Higher School of Economics
Center for Institutional Studies

Lecture 3. Networks, Institutions and TrC

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Plan

- Examples of Social Networks and their Impact
- Networks in IE
- Structure matters – conventions
- Definitions, Measures and Properties
  - Network characteristics
  - Personal characteristics
- Applications

Examples of Social Networks and their Impact [1]

Many economic, political, and social interactions are shaped by the local structure of relationships:

– trade of goods and services, most markets are not centralized!

…

– sharing of information, favors, risk, ...

– transmission of viruses, opinions...

– access to info about jobs...

– choices of behavior, education, ...

– political alliances, trade alliances…

Social networks influence behavior

– crime, employment, human capital, voting, smoking,…

– networks exhibit heterogeneity, but also have enough underlying structure to model

Coursera.org

Social and Economic Networks: Models and Analysis by Matthew O. Jackson

- Introduction, Empirical Background and Definitions
- Background, Definitions, and Measures Continued
- Random Networks
- Strategic Network Formation
- Diffusion on Networks
- Learning on Networks
- Games on Networks

Functions of institutions

Institutions help to solve problems of

- **Coordination, cooperation and distribution**

They unsure predictability and stability

- **Predictability of actions**
- Stability of economic interactions
- Estimation of potential benefits and costs

Transfer of knowledge

- Formal and **informal learning of rules**

They minimize costs that are associated with economic and social transactions

- **Minimizations of transaction costs**

Enforcement

Enforcing party	Enforcement system
First party	
Actor	**Self-control**
Second party	
Other participants of social interaction	Control from the other participants
Third party	
Social group	**Informal control from the social group**
State	Law system

How do neighbors influence behavior [2]

Evolutionary model of convention formation

- Bounded rationality & partially informed
- No perfect foresight
- No idea why other players acting the way they are
- Agents have memory about history (number of periods)
- History – list of all pairs of agents who have played so far and the actions that they took

Two-person coordination game

- Strategies: Left (L) and Right (R)

Convention*

Convention is a pattern of behavior that is customary, expected and self-enforcing – everyone conforms, everyone expects others to conform, and everyone has good reason to conform because conforming is in each person's best interest when everyone else plans to conform.

Convention is an equilibrium that everyone expects in interactions that have more than one equilibrium.

Convention is an example of institution that allows to solve coordination and distribution problems.

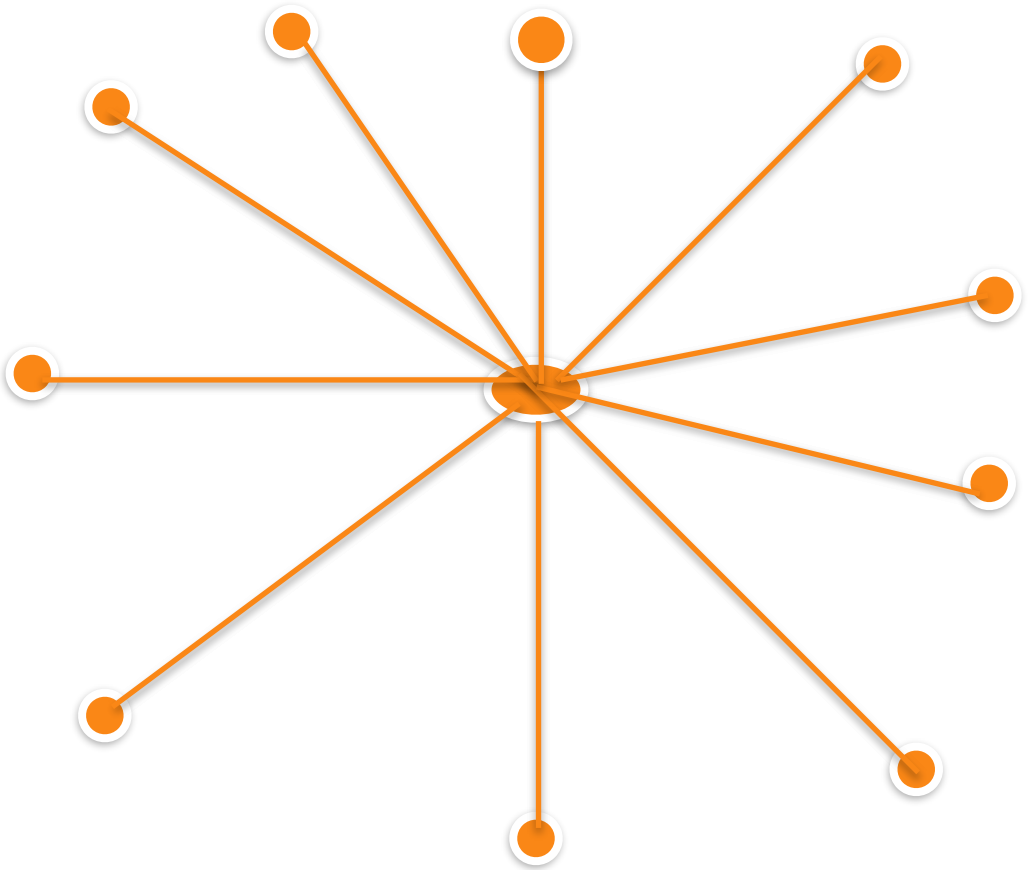
*David, Lewis. "Convention: a philosophical study." (1969) cited by [2]

Two-person coordination game

Period	1	2	3	4	5	6	7	8	9	10
Person	L	L	L	L	L	L	L	L	L	L
Others	L	L	L	L	L	L	L	L	L	L

What will be at period 11?

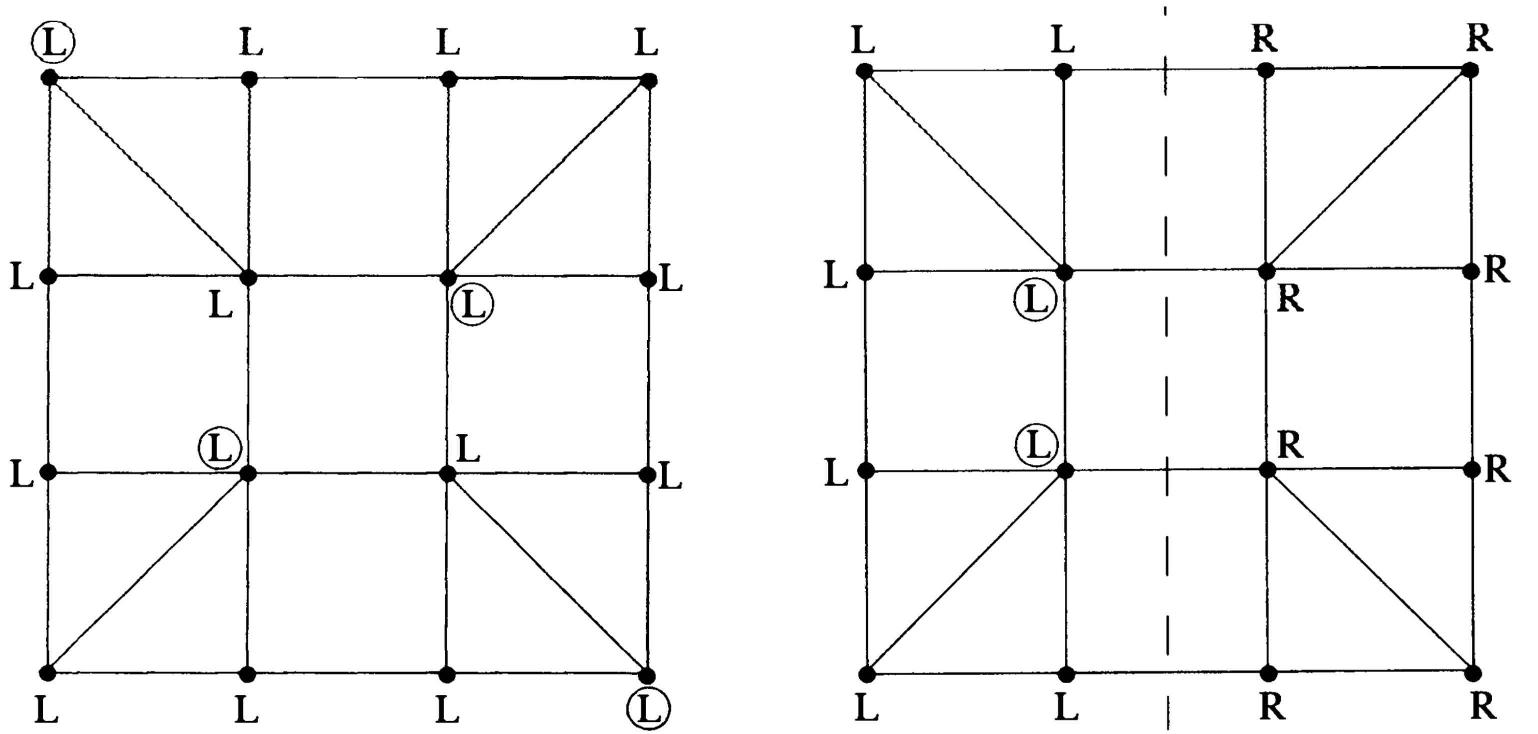
Two-person coordination game: network view



Structure matters

Nodes – countries

Edges – border crossings



Statements about conventions [2]

If all agents have a positive probability of interacting, if they have sufficiently incomplete information and if random deviations have sufficiently low probability, then most of the time most of population will be using same convention. *(local conformity effect)*

While a convention tends to remain in place for a long period of time once it is established, it will eventually be dislodged by a series of random shocks. Society then careens toward a new convention, which also tend to remain in force for a long time. *(punctuated equilibrium effect)*

Networks and cooperation games [3]

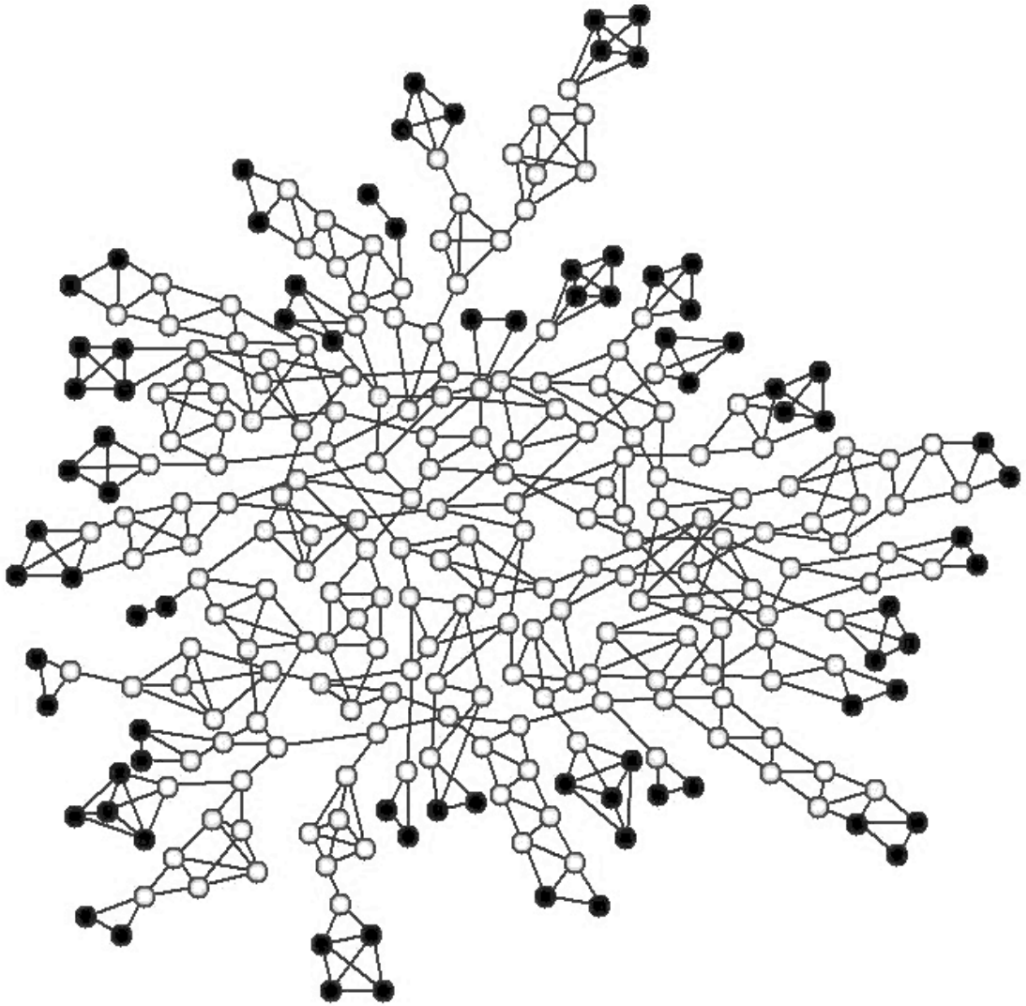


Fig.1 : Polymorphic Absorbing State $Z = I = 1$
(darker nodes are defectors)

Networks & graphs: basic definitions and measures

Network (N,g)

N={1, … , n} – nodes, vertices, players

g_{ij} = 1 (or ij in g) – link, tie, or edge between I and j

Degree

- Connectedness - number of nodes connected with the node *i*
- $d_i = \#\, N_i(g) = \{ j \mid ij \text{ in } g\}$

Average degree

$$\bar{d} = \frac{\sum_{i=1}^{n} d(\mathrm{n}_i)}{n} = \frac{2g}{n}$$

Density

$$\Delta = \frac{g}{n(n-1)/2} = \frac{2g}{n(n-1)}$$

Networks & graphs: basic definitions and measures

Walk (i_1, i_2,…, i_k)

- A sequence of nodes *(i_1, i_2,…, i_k)* and sequence of links *(i_1 i_2, i_2 i_3,…, i_{k-1} i_k)* such that i_{k-1} i_k in g for each k

Path

- A walk *(i_1, i_2,…, i_k)* with each node i_k distinct

Cycle

- A walk where $i_1 = i_k$

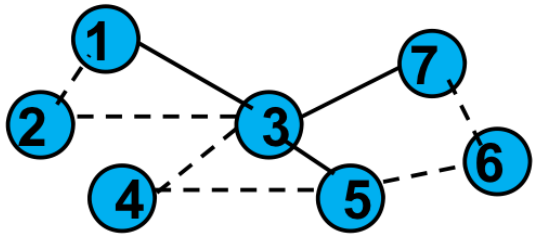
Geodesic distance

- A shortest path between two nodes

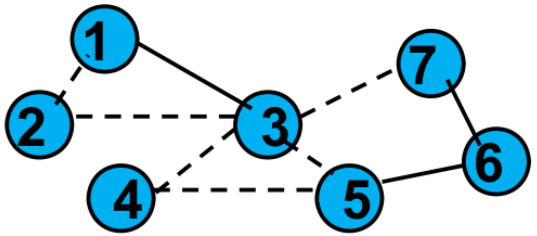
Diameter

- Largest geodesic distance (if unconnected, of largest component)

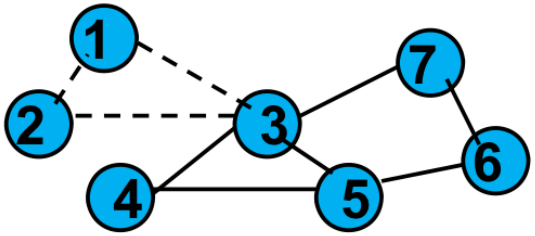
Networks & graphs: basic definitions and measures



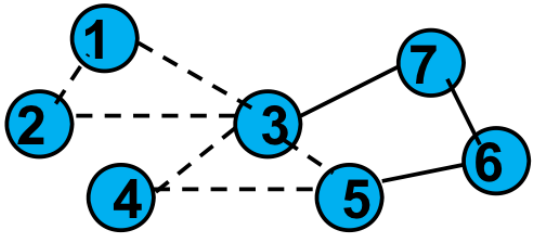
Path (and a walk) from 1 to 7:
1, 2, 3, 4, 5, 6, 7



Walk from 1 to 7 that is not a path:
1, 2, 3, 4, 5, 3, 7



Simple Cycle (and a walk)
from 1 to 1: 1, 2, 3, 1



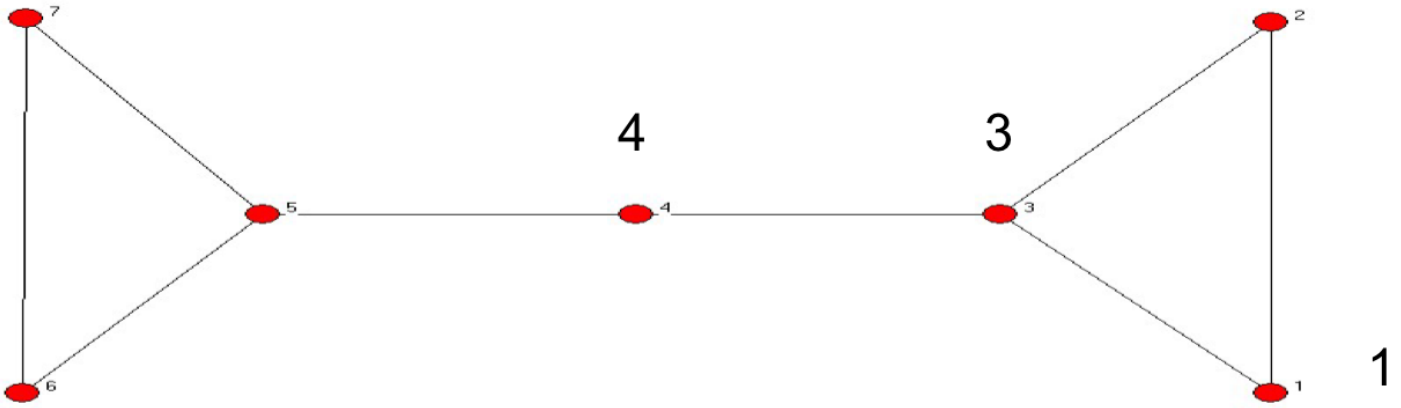
Cycle (and a walk) from 1 to 1:
1, 2, 3, 4, 5, 3, 1

Networks & graphs: basic definitions and measures

Position in Network

- Centrality
  - Degree normalized by network size
  - $d_i/(n-1)$
- Closeness
  - Ease of reaching other nodes
  - Relative distance to other nodes
  - $(n-1) / \sum_j l(i,j)$
- Betweenness
  - Role as intermediary in network
  - $P(i,j)$ – number of geodesics btwn *i* and *j*
  - $P_k(i,j)$ – number of geodesics btwn *i* and *j* that *k* lies on
  - $\sum_{i,j \neq k} \frac{P_k(i,j) / \mathrm{P}(i,j)}{(n-1)(n-2)/2}$

Networks & graphs: basic definitions and measures



	Node 1	Node 3	Node 4
Degree	0.33	0.50	0.33
Closeness	0.40	0.55	0.60
Betweenness	0	0.53	0.60

Theorem of network structure

For large *n* average path length and diameter are approximately proportional to *log (n)* / *log(d)*

Small world in economics [4]

NETWORK STATISTICS FOR THE COAUTHOR NETWORKS

	1970s	1980s	1990s
Total authors	33,770	48,608	81,217
Degree:			
Average	.894	1.244	1.672
Standard deviation	1.358	1.765	2.303
Giant component:			
Size	5,253	13,808	33,027
Percentage	15.6%	28.4%	40.7%
Second-largest component	122	30	30
Isolated authors:			
Number	16,735	19,315	24,578
Percentage	49.6%	39.7%	30.3%
Clustering coefficient	.193	.182	.157
Distance in giant component:			
Average	12.86	11.07	9.47
Standard deviation	4.03	3.03	2.23

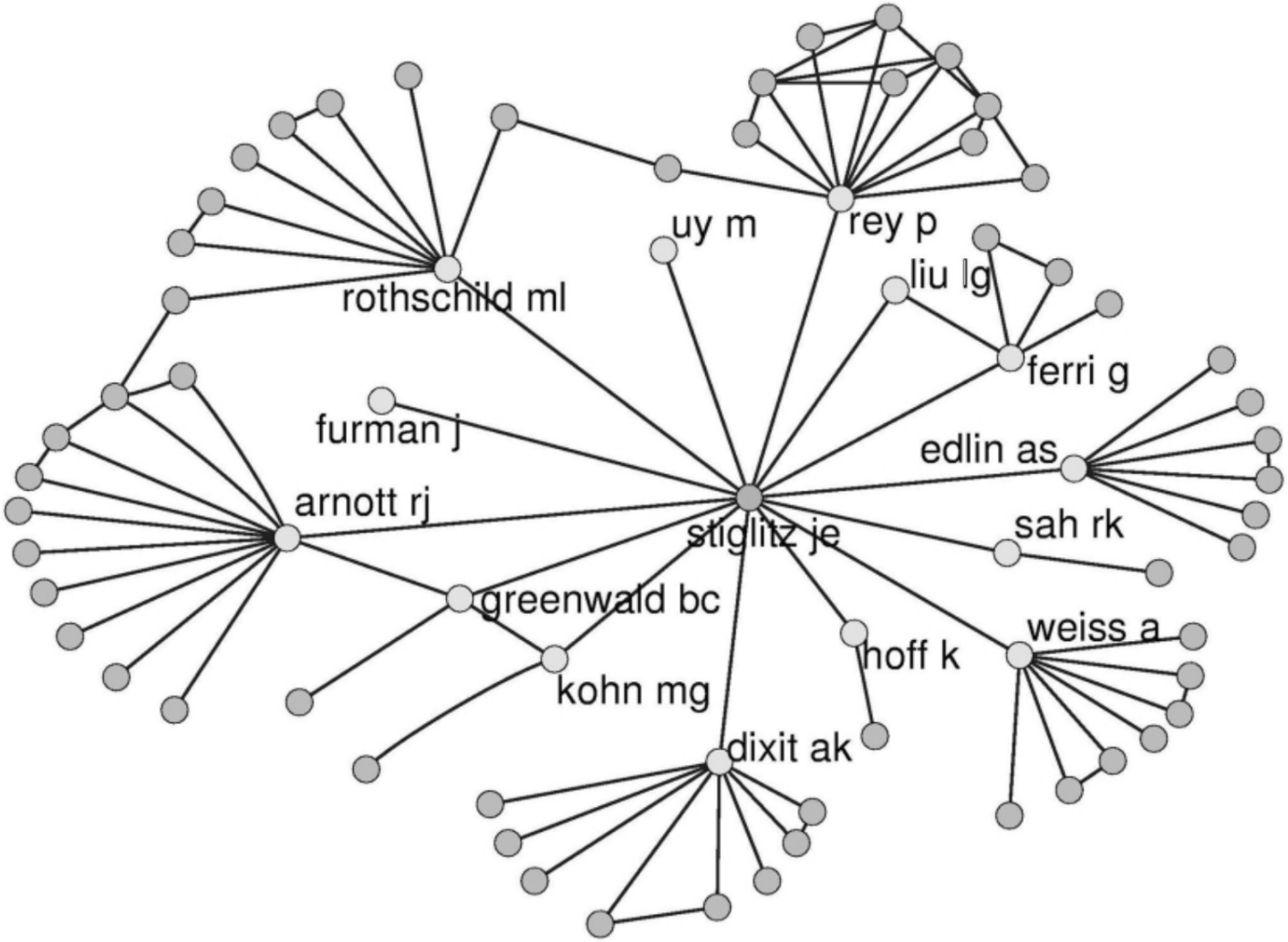
Small world in economics [4]

NETWORK STATISTICS FOR MOST LINKED ECONOMISTS: 1990s

Rank	Papers	% Coauthored	Degree	Distance 2	Clustering Coefficient
1	66	97.0	54	244	.022
2	58	58.6	45	158	.019
3	67	100.0	41	172	.045
4	67	94.0	41	57	.034
5	48	93.8	34	169	.036
Average top 100	37.69	84.9	25.31	99.40	.040
Average all	2.82	40.9	1.67	3.57	.157

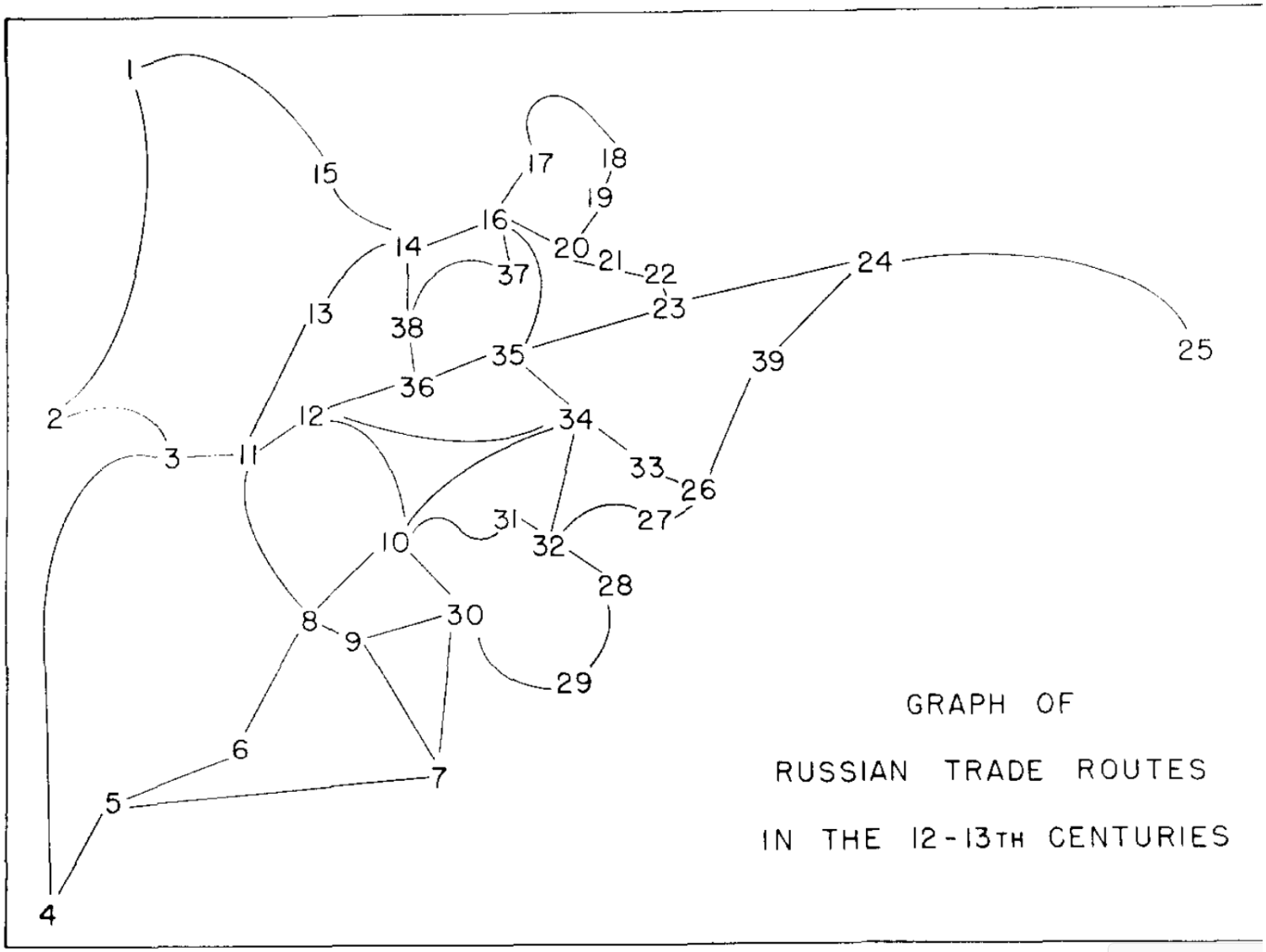
NOTE.—Economists are ordered by degree and, for nodes with the same degree, by the number of nodes at distance 2. Papers is the number of papers published by economist *i*. % coauthored is the fraction of papers published by *i* that are coauthored. Degree is the degree of *i*. Distance 2 is the number of nodes at distance 2 from *i*. Clustering coefficient is the clustering coefficient of *i*. Average clustering coefficients are calculated as in (3).

Small world in economics [4]

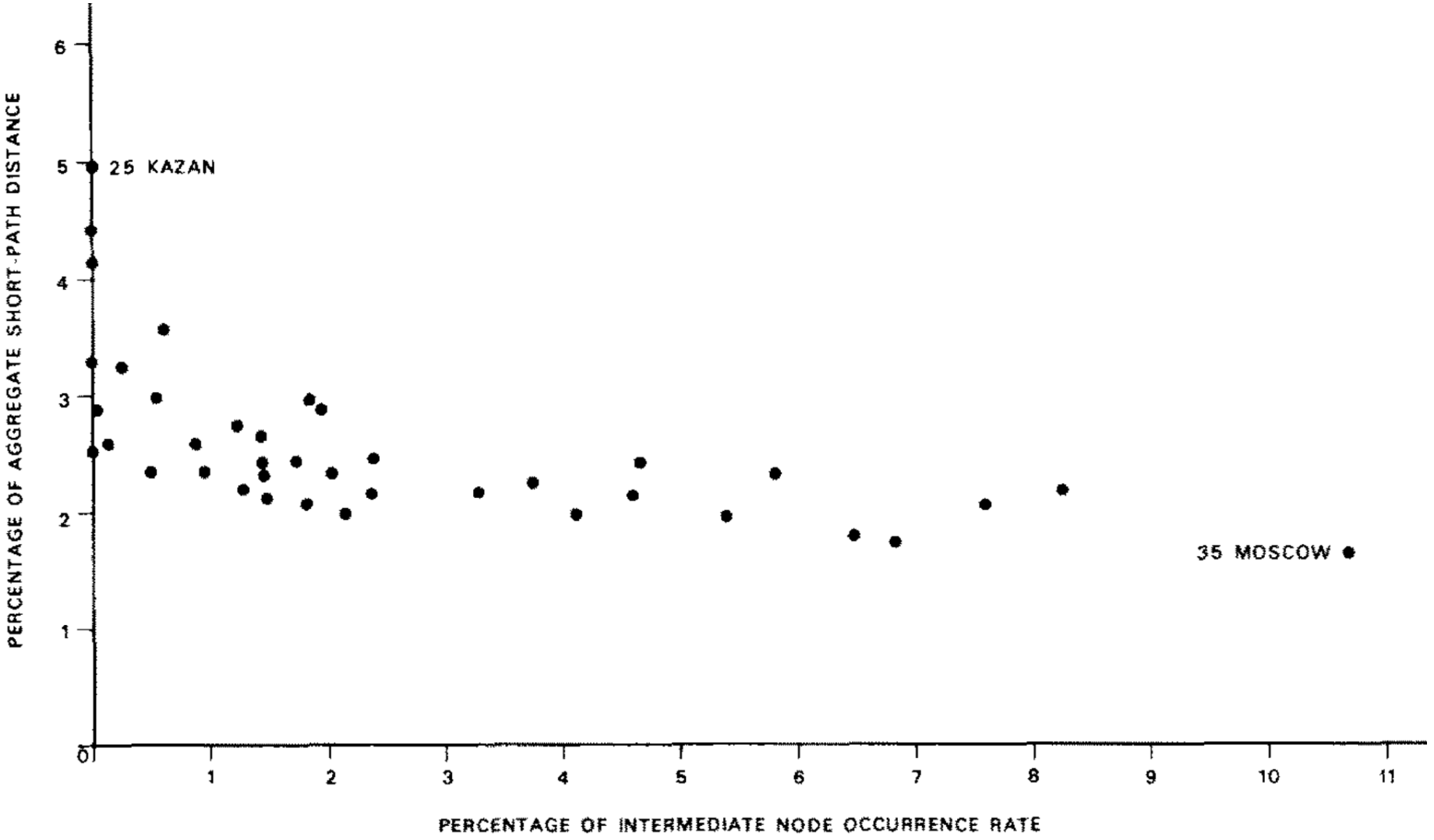


Russian trade around 1930 [5]

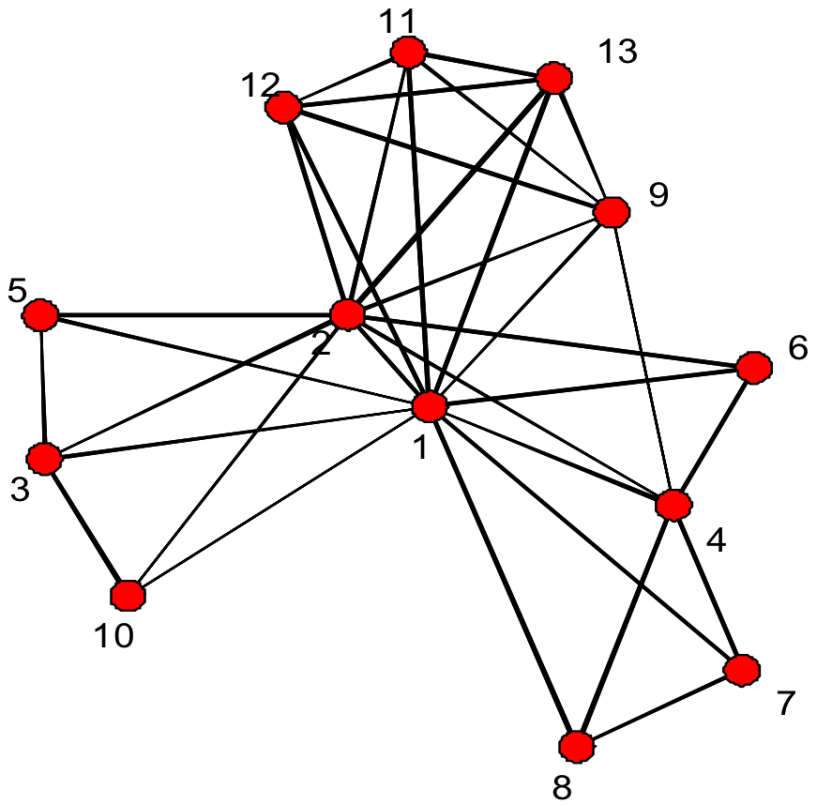
Figure 2. *Graph of Russian trade routes in the 12th - 13th centuries.*



Russian trade around 1930 [5]



Cartel networks [6]



Fields of research on networks

- Coauthors networks
- Trade and inter-firm networks
- Inter-locking board of directors
- Labor market networks
- World wide web
- Networks in education
- Political economy
- Diffusion of ideas and products

Networks and Institutions

INSTITUTIONS = RULES + ENFORCEMENT + FOLLOWERS

Through networks

- Actors could form rules (ex. convention formation)
- Actors could enforce rules
- Structure of interactions is defined

Network is an instrument to analyze behavior of actors and influence of other actors on their behavior

Transaction costs and networks

Networks allow to minimize

- Search costs
- Enforcement costs

Actors should pay for networks

- One-time costs
  - To find appropriate network
  - To join network
- Permanent costs
  - To invest in ties formation and maintenance
  - To participate in collective sanctions

Research questions based on network approach

- What are the effects of network location on individual behavior? Do better connected individuals earn larger payoffs?
- How does individual behavior respond to changes in a network?
- Are some networks better for the attainment of socially desirable outcomes? Can we characterize features of socially desirable networks?
- How can government and private agents use the network to influence agent's behavior?

References

[1] Matthew Jackson “Social and Economic Networks: Models and Analysis” Coursera.org

[2] Young, H. Peyton. "The evolution of conventions." *Econometrica: Journal of the Econometric Society* (1993): 57-84.

[3] Fosco, Constanza, and Friederike Mengel. "Cooperation through imitation and exclusion in networks." *Journal of Economic Dynamics and Control* 35.5 (2011): 641-658.

[4] Goyal, Sanjeev, Marco J. Van Der Leij, and José Luis Moraga-González. "Economics: An emerging small world." *Journal of political economy* 114.2 (2006): 403-412.

[5] Pitts, Forrest R. "The medieval river trade network of Russia revisited.“ *Social networks* 1.3 (1979): 285-292.

[6] Cuerdo Mir, Miguel, and Pilar Grau-Carles. "Networks, Cartels, and Antitrust Policy." *Cartels, and Antitrust Policy (October 30, 2014)* (2014).