: Exogenous Interaction

Let $\chi_i(\overline{g}) = \{j \in N_i(\overline{g}) : x_j^* = \theta_i\}$.

Given an undirected network $\overline{g}$, action profile x^* is a Nash equilibrium if and only if for any $i \in N$:

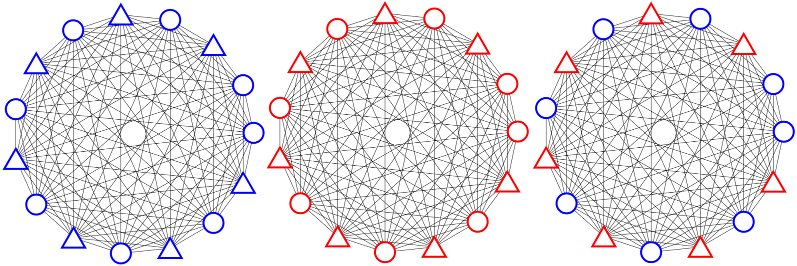
$$x_i^* \begin{cases} = \theta_i & \text{if } |\chi_i(\overline{g})| > \frac{\beta}{\alpha+\beta}|N_i(\overline{g})| - \frac{\alpha-\beta}{\alpha+\beta} \\ \neq \theta_i & \text{if } |\chi_i(\overline{g})| < \frac{\beta}{\alpha+\beta}|N_i(\overline{g})| - \frac{\alpha-\beta}{\alpha+\beta} \end{cases}$$

Example: Complete Network

Let N_O and N_Δ be the sets of players who prefer b and r.

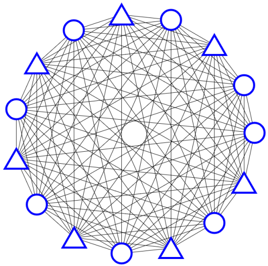
Fix a complete network $\overline{g}$. In Nash equilibrium x^*:

- **Conformity** $x_i^* = x_j^* \in \{b, r\}$ for all $i, j \in N$ if $n \geq \frac{\alpha}{\beta}$.
- **Diversity** $x_i^* = \theta_i$ for all $i \in N$ if $|N_O|, |N_\Delta| \geq \frac{\beta(n+1)}{\alpha+\beta}$.



Proposition: Efficient Outcome in Complete Network

Let aggregate welfare be given by sum of utility of all players.
A socially efficient outcome x entails all players conforming to the majority's preferred action.
$\Rightarrow$ For every $i, j \in N$, $x_i = x_j = \arg\max_{c \in A} \left|\{k \in N : \theta_k = c\}\right|$



Endogenous Interaction: Pairwise stable Networks

A network-action pair $(\overline{g}, x(\overline{g}))$ is pairwise stable if:

- $x(\overline{g})$ is an equilibrium action profile given network $\overline{g}$.
- for every $\overline{g}_{ij} = 1$, $u_i(, x, \overline{g}) \geq u_i(x, \overline{g} - \overline{g}_{ij})$ and $u_j(x, \overline{g}) \geq u_j(x, \overline{g} - \overline{g}_{ij})$, where x is such that $x_{-ij}(\overline{g} - \overline{g}_{ij}) = x_{-ij}(\overline{g})$, and $x_l \in \arg\max_{x_l' \in X_l} u_l(\theta_l, x_l', x_{-l}, \overline{g} - \overline{g}_{ij})$ for $l \in \{i, j\}$.
- for every $\overline{g}_{ij} = 0$, $u_i(x, \overline{g}) \geq u_i(x, \overline{g} + \overline{g}_{ij})$ or $u_j(x, \overline{g}) \geq u_j(x, \overline{g} + \overline{g}_{ij})$ where x is such that $x_{-ij}(\overline{g} + \overline{g}_{ij}) = x_{-ij}(\overline{g})$, and $x_l \in \arg\max_{x_l' \in X_l} u_l(\theta_l, x_l', x_{-l}, \overline{g} + \overline{g}_{ij})$ for $l \in \{i, j\}$.

Pairwise Stable Networks: Partial Characterization

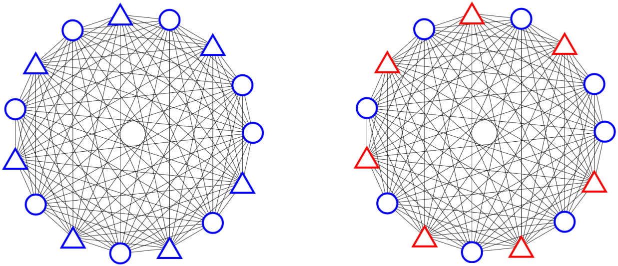
Suppose $k = 0$. In pairwise stable equilibrium $s^* = (\overline{g}^*, x^*)$, outcomes include

(i) Full Integration with Conformity.

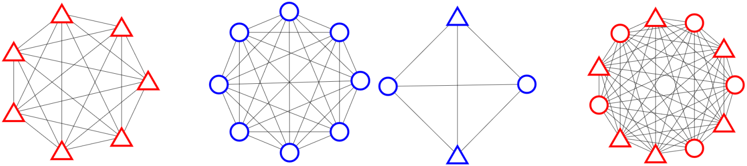
(ii) Full Segregation with diversity.

(iii) Complete integration with diversity.

Pairwise Stable Networks: Integration

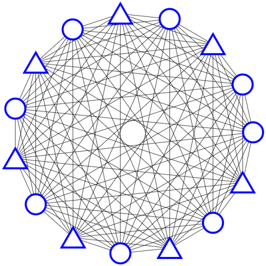


Pairwise Stable Networks: Segregation



Endogenous Interaction: Efficient outcome

A socially efficient outcome $s = (g, x)$ entails integration and conformity with the majority's preferred action.
$\Rightarrow$ For every $i, j \in N$, $\bar{g}_{ij} = 1$ and
$x_i = x_j = \arg\max_{c \in A} \left|\{k \in N : \theta_k = c\}\right|$



Summary

- Exogenous complete network:
  1. Multiple equilibria: (1) conformity and (2) diversity
  2. Types relevant only in diversity equilibrium
  3. Conformity is aggregate welfare maximizing
- Endogenous setting:
  1. Multiple equilibria: (1) integration with conformity, (2) segregation with diversity (3) Integration with diversity
  2. Integration with conformity is aggregate welfare maximizing
- How does endogenous linking shape equilibrium selection?

Design

Experimental variables:

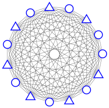
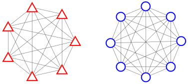
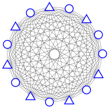
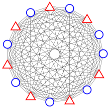
- Freedom of linking
  - ⇒ Exogenous vs. endogenous network
- Risk of linking
  - ⇒ Different cost of linking with someone who mis-coordinate

Design

Network ($N = 15$)			
Exogenous (complete net)	**Endogenous** (start from empty net)		
-	$k = 0$	$k = 2$	$k = -0.3$
$\alpha = 4$	$\alpha = 4$	$\alpha = 6$	$\alpha = 4$
$\beta = 2$	$\beta = 2$	$\beta = 4$	$\beta = 2$
EXO (6 groups)	**ENDO** (6 groups)	**COSTS** (6 groups)	**SUBSIDY** (6 groups)

Some predictions

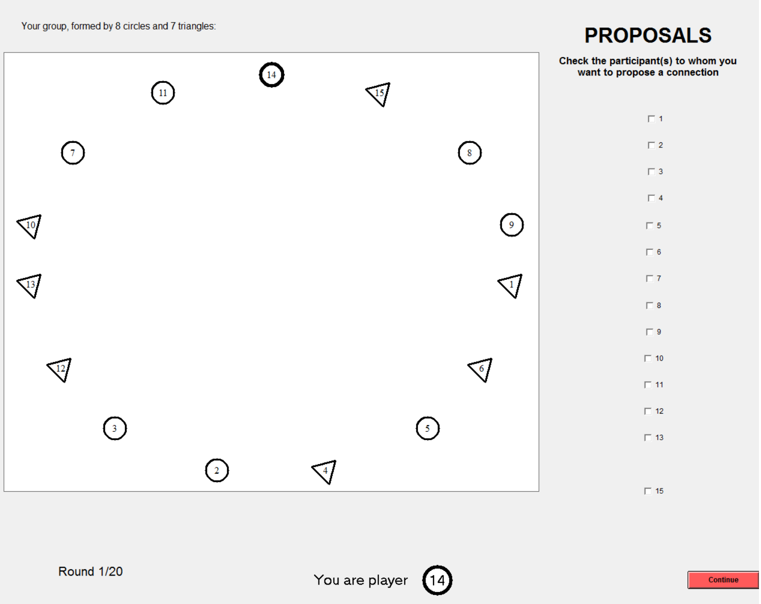
$|N_O| = 8$ and $|N_\Delta| = 7$:

Player type	Equilibrium Payoffs			
	Endogenous		Exogenous	
				
Minority (Δ)	30+k	28+k	30	28
Majority (O)	60+k	32+k	60	32

Further Details

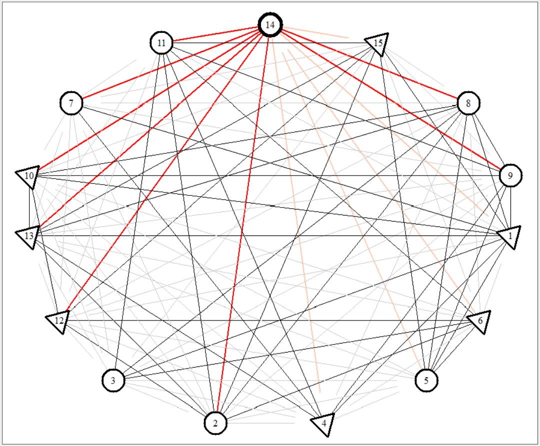
- Experiment run at **LINEEX** (University of Valencia)
- 6 groups / treatment
- Sessions of 3 groups (2 sessions / treatment)
- 5 trial rounds (no payoff) + 20 rounds (actual game)
- Fixed group matching
- Conversion rate: 50 points= 1 euro
- Mean earnings = 18 euros
- Mean duration = 100 mins
- Demographics: age: from 18 to 30; 42% male, 58% female

Stage 1 (round 1)



Stage 2

Resulting network:



ACTION

Choose an action

- Up
- Down

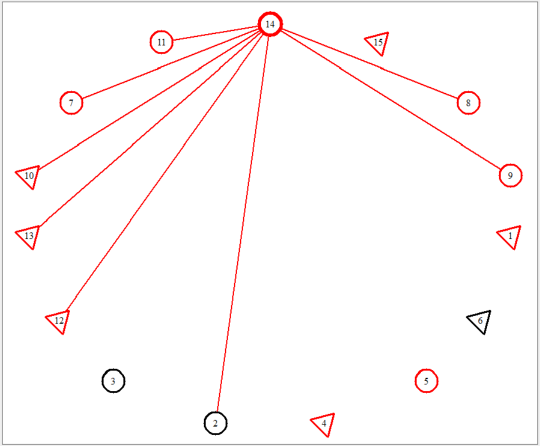
Round 1/20

You are player 14

Continue

Feedback stage 2

Your connections:



RESULTS

You chose action **Up**.

You have coordinated with **7** of your **8** connections.

You win:

4 points (coordination with yourself) +

4 * 7 = 28 points (coordinations)

Total: 32 points

In this Round you obtain:

32 points

The participants with red border chose the same action as you.

Round 1/20

You are player 14

OK

Conformity: Exogenous versus endogenous links

⇒ Animations

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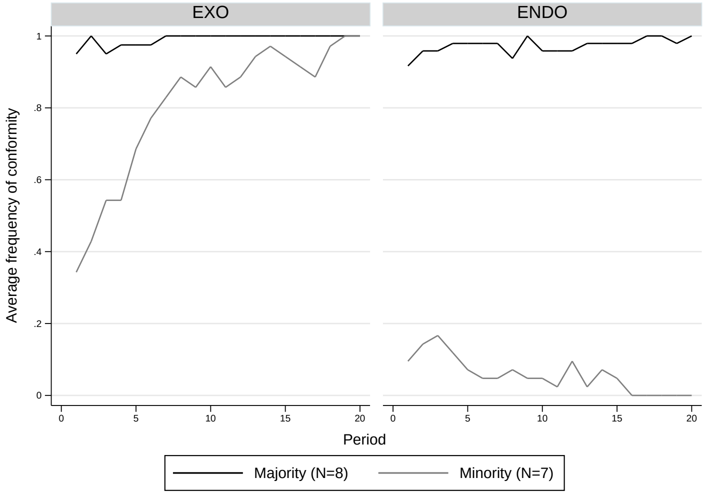
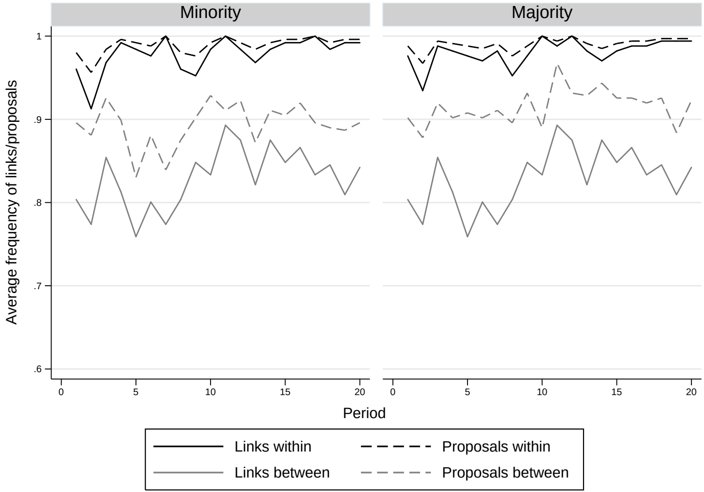


Connectivity: FREE Links

⇒ Animations



Results: summary

- Exogenous complete network:
  - Conformity on majority's preferred action.
  - Efficient outcome.
- Endogenous linking:
  - Very dense network and diversity in actions
  - Segregation across communities (with positive linking costs)
  - Large welfare losses

Hypothesis: The Network as a Signal

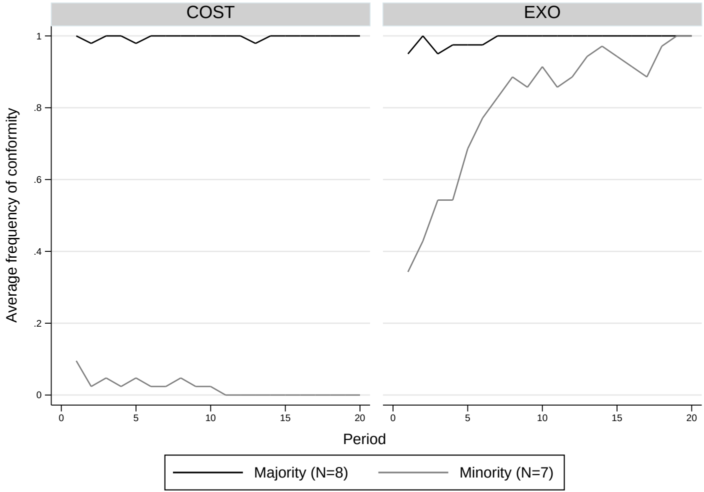
- Coordination problem is very complicated
- Links are a route to signal intention on play
- Players will be willing to pay for the signal
- Positive cost link: proposal to other type signals intention to coordinate
- Negative cost link: not proposing to other type signals intention to play own preferred action.

Cost Treatment

⇒ Animations

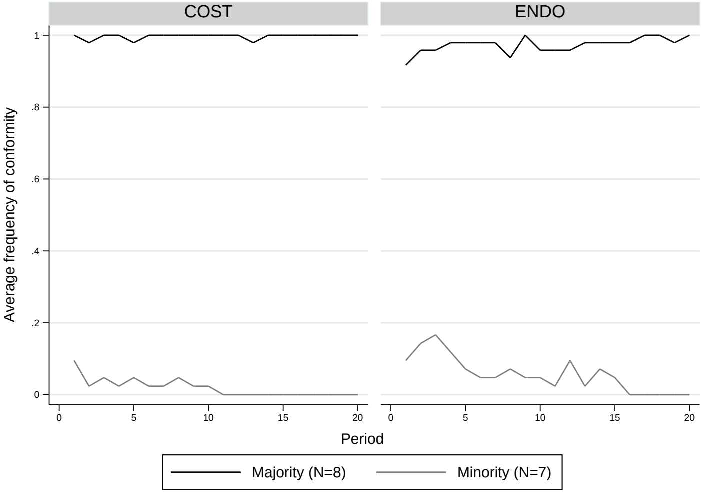
Cost Treatment

⇒ Animations



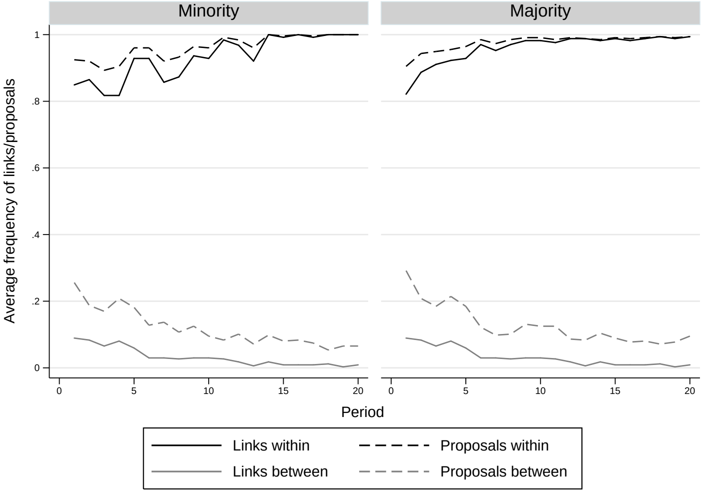
Cost Treatment

⇒ Animations



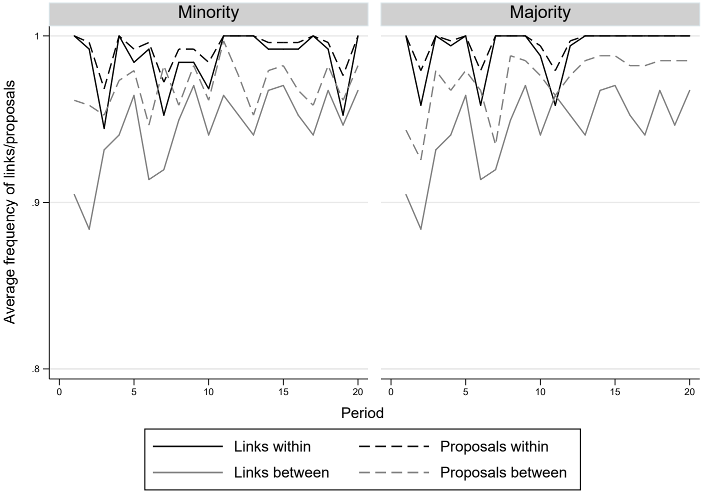
Connectivity

⇒ Animations



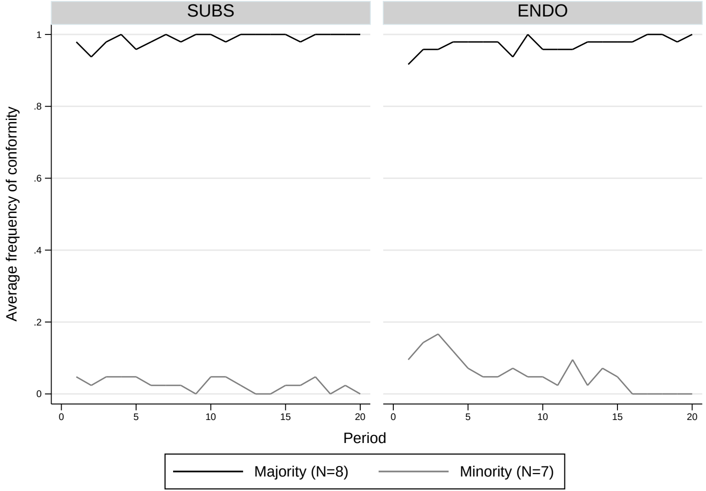
The Negative Cost Treatment: SUBSIDY

⇒ Animations



Diversity: Negative cost links vs Free links

⇒ Animations



Diversity: Negative cost links vs Exogenous

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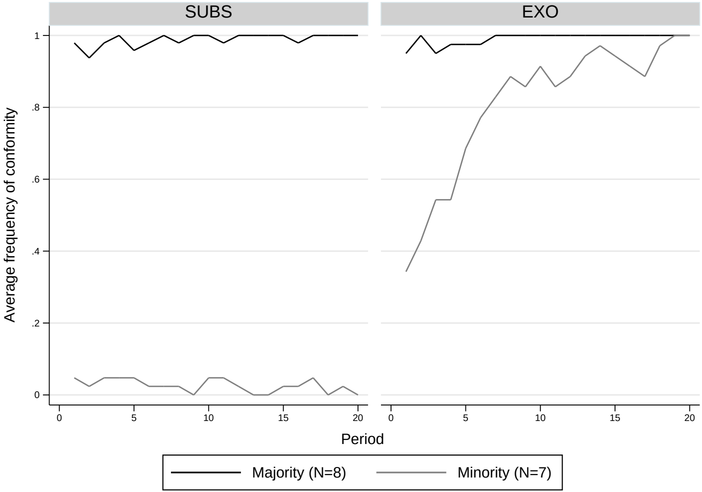

Regression on linking and conformity

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.                xtreg net_conform_min_norm rate_links_group period, cl(treat)

Random-effects GLS regression                   Number of obs      =       600
Group variable: group                           Number of groups   =        30

R-sq:                                           Obs per group:
     within  = 0.1221                                          min =        20
     between = 0.1048                                          avg =      20.0
     overall = 0.1031                                          max =        20

                                                Wald chi2(2)       =     31.73
corr(u_i, X)   = 0 (assumed)                    Prob > chi2        =    0.0000

                                   (Std. Err. adjusted for 5 clusters in treat)
```

net_conform_mi~m	Coef.	Robust Std. Err.	z	P>|z|	[95% Conf.	Interval]
rate_links_group	.6874037	.3045453	2.26	0.024	.090506	1.284301
period	-.0004691	.0055491	-0.08	0.933	-.0113452	.010407
_cons	-.1653395	.1737085	-0.95	0.341	-.505802	.1751229
sigma_u	.46032431					
sigma_e	.19024515					
rho	.85411354	(fraction of variance due to u_i)				

Concluding remarks

- Diversity is valued but it also poses a major challenge.
- We study interaction between communities that have differing views.
- Develop a model: coordination with heterogeneous preferences.
- Theory is permissive: variety of outcomes possible in equilibrium.
- Study mechanisms for equilibrium selection.
- Hypothesis: networks are a signal for intentions in the coordination game.

Main Findings

- Allowing people to choose links leads to diversity
  - With exogenous complete network: conformism
  - With endogenous free links: close to full integration but diversity.
- Links are a signalling mechanism
  - With positive cost: segregation and diversity.
  - With negative cost: high integration and diversity.