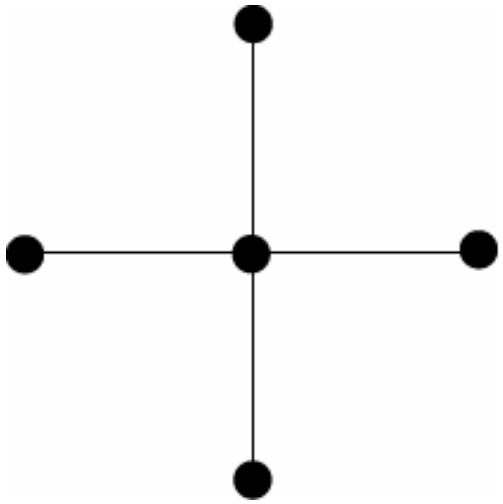
EQUICENTRALITY AND NETWORK CENTRALIZATION: A MICRO-MACRO LINKAGE

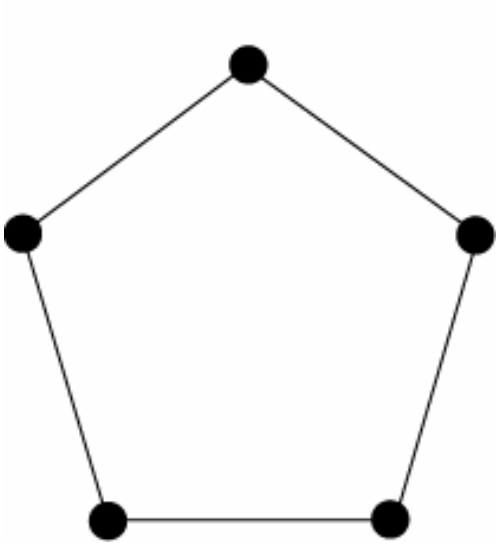
Soong Moon Kang

NetSci 2006

May 23, 2006



‘star’ graph



‘circle’ graph

EQUICENTRALITY

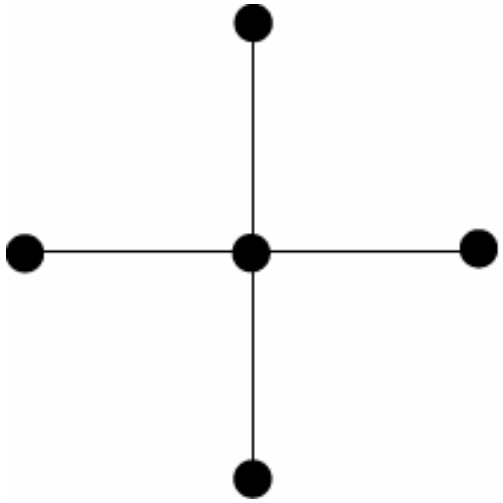
a measure that indicates how similar the pairs of actors in a network are based on their centrality measures

$$E_C = 1 - \frac{\left[\sum_{k=1}^{M}\left(c_{ik} - c_{jk}\right)^2\right]^{1/2}}{\max\left\{\left[\sum_{k=1}^{M}\left(c_{ik} - c_{jk}\right)^2\right]^{1/2}\right\}}$$

where c_{ik} and c_{jk} are **normalized centrality of actors *i* and *j* at the end of edge *k*** (*i,j* = 1,…,*N* and *k* = *1,…,M*)

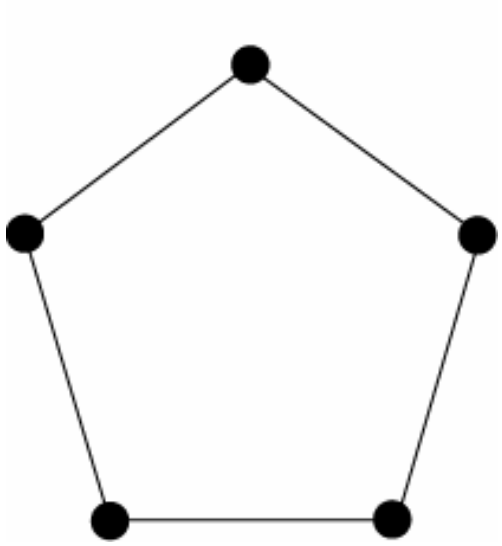
EQUICENTRALITY

a measure of *micro-level* process because
it evaluates individual dyads, and
it captures how individual actors choose with whom to interact



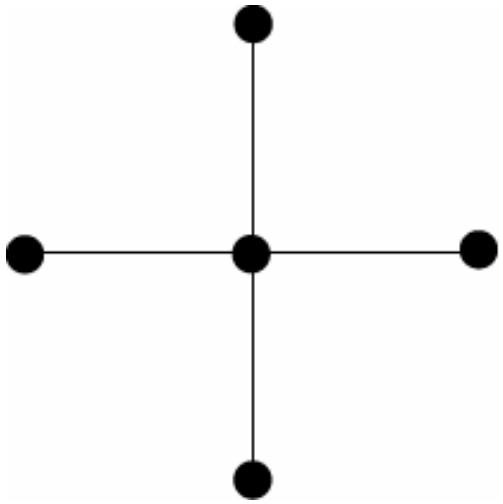
‘star’ graph

***E*$_C$ = 0**

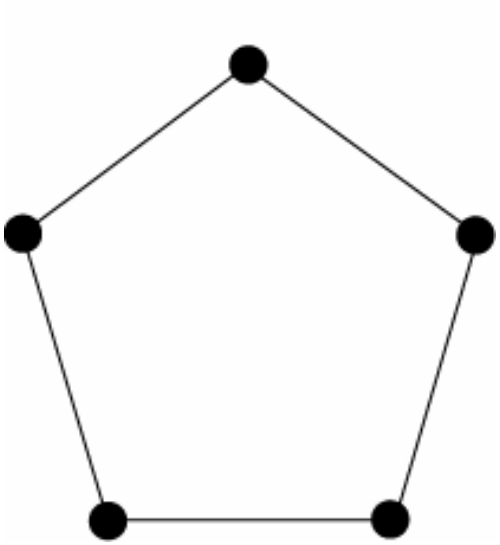


‘circle’ graph

***E*$_C$ = 1**



‘star’ graph



‘circle’ graph

NETWORK CENTRALIZATION

a measure of how 'concentrated' the degree centralities of the actors are in the network

(Freeman, 1979)

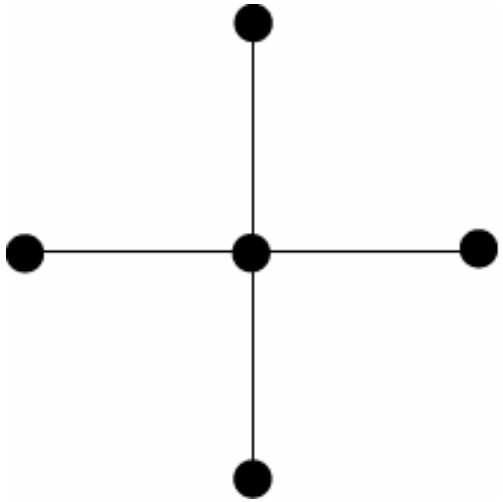
$$C_N = \frac{\sum_{i=1}^{N} \left(c_{\max} - c_i \right)}{\max \left\{ \sum_{i=1}^{N} \left(c_{\max} - c_i \right) \right\}}$$

where C_i is **the centrality of an actor *i*, and**

$C_{\max}$ is **the largest observed normalized degree centrality in a network**

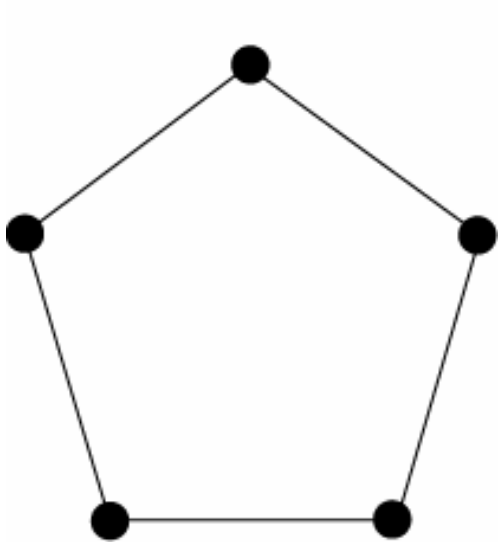
NETWORK CENTRALIZATION

a measure of *macro-level* structure because it evaluates the entire network



‘star’ graph

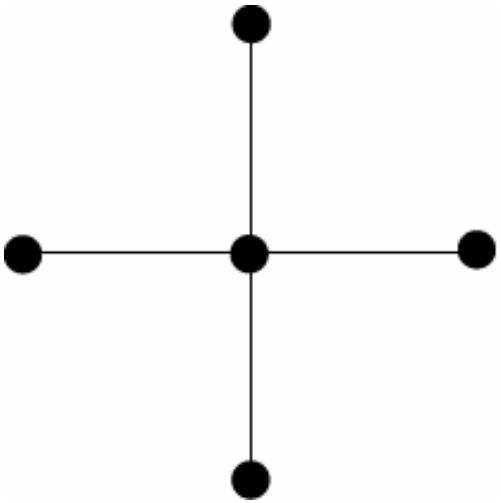
$C_N = 1$



‘circle’ graph

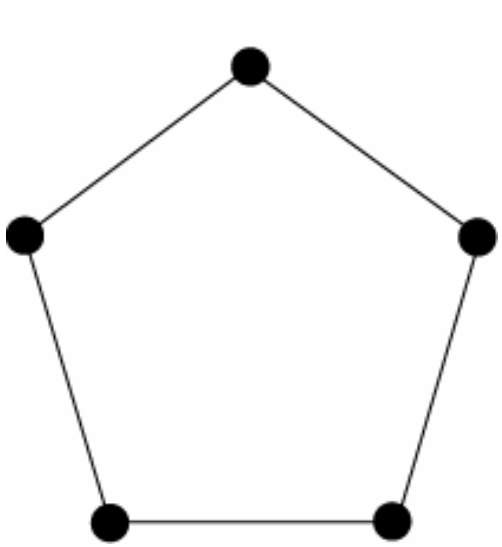
$C_N = 0$

MICRO-MACRO LINKAGE



‘star’ graph

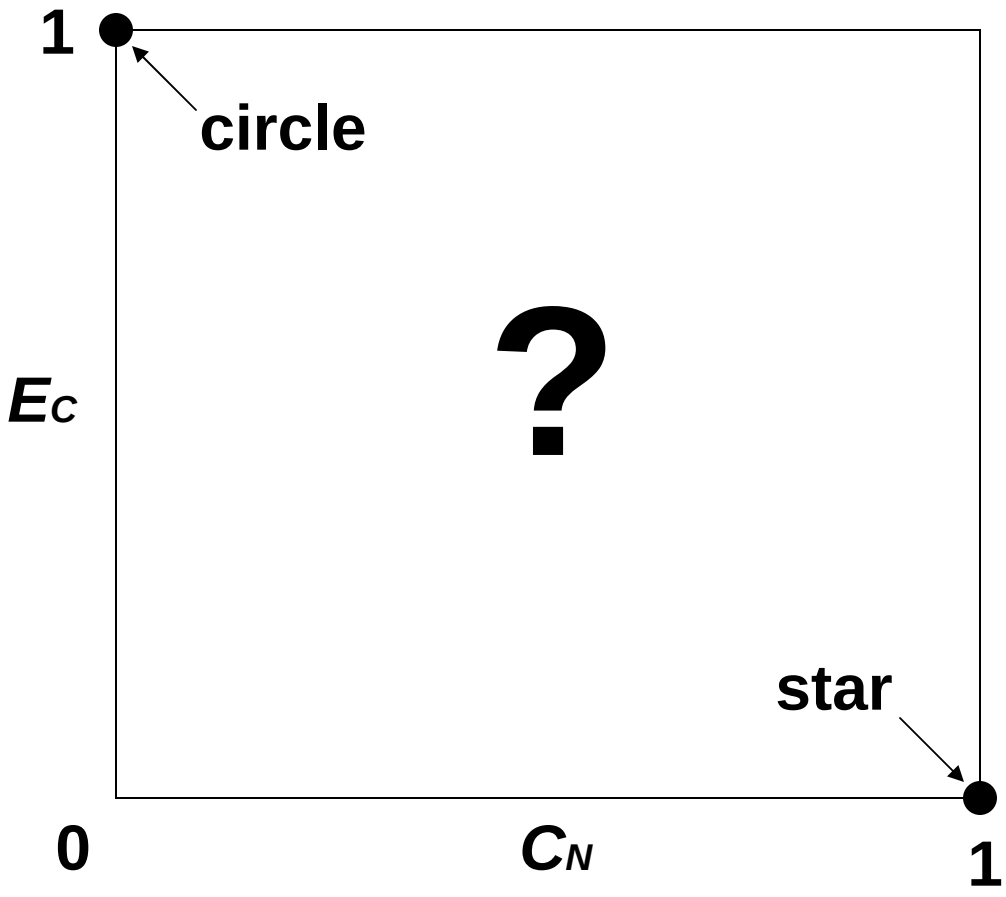
$E_C = 0$
$C_N = 1$



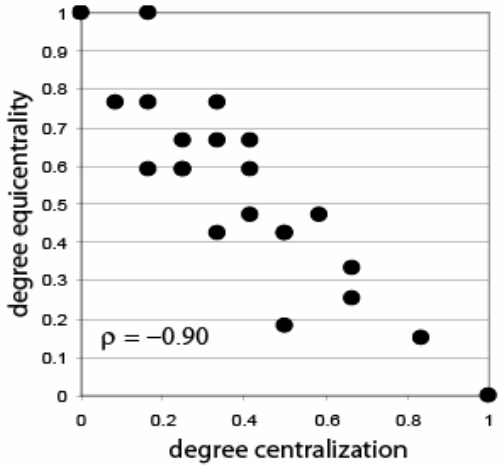
‘circle’ graph

$E_C = 1$
$C_N = 0$

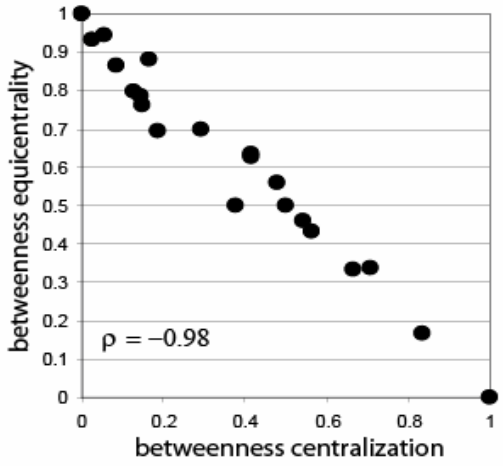
MICRO-MACRO LINKAGE



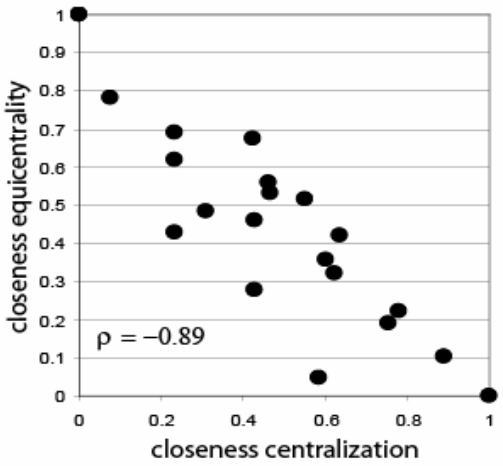
MICRO-MACRO LINKAGE



degree centrality



betweenness centrality



closeness centrality

MICRO-MACRO LINKAGE

Degree equicentrality:

$$E_C^D = 1 - \frac{\left[\sum_{k=1}^{M}\left(c_{ik}^D - c_{jk}^D\right)^2\right]^{1/2}}{\left[\frac{(N-2)^2}{(N-1)}\right]^{1/2}}$$

Degree centralization:

$$C_N^D = \frac{\sum_{i=1}^{N}(c_{\max}^D - c_i^D)}{N-2}$$

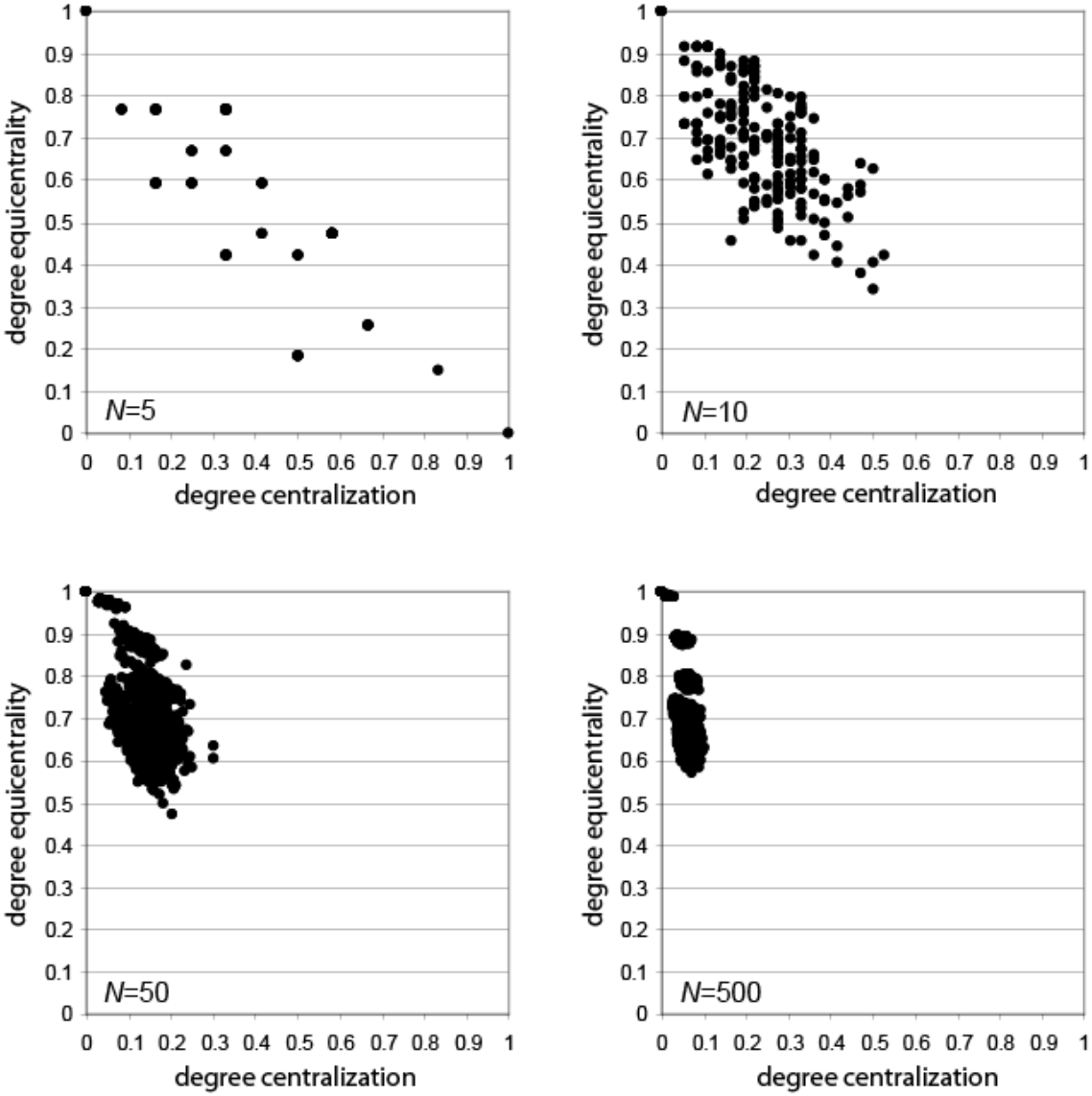
MICRO-MACRO LINKAGE

$$C_N^D = 1 - E_C^D$$

but,

$$\frac{\sum_{i=1}^{N}(c_{\max}^D - c_i^D)}{N-2} \neq \frac{\left[\sum_{k=1}^{M}\left(c_{ik}^D - c_{jk}^D\right)^2\right]^{1/2}}{\left[\frac{(N-2)^2}{(N-1)}\right]^{1/2}}$$

MICRO-MACRO LINKAGE



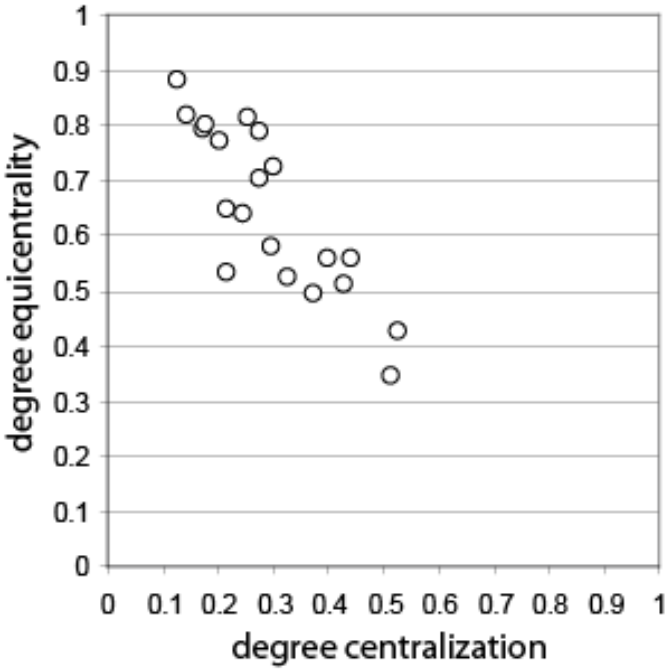
MICRO-MACRO LINKAGE:
UCINET DATA

20 undirected social networks (in dichotomized form) from UCINET:

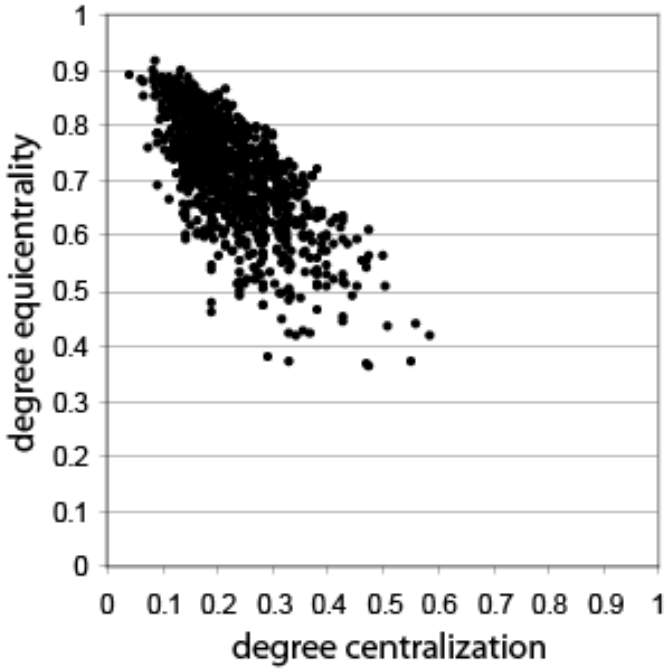
- Network size: 8 to 41 nodes

- Network density: 0.139 to 0.736

MICRO-MACRO LINKAGE:
UCINET DATA

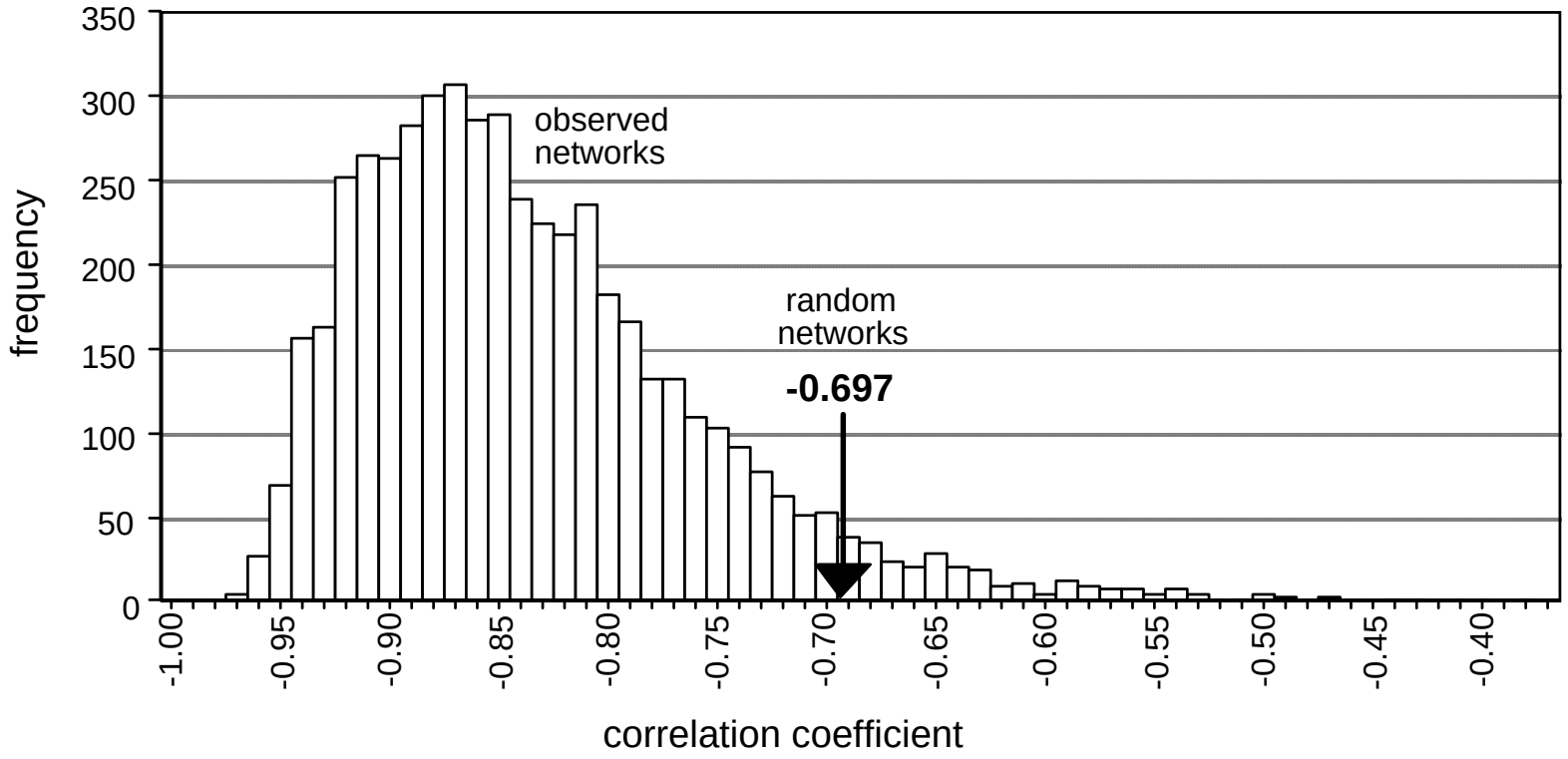


observed networks

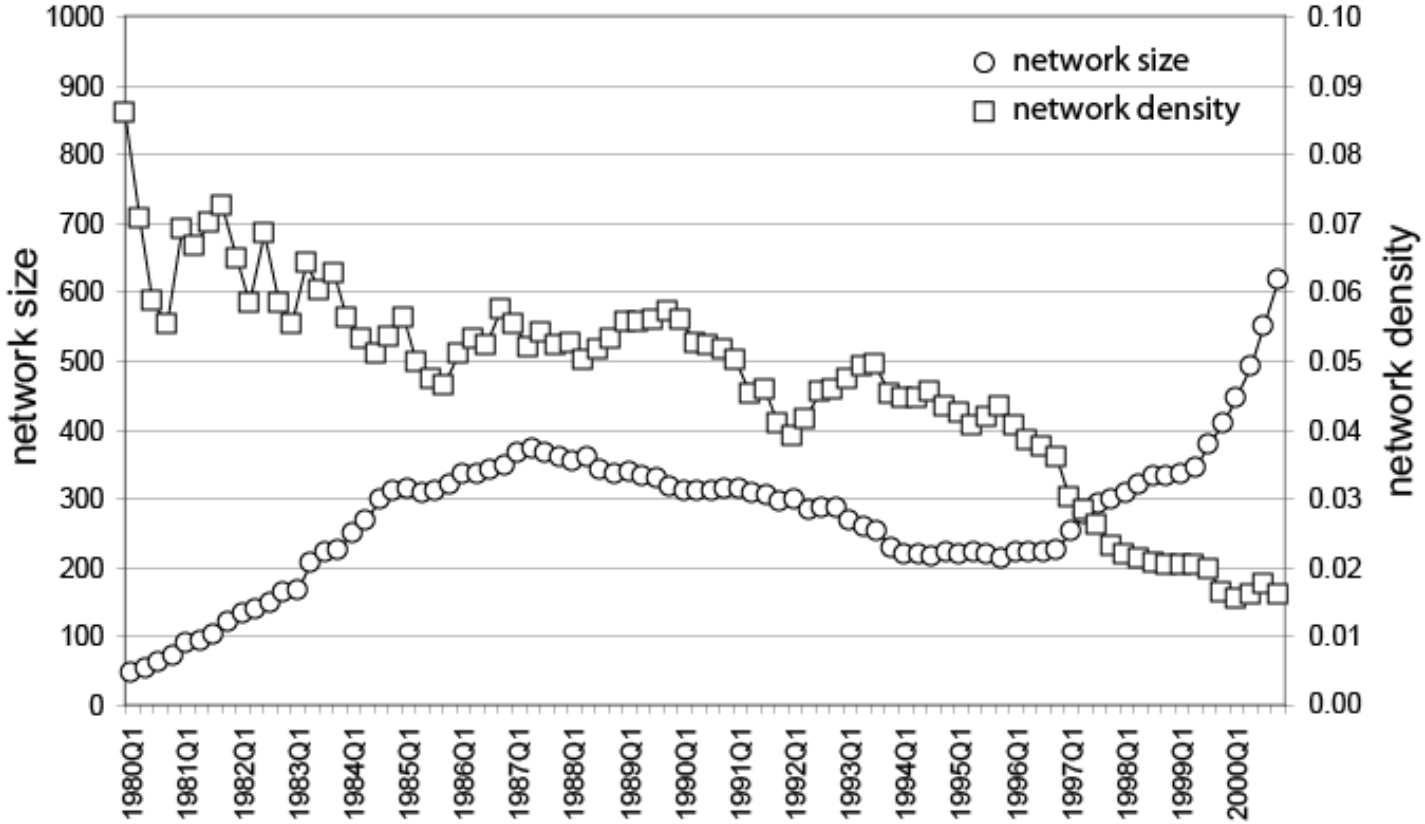


random networks

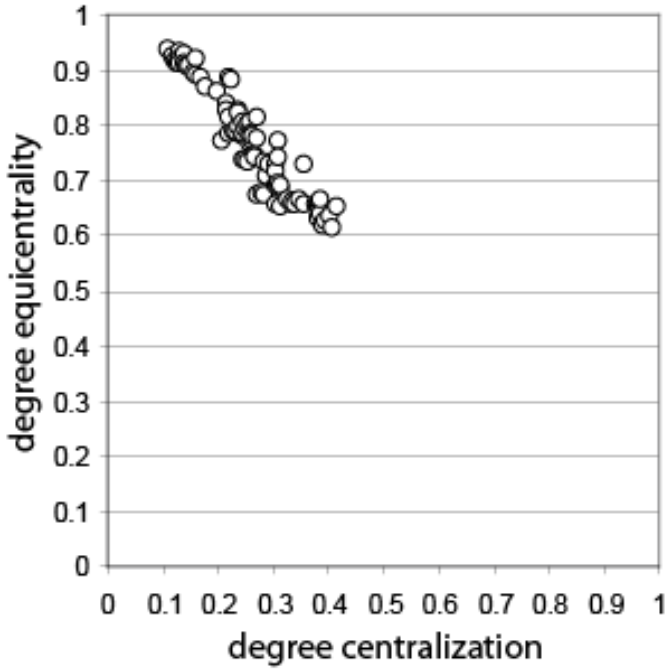
MICRO-MACRO LINKAGE:
UCINET DATA



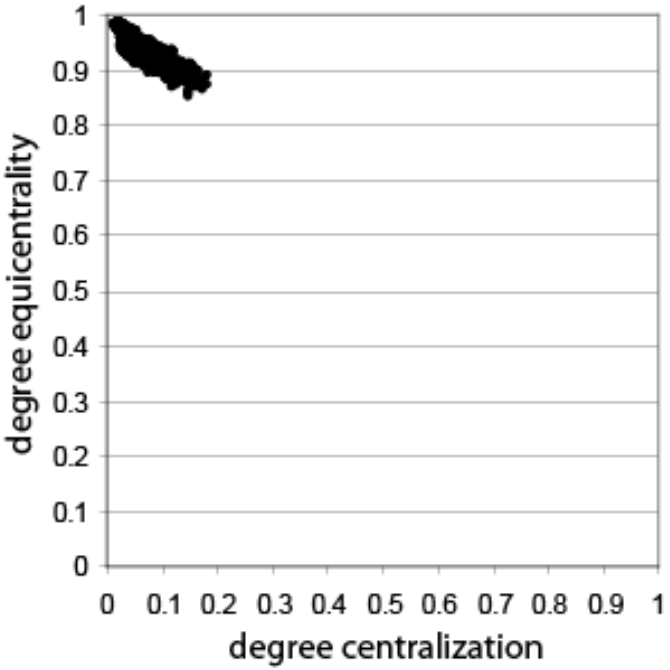
MICRO-MACRO LINKAGE:
VENTURE CAPITAL INVESTORS' DATA



MICRO-MACRO LINKAGE:
VENTURE CAPITAL INVESTORS' DATA

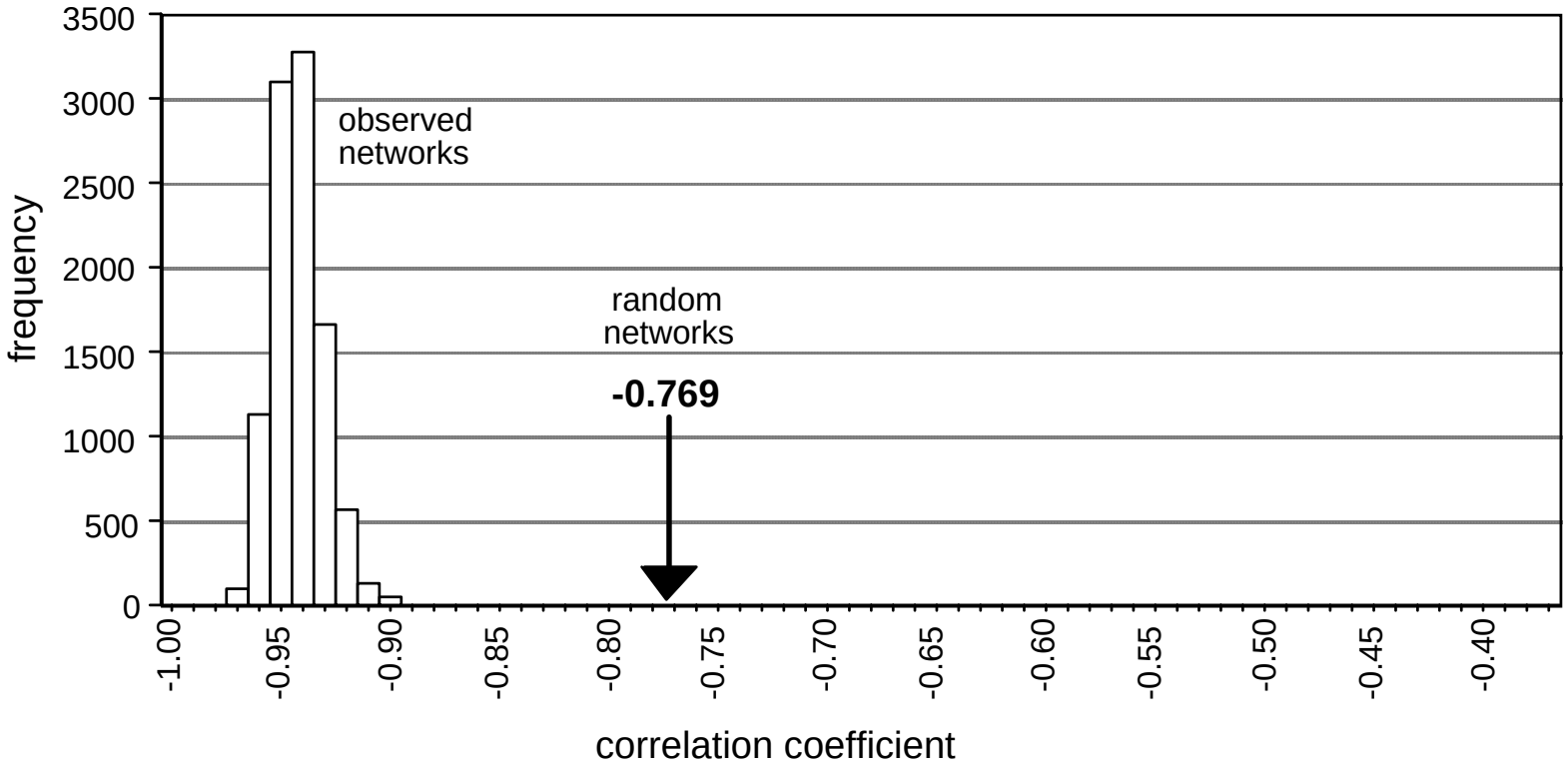


observed networks

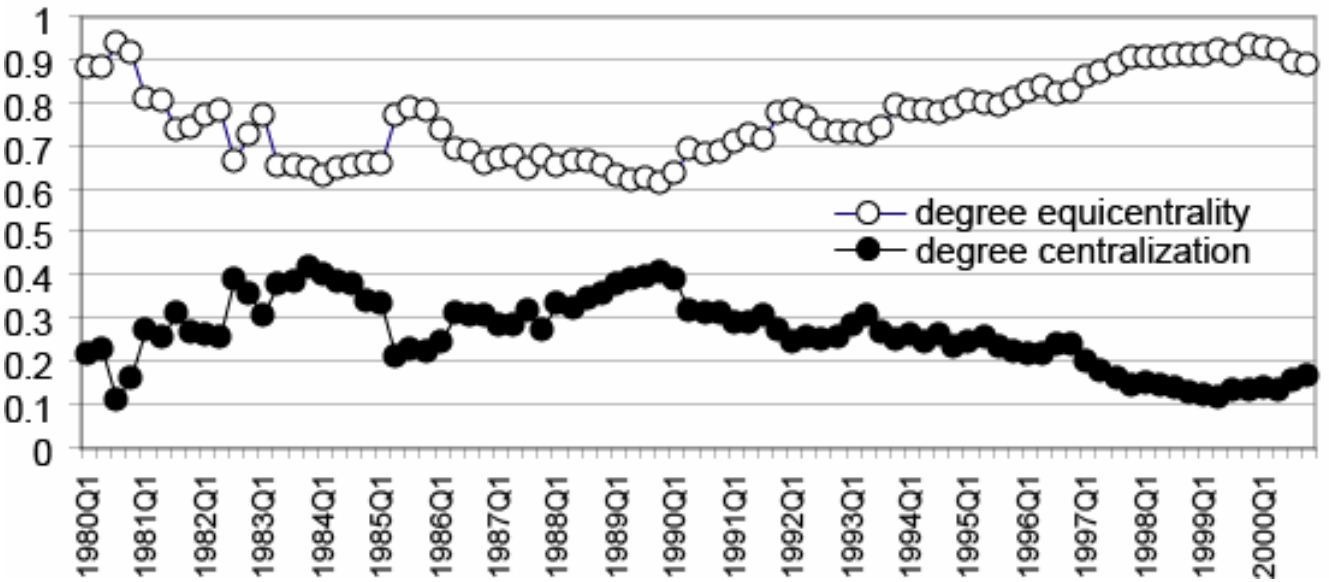


random networks

MICRO-MACRO LINKAGE:
VENTURE CAPITAL INVESTORS' DATA



MICRO-MACRO LINKAGE:
VENTURE CAPITAL INVESTORS' DATA



Structural social psychology
(Lawler, Ridgeway and Markovsky, 1993):
The basic relationship between microprocesses and macrostructures is one of interdependence:
→ changes in micro-level processes lead to changes in macrostructures, which in turn affects microprocesses

IMPLICATIONS

- **there is a significant negative linear association between equicentrality and network centralization**
  - **when actors associate with similarly central alters (i.e., high equicentrality)**
    → low network centralization
  - **when highly central actors associate with low centrality actors (i.e., low equicentrality)**
    → high network centralization

- **the negative linear association between equicentrality and network centralization is much more significant for networks evolving over time**
  → important property for network dynamics

- **evaluation of network centralization by sampling dyads instead of assessing every node in order to identify the most central actor (i.e., $C_{\max}$)**