Design Issues in Network Analysis

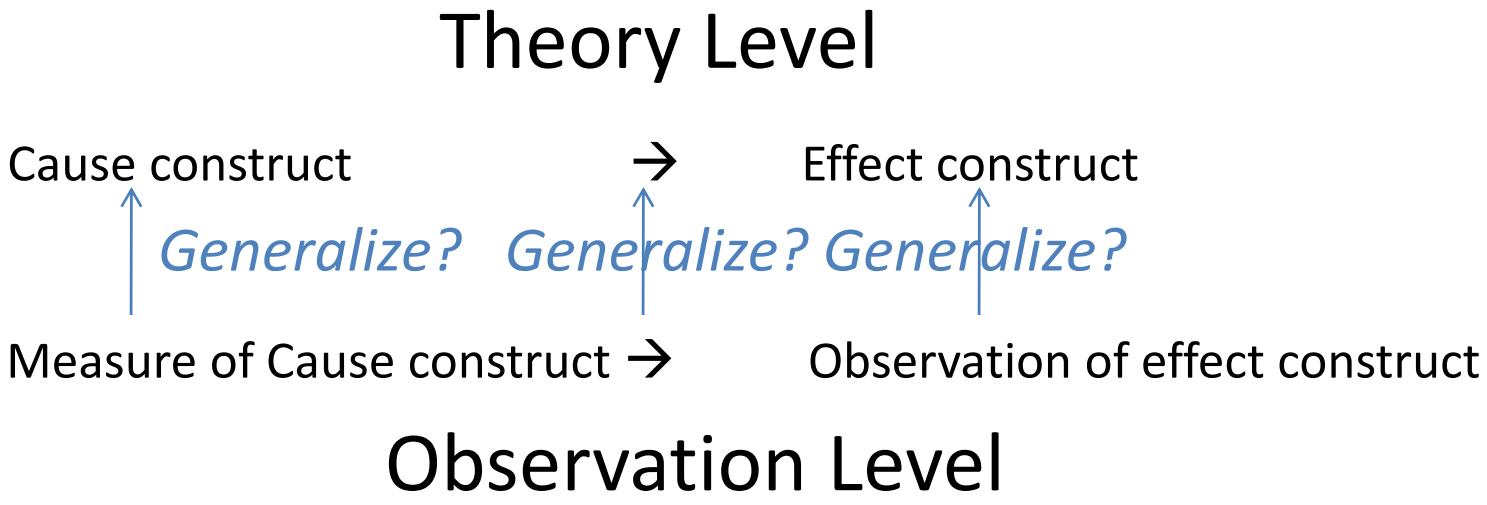
A Survey of Seven Deadly Sins

Worksheet for Study Discussion

1. What is your research question?
2. Why is your research question important? How might it open up, redirect, or shut down a line of inquiry?
3. Who is your primary audience?
4. What is the explanation(s) you are proposing and how will you test it? If your goal, instead, is to establish/describe a phenomena, what is the phenomena you are focusing on and how do you hope to establish it?
5. Are you planning to use a quantitative, qualitative, or hybrid approach?
6. Will you use a cross-sectional or longitudinal (repeated measure or time series) design? Explain.
7. What are the major design challenges facing this research? Briefly list and describe.

Validity and Reliability in Network Research

- Construct Validity: Can you legitimately draw inferences from the measures to the theoretical constructs?



Validity and the Philosophy of Science

Table 1 Various Positions in the Philosophy of Science

Positions in the Philosophy of Science	General Epistemological Focus	Criterion of the Philosophy	Representative Philosophers	Validation Approaches
Rationalism	Logical justification of knowledge claims	Logical reduction	Descartes	Derived from rational foundation
Classical Empiricism		Inductive generalization	J. S. Mill J. N. Keynes	Induced from empirical data
Logical Positivism		Empirical verification	Carnap, Russell Wittgenstein	Derived from empirical foundation
Instrumentalism	Theories as frameworks for prediction and testing	Predictive success, simplicity, or other aesthetic value	Pierce Friedman	Shown by predictive accuracy, simplicity, or other value
Dogmatic Falsificationism		"theory-free" observations to test theories	Popper	Continued testing to eliminate faulty models
Methodological Falsificationism		Survival of testing and criticism	Lakatos' version of Popper	Shown by testing and criticism
Bayesianism	Consistent treatment of probabilistic induction	Increase subjective probability	Howson Urbach	Empirical success increasing belief
Kuhnianism	Progressive historical growth of knowledge	Growth of knowledge through Paradigm shifts	Kuhn, Polyani Bohm Weimer	Accordance with expert opinion, professional acceptance
Lakatos' MSRP		Growth of knowledge through Research Programmes	Popper, Lakatos Bartley, Agassi	Increase empirical and theoretical content without ad hoc adjustment
Hermeneutics	Interpretation and understanding through dialog and practice	Knowledge growth by application with participation	Bernstein Gadamer	Participation by all interested in the outcome

Source: Kleindorfer et. al. in "Management Science" 1998

Construct Validity

- Face/Content validity: Is the measure a good reflection of the construct? Need to have a *clear definition* of the construct.
  - Face validity: use "local experts" to evaluate validity of network content items.
  - Do you have a detailed description of the content domain– e.g., social capital?
- Criterion validity: Does the measure behave the way it should (given your theory)?
  - Predictive validity: ability to predict something it should– e.g., network centrality predicts job performance.
  - Concurrent validity: can the measure distinguish between groups it should be able to distinguish between (e.g., well integrated versus poorly integrated group members)?
  - Convergent validity: does the measure converge with other measures it should theoretically be similar to (e.g., network density and social cohesion)?
  - Discriminant validity: does the measure diverge from other measures that it should not be similar to– e.g., is friendship centrality different than advice centrality?

Types of Validity

- Convergent:
  - Are different measures of the same construct related (e.g., different measures of social capital)?

- Discriminant:
  - Are measures of different, unrelated, constructs themselves unrelated (e.g., are measures of financial capital unrelated to measures of social capital)?

Types of Reliability

- Inter-rater: do different raters give consistent estimates of the same phenomenon?

  - consider computing reciprocity
- Test-retest: consistency of measure from one time to another: rarely examined in social network studies.
- Internal consistency: rarely done unless multiple network items are used to establish network (e.g., Burt, 1992)

Rejected!
Common Threats to Validity/Reliability in Network Research

- Research question and constructs are insufficiently fleshed out.
- Lack of multiple items to assess networks
- Overreliance on subjective report (e.g., ego as sole source of network data; and/or ego as source of both network data and outcome data)
- Under-reliance on subjective report (e.g., what do email ties really mean at interpersonal/psychological level)?
- Tendency to treat mechanisms as a black-box affair.
- Failure to account for alternate (especially non-relational) explanations.
- Failure to draw the boundary properly in coming up with the network(s)
- Pygmalion in network research involving human subjects
- Failure to triangulate across methods
- Failure to take time into account (both in terms of theory and methods)

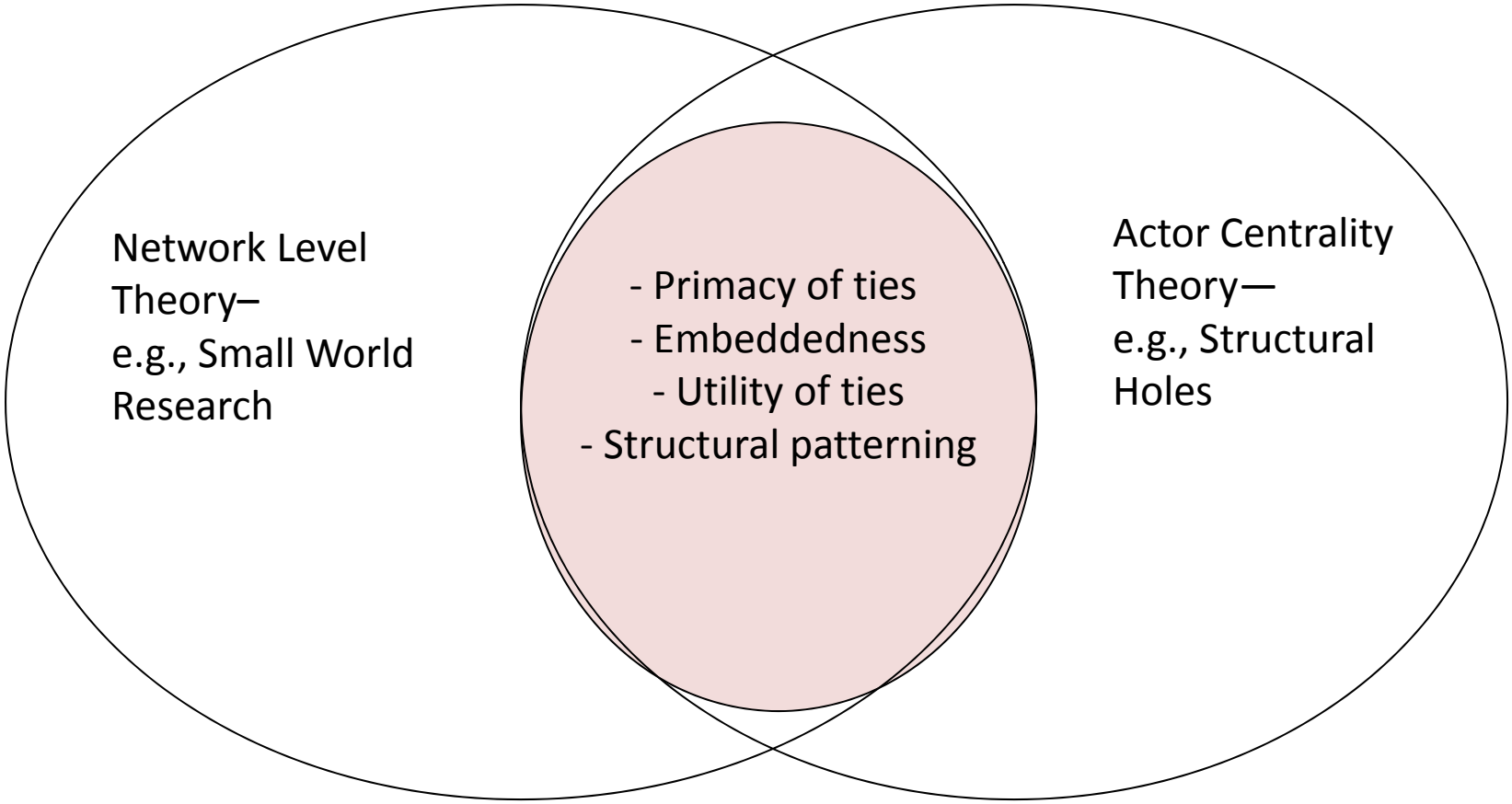
Types of Research Questions

- Descriptive: What exists? Simply describe something and draw out some of its implications.
- Relational: What is the relationship between two or more variables.
- Causal: Does one or more variable cause or effect another?

Honing the Research Question

- What is the one research question?
- What is it that I hope to learn from this research?
- What do we know about this question from previous research?
- Are there inconsistent findings and what would account for them?
- What is missing from our understanding and why is it important? A lack of research is not a sufficient justification for doing research.
- What is your primary audience?
  - If research audience: Question should be theory driven; it should attempt to open up, redirect, or shut down a line of inquiry.
  - If practitioner audience: Solution of question should make an actionable difference, although consciousness-raising also important.
- Don't digress from research question. All your decisions about methods will be dependent on your research question.

What's Distinctive About Network Research?



- Actors are embedded within a web (network) of interrelationships with other actors.
- Network: set of nodes (actors) and ties representing some relationship, or lack of relationship, between the nodes.

Generic Explanations in Network Research

Explanation	Focus
Individual-centered	How individual attributes influence other individual attributes
Structural	Focus on patterns of relations among actors (e.g., Burt, 1992)
Relational	Focus on ties– measure some aspect of relations themselves (e.g., Granovetter, 1974)
Resource	Focus on resources of alters (e.g., Lin, 2001)
Cognitive	Focus on how third parties' observations of relations between a focal party and another influence outcomes for the focal party (e.g., Podolny, 2005)

Four Proto-Mechanisms in Network Research (TABE)

- Transmission
- Adaptation
- Binding
- Excludability

The Transmission Mechanism: On Golden Parachutes and Poison Pills

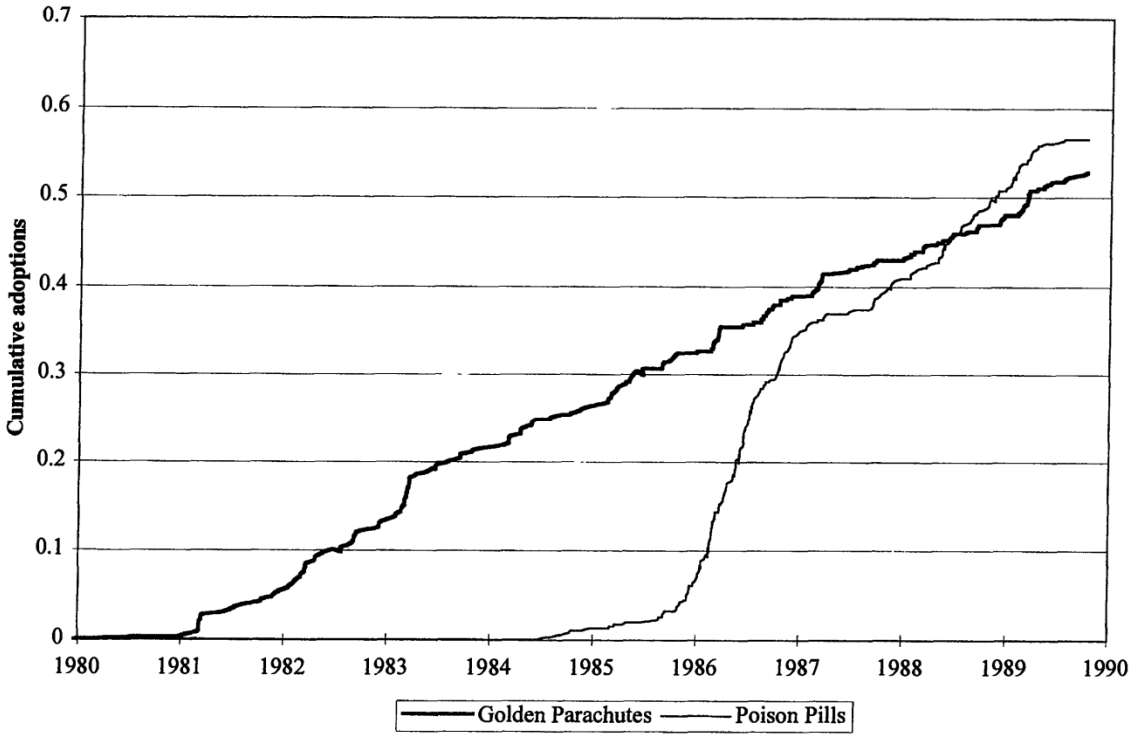


FIG. 1—Diffusion of poison pills and golden parachutes among 1986 Fortune 500 firms, 1980–89.

Pills grew from 5% to 50% in <3 years; took 7 years for parachutes.

Why the divergent diffusion processes?

Source: Davis & Greve, 1997 (AJS)

Transmission Mechanism

- **Goal**: “Link adaptations of individual firms to the structure of networks in which firms’ decision makers are embedded”
- **Key Theoretical Insight**: Network structures determine the speed of adaptation by exposing firms to “particular role models and standards of appropriateness”
- “Networks are often part of the explanation [but] are rarely examined”
- **Ties**: Shared board memberships: interlocks: on avg. 7 interlocks per firm
- **Mechanism**: Ties provided “conduits for the flow of information and norms of corporate governance.” (Cultural embeddedness also mattered)
- **Four factors**: Propensity; susceptibility; infectiousness; social similarity
- **Result**: Pills spread rapidly: adoption influenced by whether contacts had adopted; but no board-to-board diffusion for parachutes, instead georgaphic proximity mattered (cf. Rogers, 1995).

Transmission Mechanism

- **How does transmission occur?** Where's the locus of agency? Does A pull from B, or does B push to A, do they both try to pull and push, or could it be simple exposure with intent/goal?

Adaptation Mechanism

- A can be influenced by its network environment (through transmission or structural equivalence), but it does *not* have to adopt the same state as the environment:

The Adaptation Mechanism

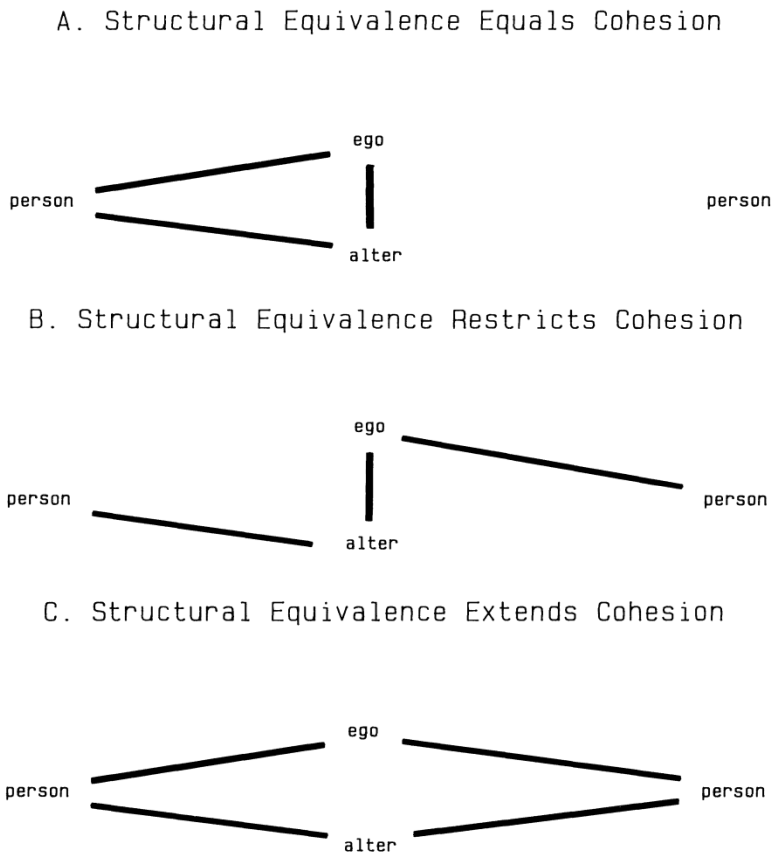


FIG. 1.—Kinds of social structural situations in which structural equivalence and/or cohesion predict contagion between ego and alter.

Structural equivalence: "the trigger to ego's adoption is adoption by the people with whom he jointly occupies a position in social structure, the people who could replace him in his role relations if he were removed from the social structure" (Burt,1987) AJS

Diffusion: Theory versus Observed

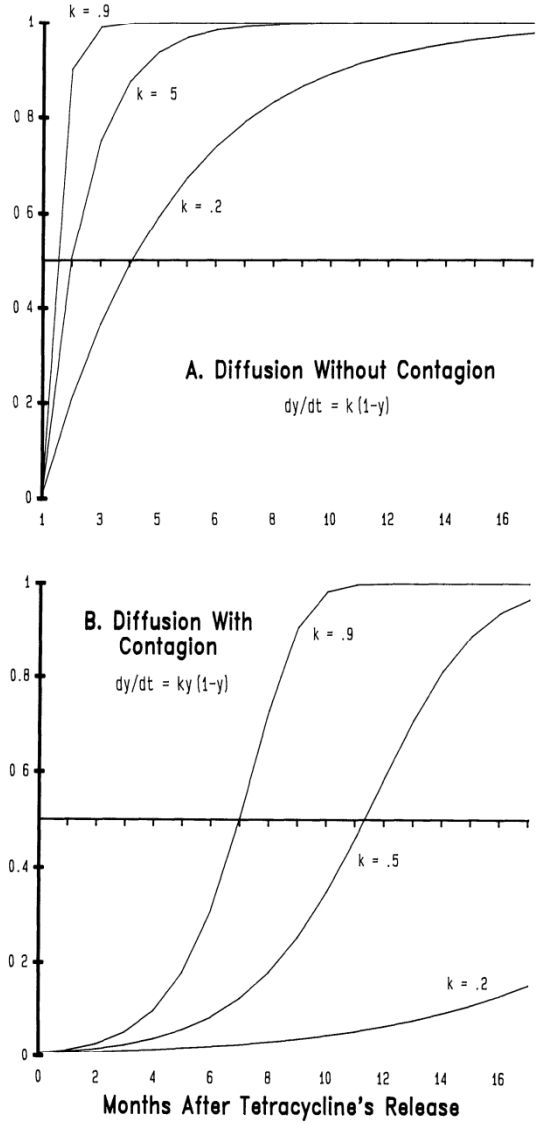
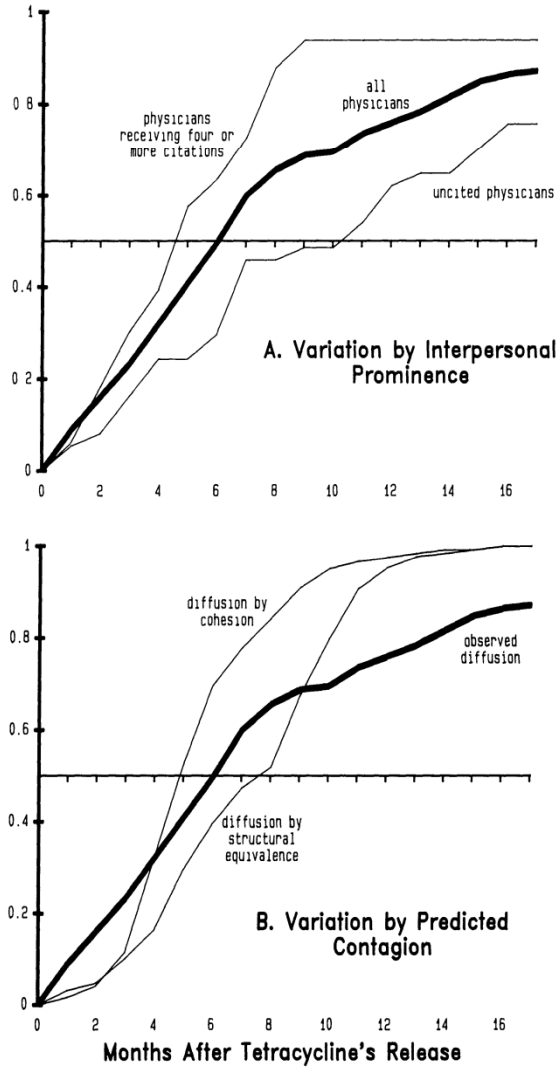


FIG. 2.—Diffusion in theory (cumulative proportion of physicians adopting over time)

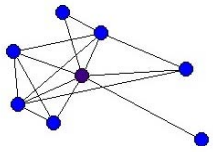
Burt, 1987

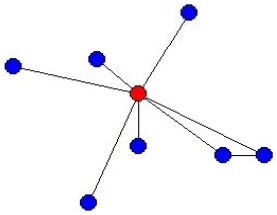


3.—Diffusion observed (cumulative proportion of physicians adopting ime)

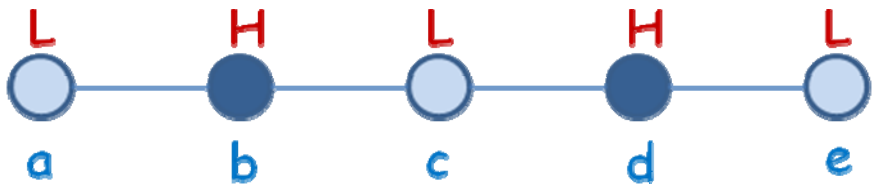
The Binding Mechanism

- Lin (1982) social resources theory: The more and stronger connections to resourceful others, the better ego performs. Focus on direct ties, but indirect ties obviously matter.
- Burt (1992, 2005): Control? Information speed and novelty? Referrals? Vision?





The Excludability Mechanism



Adapted from Figure 1c in Cook, et al(1983).

Boundary Specification

- "It's a small world." Many possible relationships. Thus, network boundary is practically endless. For practical purposes, we need to limit it.

  1) Selection of actors

  2) Selection of relational content – types of social relationships.

  **3) Selection of time frame: consider only current relations?

- Lauman, Marsden, & Prensky. 1983. The boundary specification problem in network analysis. In Burt & Minor, Applied Network Analysis, A Methodological Introduction, 18-34. Beverly Hills, Sage.

Boundary Specification: Selection of Actors

- In organizational research, we have some formal boundaries: work groups, departments, organizations, industries. Thus, we include all actors in a group. Need to justify in terms of your research question.
- Question of "entitativity." How do we identify a "group"?
- Actors themselves: collectively shared, consciously experienced by the actors involved.
- Researcher: delineate the relevant network based on the research question.

Boundary Specification: Selection of Actors

- How many links? Direct links only? Indirect links? How many indirect links?

- Burt, R.S. 2007. Second-hand brokerage: Evidence on the importance of local structure on managers, bankers, and analysts. Academy of Management Journal, 50:110-145.

- Bian, 1997; Labianca, Brass & Gray, 1998. Third-party important in finding good jobs and perceptions of conflict, respectively.

Boundary Specification: Selection of Relational Content

- What types of relationships should I measure?
- Typical organizational relational content: friendship, communication, advice, alliances/joint ventures, boards of directors.
- What relationships do people identify? (e.g., Burt, 1983 – Friendship, acquaintance, work, and kinship).
- Instrumental/expressive (e.g., Ibarra, 1992).
- Appropriability? Overlap? Combine across networks or treat separately?

What's a tie?

Proximities			Social Relations			Interactions	Flows
Location	Membership	Attribute	Kin & Role	Affective	Cognitive		
Physical distance	Same groups Same events Distance etc.	Same gender Same attitude etc.	Mother of, Friend of, boss of, student of Competitor	Likes, Hates, etc.	Knows, knows about, sees as happy, etc.	Sex with, Talked to, Advice to, Helped, Hurt, etc.	Information, beliefs, personnel, resources, etc.

Figure 3. A typology of ties studied in social network analysis.

Name generators: Examples

- “Over the last six months, are there any work related contacts from whom you regularly sought information and advice to enhance your effectiveness on the job?

- Suppose you were moving to a new job and wanted to leadve behind the best network advice that you could for the person moving into your current job. Are there any individuals whom you would name to your replacement whose “buy-in” is essential for your office or department?

- Think back over the past six months, are there individuals on whom you have relied on as souces for general information on the “goings on” at [company] – perhaps who have given you special insight into the goals and strategies of important individuals, divisions, or perhaps even the firm as a whole?

Name generators: Examples

- Are there any individuals whom you regard as a mentor – that is, someone who has taken a strong interest in your professional development over the last six months by providing you with opportunities and/or access to facilitate your career advancement?

- Is there anyone in your work environment over the last six months whom you regard as a source of social support – that is, someone with whom you are confortable discussing sensitive matters?"
- (Podolny & Baron, 1997)

- "Consider the people with whom you like to spend your free time. Over the last six months, who are the three people you have been with most often for informal social activities such as going out to lunch, dinner, drinks, films, visiting one another's homes, and so on?

Name generators: Examples

- “Consider the people with whom you like to spend your free time. Over the last six months, who are the three people you have been with most often for informal social activities such as going out to lunch, dinner, drinks, films, visiting one another’s homes, and so on?

- From time to time, most people discuss important matters with other people, people they trust. The range of important matters varies from person to person across work, leisure, family, politics, whatever. The range of relations varies across work, family, friends, and advisors. If you look back over the last six months, who are the four or five people with whom you discussed matters important to you?”

(Burt, 1992, p. 123)

Measurement: Ego or Whole Network

- Ego networks: centered around a particular actor. Includes the "ego" and direct tie "alters," and, in some cases, ties among the alters. One actor's network.

  Advantage: can sample across groups, easy to collect.

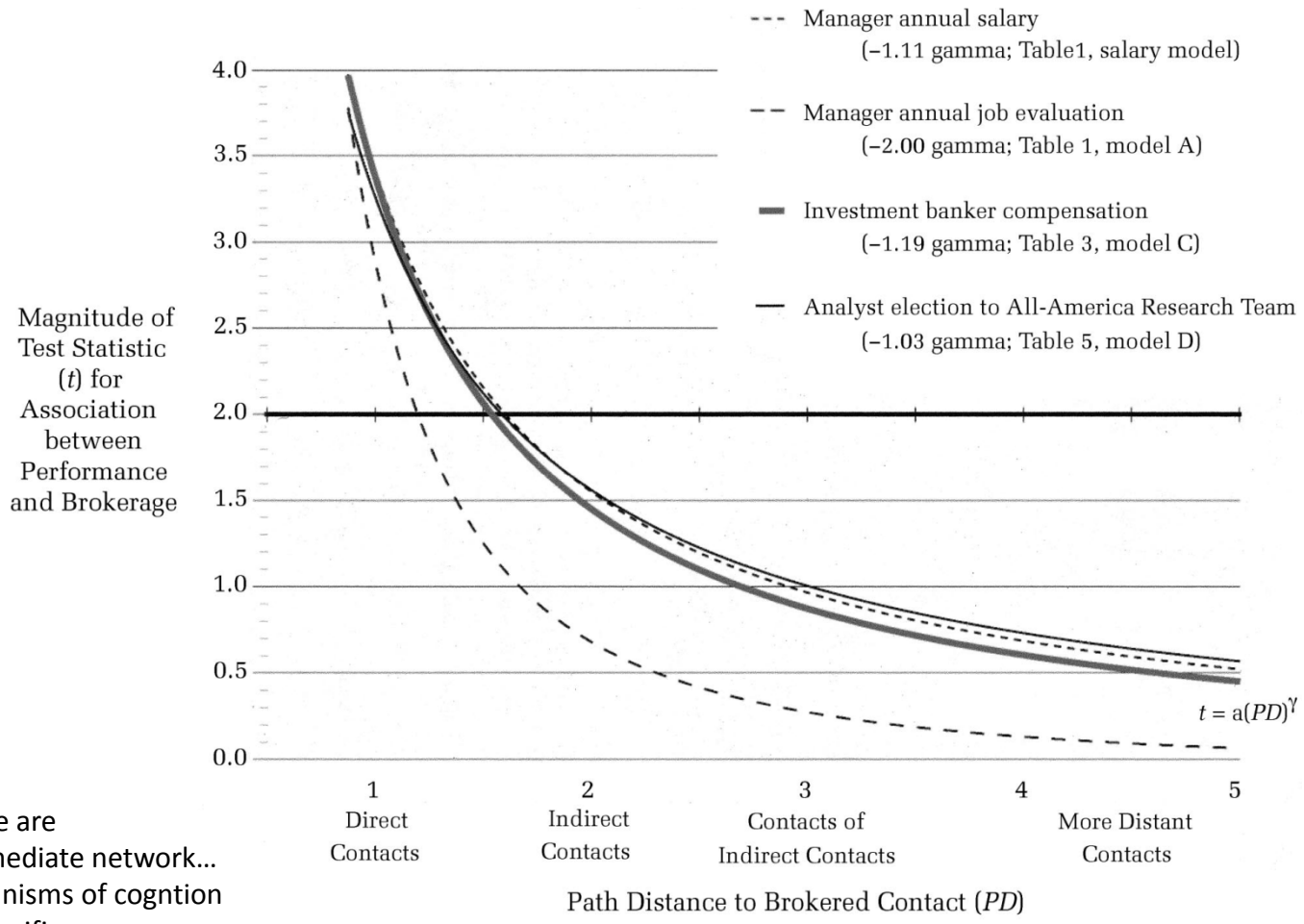
  Disadvantage: limited to direct ties, limited number of SNA measures.

- Whole networks: attempt to get data from all members of a bounded network.

  Advantage: can assess reciprocation, can assess effects of indirect ties, more SNA measures.

  Disadvantage: need high response rate, boundary may be wrong.

How Many Links Should one Consider?



Returns to brokerage are concentrated in immediate network… giving "micro mechanisms of cogntion and emotion new significance as success factors in brokerage" Burt, 2007: 143

Name generators and ego-networks

- Name generators can be used for both ego-network or whole network.

- If ego-network, you will then need to ask the respondent to provide information about the links between alters.
- For an example of how to do this, go to http://faculty.chicagogsb.edu/ronald.burt/research/GSBAS1.pdf
- Is ego's perception of links between alters accurate? See Krackhardt & Kilduff, 1999, JPSP

Measurement: Binary or Valued?

- Binary – yes or no, 1 or 0. Only the presence or absence of the relationship is important.

- Valued – example: on a scale from 1-7. Particularly important if adopting the relational approach. Measure frequency, intensity (closeness), duration.

- Valued data take longer for the respondent, but valued data can always be converted to binary data.

Measurement: Perceptual methods

- Roster: present people with list of all members of the network

  Advantage: not dependent on person's recall of names; all actors considered, probably more complete in terms of weak ties.

  Disadvantage: may have incomplete list (specified wrong boundary).

- Name generator: ask people to generate names based on questions about relationships.

  Advantage: no boundary specified.

  Disadvantage: dependent on person's ability to recall, may be biased toward strong ties.

- Snowball (type of name generator): start with one person then continue contacting all alters and alters of alters

  Advantage: no boundary; may eventually identify boundary, diffusion studies.

  Disadvantage: doesn't tap lack of relationships – everyone well integrated.

Measurement: Archival, Observational, or Perceptual?

- Archival Data (alliances, e-mail, affiliations)

  Advantage: not dependent on personal perceptions.

  Disadvantage: not clear what it represents.

- Observational.

  Dependent on your perceptions. May not see it all, or may misinterpret.

  Very time consuming.

- Perceptual Data (questionnaires, interviews).

  Actors are not very good about remembering specific interactions.

  Bernard et al. 1984

  But they are good about remembering recurrent, repeated interactions or on-going relationships.

  Freeman et al. 1987

Measurement: Actual or Perceived

- Actual networks or perceptions of networks? (e.g., Kilduff, M., & Krackhardt, D. 1994. Bringing the individual back in: A structural analysis of the internal market for reputation in organizations. Academy of Management Journal, 37: 87-108.)

- Potential or actual? (e.g., affiliaitons or diffusion?)

Measurement: Directional?

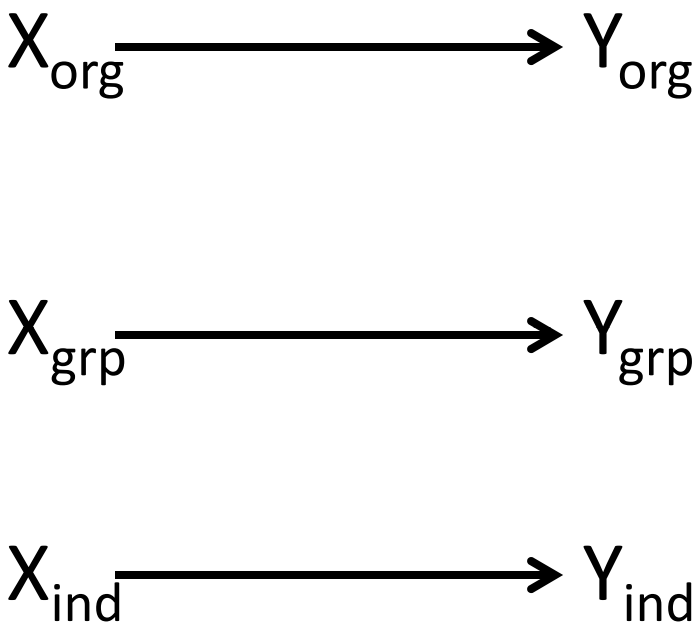
- Most network data is directional – at least in the sense that ego chooses alter. Allows for measure like in-degree and out-degree. Some relational network content is directional by nature – advice network. In diffusion studies, direction is important.

- Directional data can always be treated as nondirectional – symmetrized. Higher, lower, or average? When collecting whole network data, what to do if respondents don't agree? Does link exist?
- How to treat valued data?

Units of Analysis

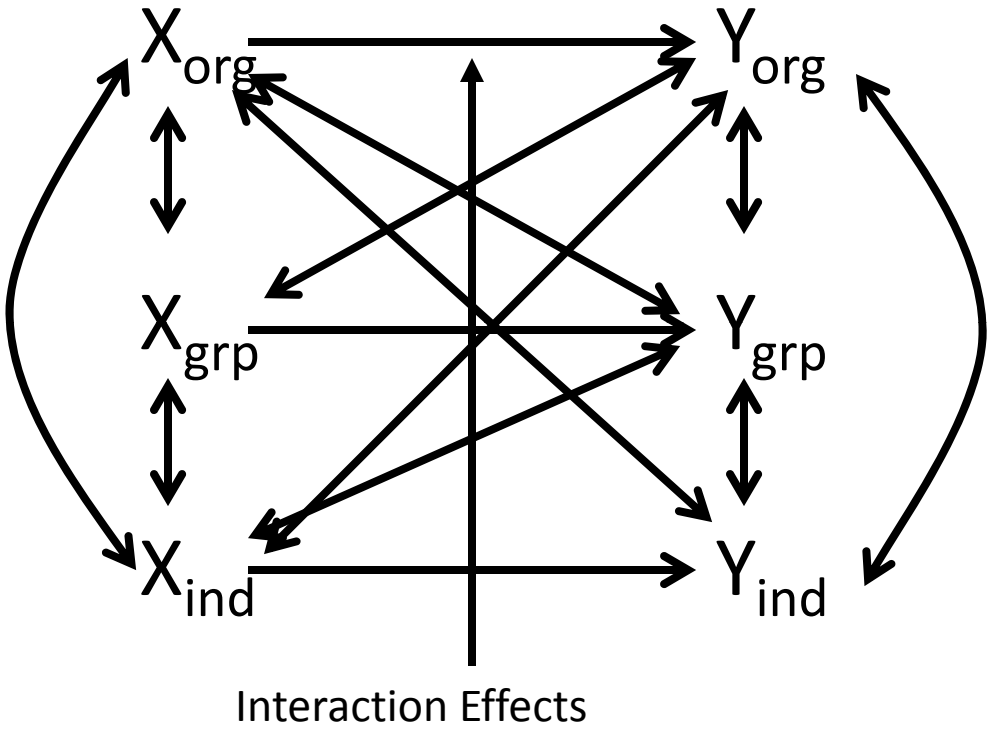
- Persons, Groups, Organizations?
- Duality of persons and groups. Any time two persons interact, they represent both themselves and groups they are members of. Does interpersonal interaction represent inter-group interaction? Ask question about persons or groups?
- Affiliations. Does affiliation with a group represent interpersonal interaction? Inter-group interaction? (e.g., boards of directors).
- Cross-level research. E.g., What is the effect of a central actor in a centralized network? Many opportunities here.

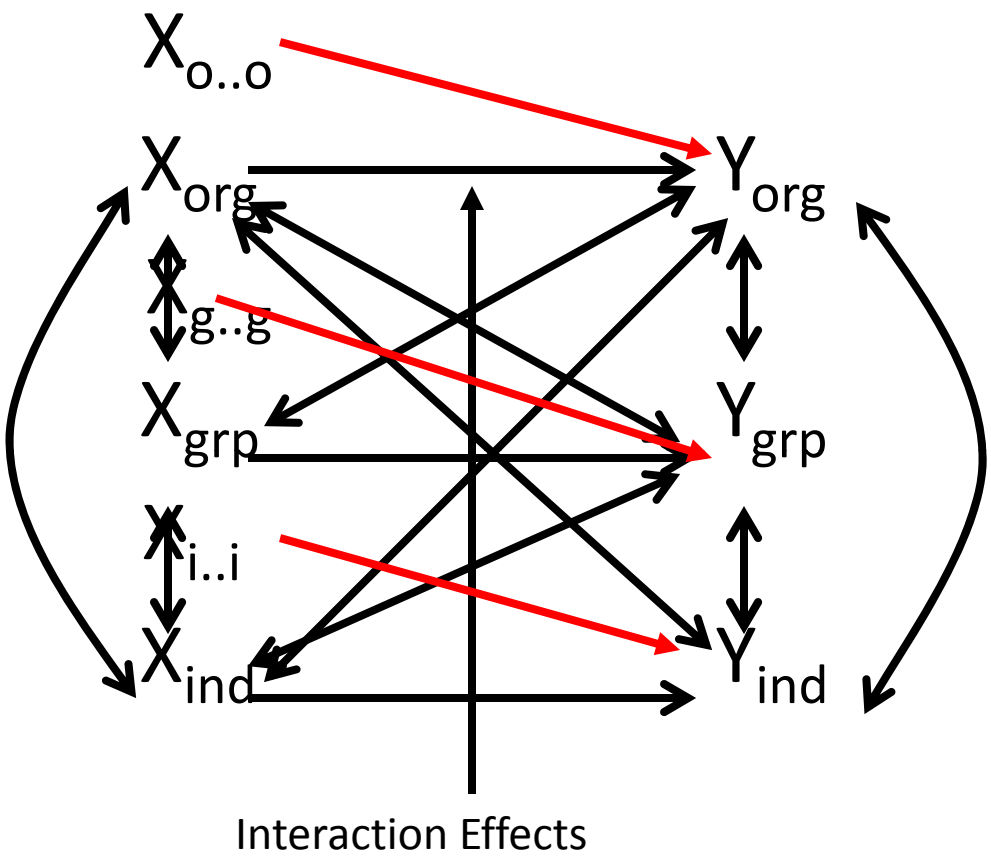
Traditional Management Research



X independent variable
Y dependent variable

Multi-level Management Research




$X_{o..o}$
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Y_{org}
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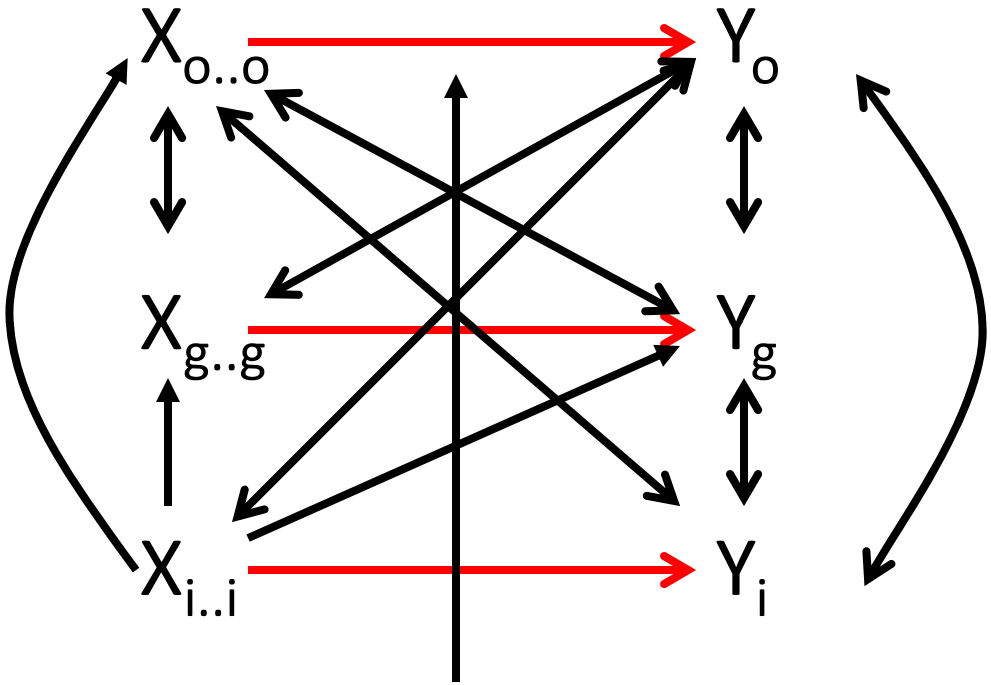
X_{grp}
Y_{grp}
$X_{i..i}$
X_{ind}
Y_{ind}
Interaction Effects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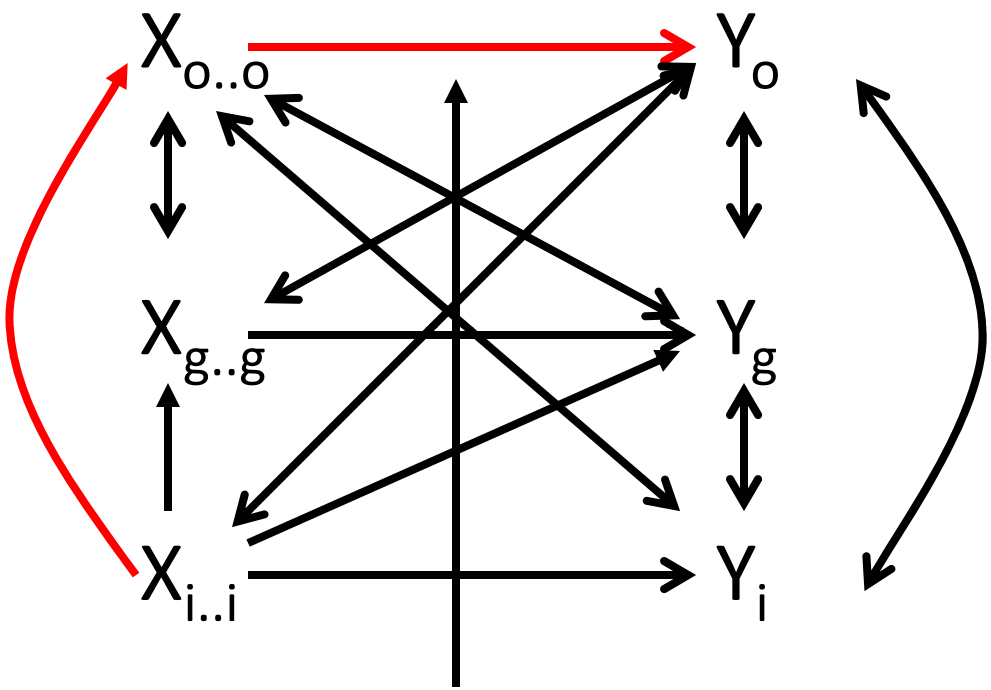
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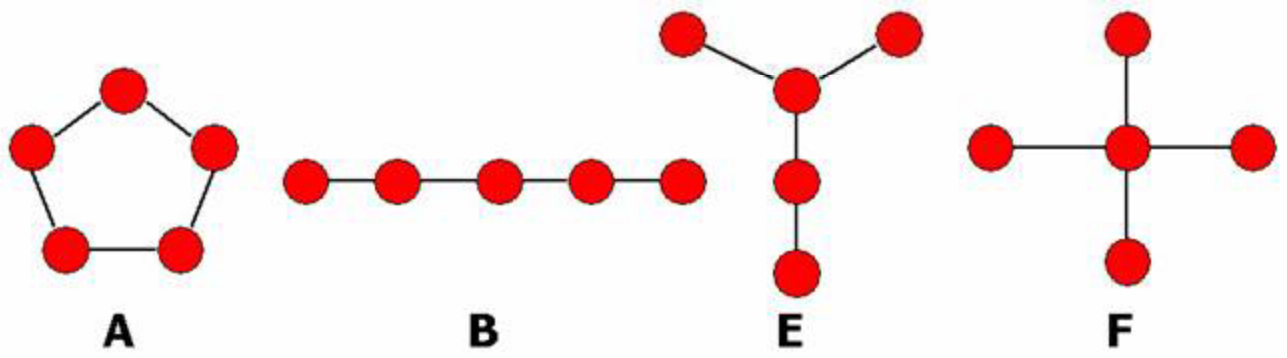
The Role of Time

- Is your study cross-sectional or longitudinal (repeated measure versus time series) in terms of data? Are the claims you are making/testing cross-sectional or longitudinal?

Networks in the Lab



Small Group Communication Networks: The MIT lab studies of Bavelas and colleagues (’50s—’60s)
See, for example, Shaw, M. 1964. Communication networks. In L. Berkowitz (Ed.), Advances in Experimental Psychology (Vol.1, pp. 111-147). New York: Academic Press.

Participant Observation and Interviews

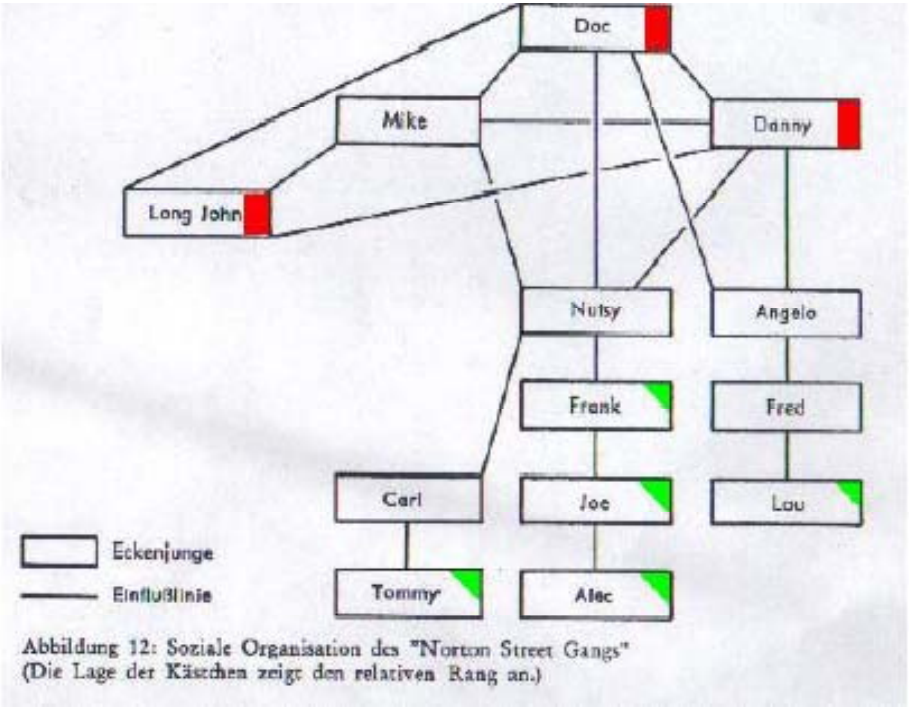
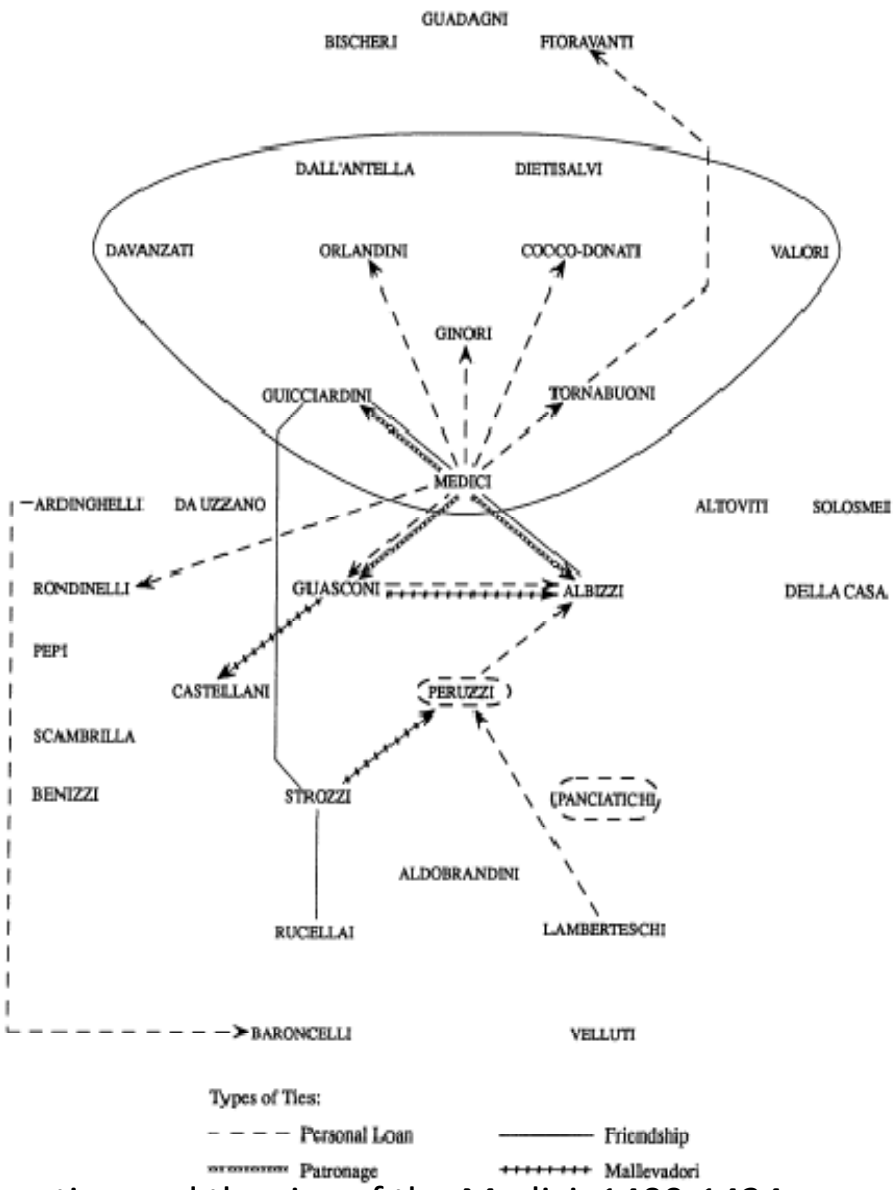


Abbildung 12: Soziale Organisation des "Norton Street Gangs"
(Die Lage der Kästchen zeigt den relativen Rang an.)

Whyte, W. F. 1943. Street Corner Society: The social structure of an Italian Slum. The University of Chicago Press.

Source: Whyte, 1943

Historical Methods



Padgett, J.F., & Ansell, C.K. 1993. Robust action and the rise of the Medici, 1400-1434. American Journal of Sociology, 98: 1259-1319.

Network Simulations

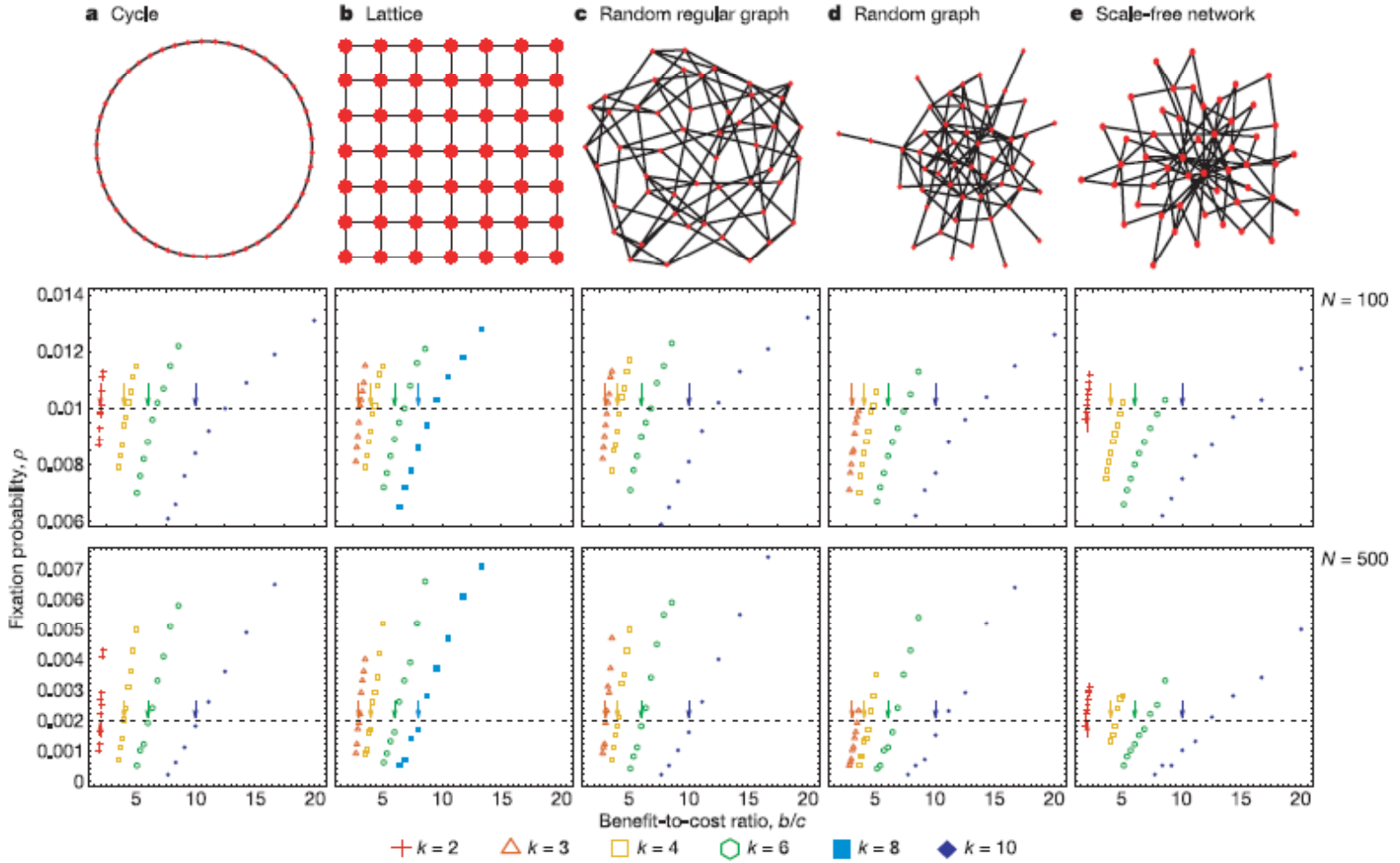


Figure 2 | The simple rule, $b/c > k$, is in good agreement with numerical simulations. The parameter k denotes the degree of the graph, which is given by the (average) number of neighbours per individual. The first row illustrates the type of graph for $k = 2$ (**a**) and $k = 4$ (**b**–**e**). The second and third rows show simulation data for population sizes $N = 100$ and $N = 500$. The fixation probability, ρ, of cooperators is determined by the fraction of runs where cooperators reached fixation out of 10^6 runs under weak selection, $w = 0.01$. Each type of graph is simulated for different (average) degrees ranging from $k = 2$ to $k = 10$. The arrows mark $b/c = k$. The dotted horizontal line indicates the fixation probability $1/N$ of neutral evolution. The data suggest that $b/c > k$ is necessary but not sufficient. The discrepancy is larger for non-regular graphs (**d**, **e**) with high average degree ($k = 10$). This is not surprising given that the derivation of the rule is for regular graphs and in the limit $N \gg k$. Note that the larger population size, $N = 500$, gives better agreement. Interactive online tutorials can be found at http://univie.ac.at/virtuallabs.

Ohtsuki et. al. in Nature vol. 441, 2006

Network Survey

Please check those that apply:

☐ High school diploma ☐ Bachelor's ☐ M.D. ☐ Physician's Assistant

☐ Associate's ☐ Master's ☐ R.N. ☐ Nurse Practitioner

Other (*please specify*) _____

Please check the shift during which you normally work:

☐ Day ☐ Night ☐ Swing ☐ Rotate shifts

For each person below, please check the boxes that apply (*check as many as are applicable*).

	Consider a friend	Consider an acquaintance	Go to for advice	Go to for support	Are required to interact with because of the nature of your work	Prefer to avoid	Usually communicate with (*please rate on the scale below*) Seldom (less than once a week)	Often (many times a day)	Has the following amount of influence in UHS (*please rate on the scale below*) Very little influence	A great deal of influence
BUSINESS OFFICE										
Joslyn Armstrong	☐	☐	☐	☐	☐	☐	1 2 3 4 5		1 2 3 4 5	
Staci-Jo Bruce	☐	☐	☐	☐	☐	☐	1 2 3 4 5		1 2 3 4 5	
Myrna Covington	☐	☐	☐	☐	☐	☐	1 2 3 4 5		1 2 3 4 5	
Donna Decker	☐	☐	☐	☐	☐	☐	1 2 3 4 5		1 2 3 4 5	
Donna Gibboney	☐	☐	☐	☐	☐	☐	1 2 3 4 5		1 2 3 4 5	
Lorraina Hazel	☐	☐	☐	☐	☐	☐	1 2 3 4 5		1 2 3 4 5	
Debra Hoover	☐	☐	☐	☐	☐	☐	1 2 3 4 5		1 2 3 4 5	
Kim Johnson	☐	☐	☐	☐	☐	☐	1 2 3 4 5		1 2 3 4 5	
Tom Lawton	☐	☐	☐	☐	☐	☐	1 2 3 4 5		1 2 3 4 5	
Connie Mann	☐	☐	☐	☐	☐	☐	1 2 3 4 5		1 2 3 4 5	
Joe Reilly	☐	☐	☐	☐	☐	☐	1 2 3 4 5		1 2 3 4 5	
Pat Robinson	☐	☐	☐	☐	☐	☐	1 2 3 4 5		1 2 3 4 5	
Carolyn Schenk	☐	☐	☐	☐	☐	☐	1 2 3 4 5		1 2 3 4 5	

The Underdeveloped Role of Agency in Network Research

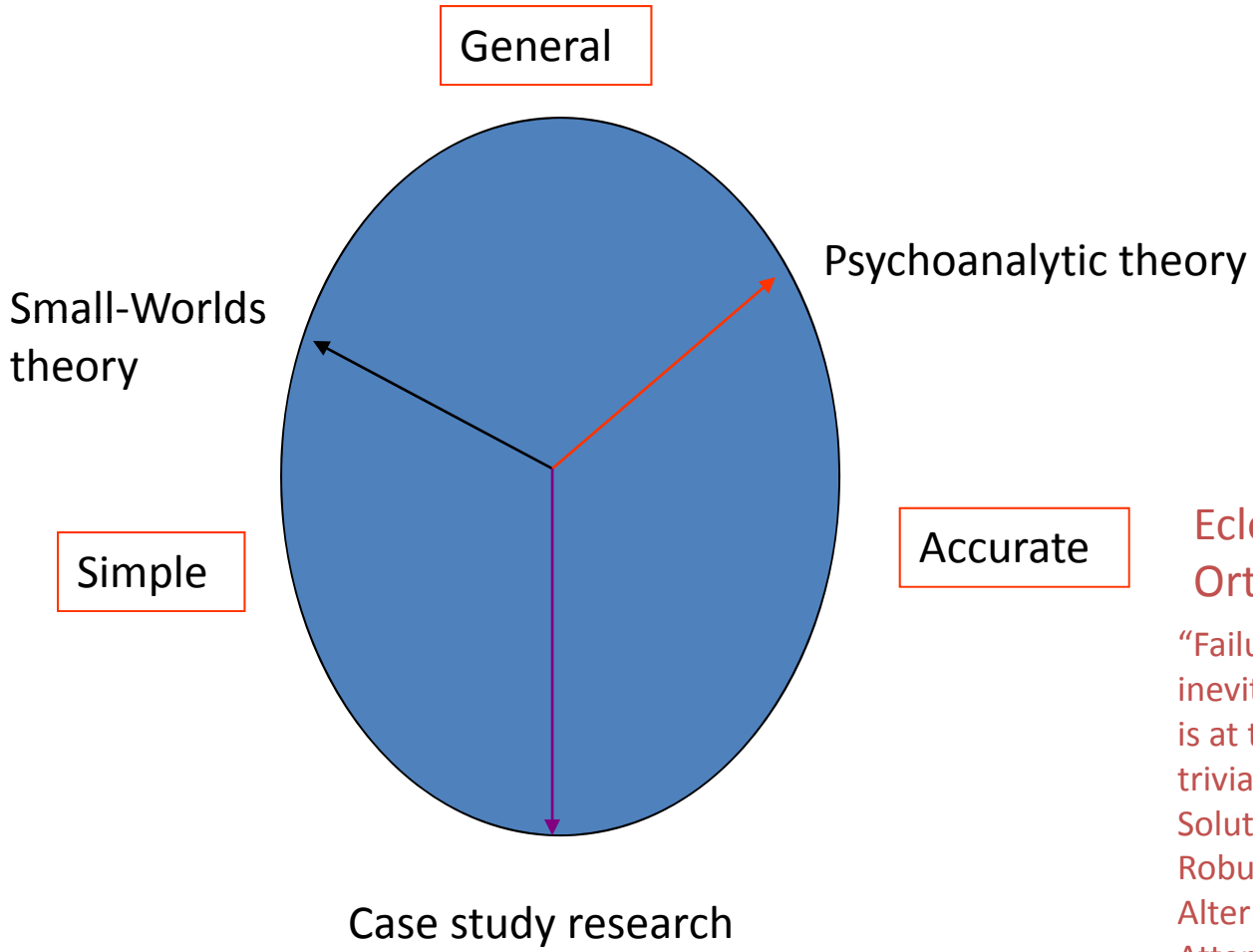
In re-investigation of small world effect:

- presence of highly connected hubs not supported: people "rarely nominated an individual because s/he had more friends" (p.827)
- "the experimental approach adopted here suggests that empirically observed network structure can only be meaningfully interpreted in light of the actions, strategies, and even perceptions of the individuals embedded in the network: Network structure is not everything." (Dodds, Muhamad, Watts, 2003: 829)

The Underdeveloped role of Agency in Network Research

- We need far more information on “what people know, how they use their knowledge during searches… as in other branches of science, progress in understanding requires that tightly controlled experiment and real-world complexity regularly and systematically inform one another” (2003: 774)

Thorngate's (Im)postulate: Tradeoffs in Social Network Research



Eclecticism over Orthodoxy?

"Failure to accept [these] inevitable tradeoffs… is at the heart of much trivial research… The Solution would seem to Robust compromises or Alternation rather than an Attempt to accomplish all three" (Weick, 1979: 36)

A way of seeing is also a way of not seeing– Kenneth Burke, 1935

What Counts as an Explanation?
Metaphysical Assumptions Masquerading as Debatable Points

Methodological Individualism (Homans, 1950)

-Social structures emerge because of a proclivity towards the structure (Spencer, 1881: 48-9)

-This explanation carries force only because individuals have been obliged to take on board factors that properly belong to social structure.

-These theories do not explain how individuals acquired these socially infused preferences.

Methodological Collectivism (a la Padgett and Ansell, 1994)

- Person as puppet in hands of structural forces

- Obscures mechanisms of power whereby structure and agency interpenetrate

Structuration (a la Giddens, 1984)

- Structure is not all in the head; an obdurate interpersonal reality out there.

The Seven Deadly Sins:
Common Threats to Validity in Network Research

1. **The sin of vagueness**: Are the research question and constructs adequately fleshed out?
   - Be clear about your research question and its importance in light of previous work.
   - Think through the concepts that populate your theory.
   - Pilot test: Get local experts to critique your measures that attempt to translate these unobservable constructs into observable measures.
2. **The sin of singularity**: Mono-item, Mono-study, Mono-method bias
   - Try to use multiple items to assess network and establish differences between different networks.
   - Multi-sample frameworks tend to be more persuasive than single sample studies.
   - Triangulate across methods (e.g., participant observation and self-report/survey)
3. **The sin of lack-of-theory**: Is your theory clearly articulated?
   - What are the mechanism(s) you are invoking? Do your measures and design fit the assumptions about mechanisms?
4. **The sin of insufficient attention to alternative explanations**: Are you ruling out plausible alternative explanations
   - E.g., account for individual effects?
   - Consider reverse causality
5. **The sin of subjectivity**: Any science that relies on subjective report is lost (Mayhew)
   - Does your theory require objective/impersonal data? Or are you interested in subjectivities? What kinds of assumptions are you making about individual subjectivity, and are these claims supportable? Collect data in a manner that allows you to address these criticisms (e.g., collect data on interpersonal relations from both ego and alter; couple reports with observation).
6. **The sin of incorrect boundary specification**: Did you specify the boundary properly?
   - Selection of actors, relational contents, and number of links to consider (from ego networks to whole networks). These selections should fit the theory/arguments you are making.
7. **The sin of self-ignorance**: Creating the reality one purports to be merely observing
   - Does the testing or measurement itself influence the data collected? A real problem in many survey based studies: Manage expectations; clarify outcomes; beware of hypothesis guessing and evaluation apprehension.

The Classic Stages of a Theory's Career

- First "…attacked as absurd; then it is admitted to be true, but obvious and insignificant; finally, it is seen to be so important that its adversaries claim that they themselves discovered it"

William James