Centrality and Centralization

Aneela, James and Santiago
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Overview

• Aneela – Centrality and Prestige, Power
  (Wasserman and Faust 1994, Freeman 1979 and Emerson 1962)

• James- Power-dependence and Brokerage
  (Bonacich 1987, Cook 1983 and Fernandez 1994)

• Santiago- Case studies
  (Padgett 1993, Ibarra 1992 and Brass 1984)
Centrality and Prestige
Wassermann and Faust, Chapter 5

• Graph theory in SNA helps to identify ‘most important’ actors in social network.

• Chapter is divided into two parts:
  – Centrality measures for non directional relations
  – Centrality and prestige measures for directional relations

• Nondirectional Relations
  – Degree Centrality
  – Closeness Centrality
  – Betweenness Centrality
  – Information Centrality
Prominence: Centrality and Prestige

- Prominence: An actor is prominent if the ties of the actor make the actor particularly visible to the other actors in the network.
- To determine which of the actors in a group are prominent, one needs to examine not only all ‘choices’ made by an actor and all ‘choices’ received, but also indirect ties.
- Two classes of prominence:
  - Centrality
  - Prestige
Actor Centrality

• Prominent actors are extensively involved in relationships with other actors and are more visible than others.
• In non-directional relations there is no distinction between receiving and sending.
• Actor centrality index = $C_A(n_i)$
Actor prestige

• Prestigious actor: one who is the object of extensive ties, thus focusing solely on actor as a recipient.
• Refined concept but difficult to measure
• Prestige can only be quantified for directional relations
• Term prestige can be misleading if the relation is negative (hatred or laughing stock)
• Prestige can also be called status, rank, deference and popularity.
• Notation: P
Group centralization

• Group level measures allow us to compare different networks easily.

• Group level index of centralization
  – Shows that the larger it is, the more likely is it that a single actor is quite central, with the remaining actors are considerably less central

• The star graph is maximally central
Degree centrality

• Actor centrality: central actor must be most active i.e. have most ties to other actors in the network. We measure activity as *degree*.

• **Actor Degree centrality:** Centrality measure of an actor is the degree of the node $d(n_i)$
  - $C_D(n_i)$: actor-level degree centrality index
  - $C_D(n_i)=d(n_i)=x_i+ =\Sigma x_{ij} =\Sigma x_{ji}$
  - $C’D(n_i) = d(n_i)/g-1$

• Related index
  - Ego density (for a nondirectional relation is the ratio of the degree of an actor to the maximum number of ties that could occur)
  - Span (of an actor is the percentage of ties in the network that involve the actor or the actors that the primary actor is adjacent to)
Group Degree Centralization

\[ C_D = \sum_{g_i=1} \left[ C_D(n^*) - C_D(n_i) \right] / \max \sum_{g_i=1} [C_D - C_D(n_i)] \]

• Where \( \{C_D(n_i)\} \) are the \( g \) actor degree indices, while \( C_D(n^*) \) is the largest observed value.

• Another standard statistical summary of the actor degree indices is the variance of degrees:

\[ S_{2D} = \left[ \sum_{g_i=1} (CD(n_i) - \text{mean degree } CD)^2 \right] / g \]
Closeness Centrality

• Measure focuses on how close an actor is to all the other actors in the set of actors.
• Central nodes in a network have minimum steps when relating to other nodes i.e. the geodesics / shortest paths must be as short as possible.
• **Actor Closeness Centrality measures:**
  • Actor closeness is measured as a function of geodesic distances (Sabidussi 1966)
  • Depends on direct and indirect ties, especially when any two actors are not adjacent.

\[
C_c(n_i) = \left[ \frac{1}{k} \sum_{j=1}^{k} d(n_i, n_j) \right]^{-1}
\]
Group Closeness Centrality

- Measuring of group centralization by using actor closeness centralities
- Index of group closeness (Freeman 1976)

\[ C_c = \frac{\sum_{i=1}^{g} [C_{c}(n^*) - C_{c}(n_i)]}{\left[ (g-2)(g-1)/(2g-3) \right]} \]

- \( C_{c}(n^*) \) is the largest standardized actor closeness in the set of actors
- \( \left[ (g-2)(g-1)/(2g-3) \right] \) is the maximum possible value for the numerator
Betweenness Centrality

• An actor is central if it lies between other actors on their geodesics
• Strategic importance of locations on geodesics

Actor Betweenness Centrality

• The actor betweenness index for ni is the sum of the estimated probabilities over all pairs of actors not including the ith actor

\[ C_g(n_i) = \sum_{j<k} \frac{g_{jk}(n_i)}{g_{jk}} \]
Group Betweenness Centrality

• Group centralization indices based on betweenness allow to compare different networks with respect to the heterogeneity of the betweenness of the members of the networks

\[ C_B = \frac{2 \sum_{i=1}^{g} [C_B(n*) - C_B(n_i)]}{[(g-1)^2(g-2)]} \]
Information centrality

Actor Information Centrality:

\[ C_i(n_i) = \frac{1}{C_{ii} + (T - 2R)/g} \]

- This version of centrality focuses on information contained in all paths originating with a specific actor. The information of an actor averages the information in these paths, which in turn is inversely related to the variance in the transmission of a signal from one actor to another

Group Information Centralization

\[ \bar{C}_i = \sum_i C_i(n_i) \]
Directional Relations

• Focus on choices made
• Prestige indices generally examine choices received, direct and indirect
• The centrality indices for degree and closeness are easily applied to directional relations.
• Betweenness and information are not easily applied to directional relations because of their reliance on nondirected paths and geodesics
Prestige

• Only for directional relations- as choices received
• **Degree Prestige**: actor-level measure of prestige means the indegree of each actor
• Actors who are prestigious tend to receive many nominations or choices
  \[ P_D(n_i) = d_i(n_i) = X+i \]
• **Proximity Prestige**: closeness that focuses on distances to rather than from each actor
• **Status Rank or Prestige**: Numbers of direct ‘choices’ or distances need to be combined to a specific actor, with the status or rank of the actors involved
Centrality in Social Networks: Conceptual Clarification (Freeman 1979).

- **Adjacent**: When two points are connected by an edge
- **Degree**: the number of other points to which a given point is adjacent
- **Reachable**: an unordered pair of points (pi and pj) is reachable if there exists a path i.e. a sequence of one or more edges. The path begins at pi, passing through intermediate linking points and ending at pj.
- **Cycle**: A path that begins and ends at the same point is called a cycle e.g. (p2,p3) (p3, p4) (p4, p2).
- **Connected**: When every point is reachable from any other point the graph is called connected.
- **Geodesics**: The shortest paths linking a given pair of points
Point centrality

- **Degree**: thick of things/ visibility.
- Measure of point centrality based on degree

- **Betweenness**: frequency with which a point falls between pairs of other points on the shortest or geodesic paths connecting them

- **Closeness**: the degree to which a point is close to all other points in the graph.
  Not dependent on others as ‘relayers’ of information/ messages
Power-Dependence Relations
Emerson (1962)

• Developed a simple theory of power relations to resolve the ambiguities surrounding ‘power’ and ‘authority’

• Power is a property of the social relations; it is not an attribute of the actor.

• X has power is vacant, unless we specify ‘over whom’
Power-Dependence Relations

• Power resides implicitly in the other’s dependency
• Party B depends on party A, if B aspires goals whose achievement is facilitated or hindered by A’s actions.
• \( P_{ab} = D_{ba} \): Therefore, the power of A over B is equal to the dependence of B on A.
• Ties of mutual dependence- each party is in a position to grant or deny the other’s gratification
• Reciprocity between social relations, are:
  • \( P_{ab} = D_{ba} \)
  • \( P_{ba} = D_{ab} \)
Power-Dependence Relations

• Reciprocity of power implies equality and inequality of power in the relation
• Balanced relation vs. unbalanced one

\[
\begin{align*}
P_{ab} &= D_{ba} \\
P_{ba} &= D_{ab} \\
P_{ab} &= D_{ba} \\
P_{ba} &= D_{ab}
\end{align*}
\]

• Balance does not neutralize power
• The powerful actor A could enjoy a power advantage deriving from differential power (P_{ab} - P_{ba}) which can be positive or negative
Unbalanced relation

• Unbalanced relation is unstable
• Reduced either through:
  – **cost reduction** *(refers to the process of value adjustment or changing values in order to reduce the pain incurred in meeting A’s demand)*
  – **balancing operation**
• Emerson emphasizes 4 types of balancing operations *(e.g. children play group)*
  – **Operation 1**- Withdrawal
  – **Operation 2**- Extension of power networks *(B-A-C => adding B-C or B-D C-E )* 
  – **Operation 3**- Emergence of status
  – **Operation 4**- Coalition formation *(B,C- A)*
The Distribution of Power in Exchange Networks: Theory and Experimental Results

Cook et al.
Distribution of power

• Use of graph-theory and power dependency principles to understand power distribution in exchange networks
• Discusses issues with a lack of generality and two theoretic points
Theoretic points

1. A distinction between two different principles of “connection” in social networks suggests that current measures of centrality might predict power in one type of network, but not the other.

2. Offers a first step toward fusion of power-dependence theory and structural centrality in a way which might be general across networks of both types.
Connection types

**Positive**
- Positive if exchange in one relation is contingent upon exchange in the other
- Ex. Sales of merchandise

**Negative**
- Negative if exchange is contingent on non-exchange in the other
- Ex. Friendship networks
Boundaries and Positions

• Boundaries determined by network connections and allow for analysis of cascading repercussions within the network

• Actors are relatively independent decision makers occupying “positions”

• Position – a set of one or more points in the network/graph
Graph

• Actors are points on the graph
• Relations are lines connecting positions
• Parent graph – graph with all positions and connections
• Residual graph – graph with the removal of a specific position
Network structures studied by Cook et al.

(Focus on negatively connected networks)
Point centrality measures

• Degree-based
  – Dismissed as inadequate in determining power relations

• Betweenness
  – Accepted because it plays central role in connecting actors

• Closeness-based
  – Accepted because it relates actors beyond dyadic relationships
Hypothesis 1

- In the network portrayed in figure 1c, D > E > F in power if either closeness or betweenness measures are used.
Power and confidence

- Fundamental relationship between power and dependence
  \[ P_{AB} = D_{AB} \]

- \( P_{AB} \) - the power of A over B (\( P_{AB} \)) is the potention of A to obtain favorable outcomes at B’s expense

- \( D_{AB} \) – dependence of A on B is a joint function varying directly with the value of y to A and varying inversely with the availability of y to A from alternative sources
Hypothesis 2

• As the exchange process proceeds through time, the occupants of position E will display more power use than the occupants of positions F and D. This display of power will take two forms:
  – An increase over time in the amount of benefits received from exchange at position E
  – As a result, a greater absolute level of exchange benefit obtained by the occupant of position E by the final exchange phase
Hypothesis 3

• The differential power use of E over F will be displayed before the power use of E over D (since the latter process is, in theory, predicted to be a result of E’s power use over F)
Hypothesis 4

- In the final or stable phase of power use, the occupants of position E will exert equal levels of power over the occupants of positions F and D
Hypothesis 5

• The effects implied in hypotheses 2, 3, and 4 will be more pronounced under conditions of high exchange incentive than under conditions of low exchange incentive
Hypothesis 6

• E’s use of power over D will emerge more slowly in network 1d than in network 1c
Hypothesis 6 (cont.)

1(d) 7 person network (three positions)

1(c) 5 person network (three positions)
Hypothesis 7

• E’s use of power will emerge more quickly in network 1f than in 1e, where it will emerge more quickly than in 1d
Hypothesis 7 (cont.)

1(d) 7 person network  
(three positions)

1(e) 10 person network  
(three positions)

1(f) 13 person network  
(three positions)
Hypothesis 8

• E’s use of power over D will emerge more rapidly in network 1f than in 1e, where it will emerge more rapidly than in 1d
Hypothesis 8 (cont.)

1 (e) 10 person network (three positions)

1 (f) 13 person network (three positions)
Experiment and structure

- Electronic experiment where subjects proceeded through a series of exchanges in a controlled environment
- Subjects could only communicate and possibly exchange with those chosen by the researcher
- Equity principles were prevented from operating to allow for a natural progression of power and centrality
Findings

• Two best conventional measures of centrality failed to predict the distribution of power in the network

• A more general conception of point centrality needs to be developed or applied only in certain types of networks → conventional measures do not work with negatively connected networks

• Power dependency theory needs to be raised to the macroscopic level
Dependence and network vulnerability

• To what extent does the flow of valued resources within an N-actor network depend on facilitating exchange behavior by the occupants of a given position in that network?
• Concepts of vulnerability and “point vulnerability”
Dependence (cont.)

• Vulnerability – vulnerability of a network to the removal of a given point or line
  – Removal – any from of substantial withdrawal from the network
  – Point vulnerability – element in which if a point is removed, the residual graph has weakened or impaired resource flows
Dependence (cont.)

• In negatively connected networks, locates point of least dependence

• Point of least dependence = maximum network power → removal would isolate dependents from others
What does it all mean?

• Decentralization principle – exchange networks tend to form into systems organized around multiple foci of power, “regional centers”
  – More common in negatively connected networks

• Centralization more likely to occur than decentralization in positively connected networks
Power Centrality: A Family of Measures

Bonacich
Power centrality

- Focuses on bargaining and exchange networks
- General empirical method for measuring power centrality proposed by Cook et al.
Conventional centrality

• Those with connections to others that have many connections is most advantageous
• More connections allow for more options \(\rightarrow\) power
• Standard centrality measure of a unit:

\[
\lambda e_i = \sum_j R_{ij} e_j,
\]
Bonacich centrality

• Those with connections to others with less connections is most advantageous
• Less connections allows for initiator to have more leverage $\rightarrow$ power
• Bonacich measure of centrality in terms of $c(\alpha, \beta)$

$$
\sum_{k=1}^{\infty} \beta^{k-1}R^k_1 = \sum_{k=0}^{\infty} \beta^k R^{k+1}_1 = c(1, \beta),
$$
What it means

• Bonacich’s concept of power centrality in bargaining networks focuses on the opposite of conventional thinking

• Equation that is derived is the inverse of the standard measure of centrality
A Dilemma of State Power: Brokerage and Influence in the National Health Policy Domain

Fernandez & Gould
Brokerage and influence

- Occupying a broker position in communications networks within the US health policy domain is a crucial element of influence
- Brokerage position and impartiality is a central and constitutive element of state power
Brokerage

• The occupancy of a structural position that links pairs of otherwise unconnected actors

• Different roles depending on groups in which they belong
Relevance to policy domains

- Too many actors and organizations in the environment making it extremely unlikely that effective communications ties can be maintained
- May link pairs of actors who need to communicate as a result of specific policy initiatives that unexpectedly makes other interests independent
Hypotheses

• For all five brokerage types, actors who control two-step paths between pairs of other actors are perceived as more influential, on average, than other actors who do not.
• Among government organizations, the relationship between influence and occupancy of liaison and itinerant brokerage positions will be attenuated by a tendency to take stands on policy events.
Hypotheses (cont.)

• Among government organizations, the relationship between influence and occupancy of representative and gatekeeper brokerage positions will not be attenuated by a tendency to take stands on policy events.

• For nongovernment organizations, the relationship between influence and liaison, gatekeeper, representative, and itinerant brokerage position will be unaffected by advocacy of specific policies.
Last, but not least

• Hypothesis 5 – Taking stands on policy events will contribute to the influence of coordinators, whether or not they are government organizations.
Some methodology

• Influence reputation as dependent variable
  – Greatly related to brokerage power and leverage
  – Reputation is a resource

• Brokerage in this case is a variant of betweenness centrality

• Use of questionnaires, rosters, free recall, archival records

• Regression models to measure change in influence
Research findings

- Hypothesis 1 - Data indicates that brokers that can occupy multiple brokerage types are positively related to influence reputation.
- Hypothesis 2 – influence is reduced for each additional stance taken on policy events for gov’t organizations in liaison and itinerant brokerage positions.
Research findings (cont.)

• Hypothesis 3 – influence is not weakened by a record of taking stands on policy events for gov’t organizations in representative and gatekeeper brokerage positions

• Hypothesis 4 – none of the interaction terms between taking a stand and brokerage positions were unaffected for non-gov’t organizations ➔ all positions experienced changes in influence, increased
Research findings (cont.)

• Hypothesis 5 – taking stands on policy does increase influence as a coordinator
What does this all mean?

• Government actors with records of stands on policy events derive less influence because they lose the element of impartiality → impartiality is needed to maintain influence

• Non-governmental organizations are better able to promote their private agendas
Introduction

• The House of Medici: A political dynasty of Florence that was in power from early XV century to early XVIII (on and off)

• Authors use Social network analysis methods to explain the Rise of the Medici at the beginning of the XV century

• Centrality ideas crucial to their analysis, as centralization is a key process for state formation
Method

• The authors collect information (mostly from previous research and archives) about the different relationships between Florentine elite families

• Relations are recorded: *Kinship*: (1) Marriage; *Economic*: (2) Trading, (3) partnership, (4) bank employment, (5) real estate ties; *Political*: (6) Patronage, (7) personal loans; *Personal*: (8) Friendship, (9) surety ties.
Method (continued)

• Data on the attributes of the different families is recorded. Three attributes are important to the analysis: (1) Political Party affiliation: Medician, Oligarchs or Neutral, (2) political age of the family: Patricians vs. New Men and (3) Neighborhood: name of neighborhood where they live.

• Block modeling. They aggregate the different actors into structurally equivalent sets and end up with a reduced number of blocks (96 families to 34 blocks)
Results
“The capacity of marriage and economic blockmodels to predict political partisanship is remarkable” (pg 1275).
The Medici party was an extraordinary centralized, and simple “star” or “spoke” network system, with very few relations among Medici followers: the party consisted almost entirely of direct ties to the Medici family”(pg 1278).

C_B (marriage)=0.362
C_B(economic)=0.429

CB (marriage)=0.184
CB(economic)=0.198
Not only the members of the Medician network were connected between them only by the Medici family, they were also only connected to the rest of the elite (oligarchs) through the Medici family.
The density of the Oligarchs network proved to be a problem because “the oligarchs were composed of too many status equals, each with plausible network claims of leadership”.

Types of Ties:
- Marriage
- Partnership
- Bank Employment
- Trade
- Real Estate
The types of ties of the Medici reveals that they do not have both economic and kinship relationship with the same blocks. The either have an economic relation or a kinship relation but not both.
How did the Medici become the center of the network?

- Medici Family isolation (Ciompi Revolt)
- Marriage outside of neighborhood
- Relationships with New Men (within neighborhood)
### Evidence

#### TABLE 9

**SOCIAL ATTRIBUTES AND PARTISANSHIP OF TIES: MEDICI VERSUS SUPERELITE VERSUS SANTA CROCE FACTION LEADERS**

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#### ECONOMIC CLASS: WEALTH (in 1,000 Florins)

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<tr>
<td>Marriage (M) .................</td>
<td>.58</td>
<td>.76</td>
<td></td>
<td>.65</td>
<td>.73</td>
<td></td>
<td>.80</td>
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<tr>
<td>Friendship (F + M) ...........</td>
<td>.78</td>
<td>.76</td>
<td></td>
<td>.33</td>
<td>.57</td>
<td></td>
<td>.70</td>
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<tr>
<td>“Political” (L + P) ..........</td>
<td>.82</td>
<td>.62</td>
<td></td>
<td>.60</td>
<td>.18</td>
<td></td>
<td>.75</td>
<td>.50</td>
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<tr>
<td>Economic (T + P + B + R) .....</td>
<td>.84</td>
<td>.60</td>
<td></td>
<td>.80</td>
<td>.80</td>
<td></td>
<td>.78</td>
<td>.82</td>
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<tr>
<td>Total</td>
<td>.80</td>
<td>.68</td>
<td></td>
<td>.61</td>
<td>.62</td>
<td></td>
<td>.76</td>
<td>.72</td>
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</tbody>
</table>
# Evidence

**Elite Marriages over Time**

<table>
<thead>
<tr>
<th>Neighborhood by Estimated Date of Marriage</th>
<th>Overall</th>
<th>1395–1410</th>
<th>1411–20</th>
<th>1421–29</th>
<th>1430–34</th>
<th>No Date</th>
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<tbody>
<tr>
<td>Medici marriage strategies:</td>
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<td></td>
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</tr>
<tr>
<td>San Giovanni</td>
<td>4 (.143)</td>
<td>0</td>
<td>0</td>
<td>3</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Santo Spirito</td>
<td>10 (.357)</td>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>0</td>
</tr>
<tr>
<td>Santa Maria Novella</td>
<td>9 (.321)</td>
<td>2</td>
<td>4</td>
<td>2</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Santa Croce</td>
<td>5 (.179)</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Total</td>
<td>28</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>
Robust Action

• The action of the Medici, especially of Cosimo de´Medici, is described as robust because he never disclosed his interests and desires as this would limit the options of the party.

• Cosimo de´Medici is described as an “indecipherable sphinx” (pg 1262) and it is precisely this characteristic that helped him build a powerful party.

• The multivocality and ambiguity of his messages allowed him to gain support both from patricians and new men.
Conclusion

Relationship structures among people can explain complex social processes such as the centralization of power and state formation.

“(…)to understand state building, we have argued, one needs to penetrate beneath the veneer of formal institutions and apparently clear goals, down to the relational substratum of people’s actual lives” (pg, 1310).
Introduction

- Studies the dynamics by which network structures create and reproduce gender inequalities in organizations.

- Reviews the existing literature about how network structure can predict sex differences and derives five hypotheses to be tested with empirical evidence.
Method

• Survey performed to 79 employees of an advertising company.

• Asked about five different types of relationships between employees: (1) communication, (2) advice, (3) support, (4) influence, and (5) friendship.

• 1,3,5 are instrumental

• 2,4 are expressive
Method (continued)

• Attribute data for all the participants of the survey is also collected:
  
• Gender, prestige, professional activity, tenure, education, rank and department.

• Properties of the individual’s choices (homophily and multiplexity) and indices of centrality were calculated for each individual.

• Homophily is the preference to interact with others of the same sex and multiplexity refers to the variety of the types of interaction (instrumental, expressive).

• Centrality is (in most cases) dependent variable and the measure of “aggregate prominence” (Burt, 1987)
Preliminary Results

Table 2

Means, Standard Deviations, and Correlations among All Variables ($N = 79$)

<table>
<thead>
<tr>
<th>Variables</th>
<th>Means</th>
<th>S.D.</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
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</tr>
<tr>
<td>1. Communication</td>
<td>.38</td>
<td>.31</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
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<td></td>
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<tr>
<td>2. Advice</td>
<td>.25</td>
<td>.31</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>3. Support</td>
<td>.45</td>
<td>.25</td>
<td></td>
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<tr>
<td>4. Influence</td>
<td>.10</td>
<td>.25</td>
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<tr>
<td>5. Friendship</td>
<td>.42</td>
<td>.33</td>
<td></td>
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<tr>
<td>6. Gender</td>
<td>.43</td>
<td>.50</td>
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<td>7. Prestige</td>
<td>.23</td>
<td>.42</td>
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<tr>
<td>8. Professional</td>
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<tr>
<td>9. Tenure</td>
<td>4.85</td>
<td>4.32</td>
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<td>10. Education</td>
<td>1.98</td>
<td>.61</td>
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<tr>
<td>11. DEPT1</td>
<td>.32</td>
<td>.47</td>
<td></td>
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<tr>
<td>12. DEPT2</td>
<td>.30</td>
<td>.46</td>
<td></td>
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<tr>
<td>13. DEPT3</td>
<td>.38</td>
<td>.49</td>
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<tr>
<td>14. Rank</td>
<td>3.09</td>
<td>1.29</td>
<td></td>
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</tr>
</tbody>
</table>

Correlation between centrality and gender

$p < .05; \bullet p < .01; \bullet\bullet p \leq .001.$
Hypothesis1:

- Controlling for availability, women will tend to choose women as expressive network contacts but will choose men as instrumental network contacts. Men will tend predominantly to choose men across multiple networks.

Table 3

<table>
<thead>
<tr>
<th>Homophily indices</th>
<th>Means*</th>
<th>T-value</th>
<th>d.f.</th>
<th>Unstandardized regression coefficients (N = 79)†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Women (N = 45)</td>
<td>Men (N = 34)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>HComm</td>
<td>−.03 (.49)</td>
<td>.21 (.78)</td>
<td>−6.90***</td>
<td>.39*** (.06)</td>
</tr>
<tr>
<td>HAdvice</td>
<td>−.05 (.42)</td>
<td>.22 (.86)</td>
<td>−8.43***</td>
<td>.40*** (.05)</td>
</tr>
<tr>
<td>HSupport</td>
<td>−.003 (.55)</td>
<td>.17 (.71)</td>
<td>−5.65***</td>
<td>.19*** (.05)</td>
</tr>
<tr>
<td>HInfluence</td>
<td>−.09 (.33)</td>
<td>.22 (.90)</td>
<td>−10.90***</td>
<td>.39*** (.04)</td>
</tr>
<tr>
<td>HFriend</td>
<td>.06 (.76)</td>
<td>.14 (.73)</td>
<td>−2.57*</td>
<td>.17*** (.04)</td>
</tr>
</tbody>
</table>

*p < .05; **p < .01; ***p ≤ .001.
*Values in bold in parentheses are cites to same sex others, as a proportion of total ties, unadjusted for availability.
† Unstandardized regression coefficients are reported for gender with homophily indices as dependent variables. All control variables (i.e., education, tenure, professional activity, prestige, department, rank) are included in the regression models; standard errors are in parentheses.

Significantly different means- Men direct their relationships more to men (positive mean) while women direct all but their friendship relations to the opposite sex (negative mean).
Hypothesis 2:

- *Men will have more multiplex network ties, in total than women, as well as more multiplex ties to men than women have to women.*

Table 4

**Differences between Men and Women in Multiplexity**

<table>
<thead>
<tr>
<th>Multiplexity indices</th>
<th>Means</th>
<th>$T$-value</th>
<th>Unstandardized regression coefficients (N = 79)*</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Women (N = 45)</td>
<td>Men (N = 34)</td>
<td>d.f. = 70</td>
</tr>
<tr>
<td>Total multiplexity</td>
<td>2.15</td>
<td>2.23</td>
<td>−.63</td>
</tr>
<tr>
<td>Multiplexity of ties to same sex</td>
<td>2.02</td>
<td>2.42</td>
<td>−2.42</td>
</tr>
</tbody>
</table>

* $p < .05$; $\bullet p < .01$.

* Unstandardized coefficients are reported for gender with multiplexity indices as dependent variables. All control variables (i.e., education, tenure, professional activity, prestige, department, rank) are included in the regression model; standard errors are in parentheses.

Different multiplexity only on relations to same sex (homophily). Men have instrumental and expressive relations with men. Women have only expressive relations with women (no women for instrumental relations)
Hypothesis 3 and 4:

- **Men will hold more central network positions than women in workplace interaction networks.**
- **Differences in centrality will be higher in instrumental networks than in expressive networks.**

Table 5

<table>
<thead>
<tr>
<th>Centrality indices</th>
<th>Means*</th>
<th>7-value</th>
<th>Unstandardized regression coefficients (N = 79)†</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Women (N = 45)</td>
<td>Men (N = 34)</td>
<td>d.f. = 70</td>
</tr>
<tr>
<td>Communication</td>
<td>.26</td>
<td>.55</td>
<td>-4.63***</td>
</tr>
<tr>
<td></td>
<td>(3.9)</td>
<td>(8.7)</td>
<td></td>
</tr>
<tr>
<td>Advice</td>
<td>.10</td>
<td>.45</td>
<td>-6.11***</td>
</tr>
<tr>
<td></td>
<td>(2.0)</td>
<td>(6.8)</td>
<td></td>
</tr>
<tr>
<td>Support</td>
<td>.35</td>
<td>.59</td>
<td>-4.69***</td>
</tr>
<tr>
<td></td>
<td>(3.9)</td>
<td>(7.5)</td>
<td></td>
</tr>
<tr>
<td>Influence</td>
<td>.02</td>
<td>.21</td>
<td>-3.53***</td>
</tr>
<tr>
<td></td>
<td>(1.2)</td>
<td>(6.2)</td>
<td></td>
</tr>
<tr>
<td>Friendship</td>
<td>.32</td>
<td>.56</td>
<td>-3.38***</td>
</tr>
<tr>
<td></td>
<td>(2.3)</td>
<td>(3.9)</td>
<td></td>
</tr>
</tbody>
</table>

* p < .05; ** p < .01; *** p < .001.

* Degree centrality scores, i.e., the raw number of nominations, are reported in parentheses.

† Unstandardized regression coefficients are reported for gender with centrality indices as dependent variables. All control variables (i.e., education, tenure, professional activity, prestige, department, rank) are included in the regression model; standard errors are in parentheses.

Significantly different means but not significant when controlled by other variables (human capital)

Notice low centrality of women on instrumental networks (advise, influence)
Hypothesis 5:  

- Men will receive greater network returns on their individual and positional resources than women.

Table 6

Regression of Centrality on Independent Variables within Sex Groups*

<table>
<thead>
<tr>
<th>Independent variables</th>
<th>Women (N = 45)</th>
<th>Centrality Indices</th>
<th>Men (N = 34)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Communication</td>
<td>Advice</td>
<td>Support</td>
</tr>
<tr>
<td>Professional activity</td>
<td>.05</td>
<td>.07</td>
<td>-.01</td>
</tr>
<tr>
<td>(.05)</td>
<td>(.04)</td>
<td>(.04)</td>
<td>(.08)</td>
</tr>
<tr>
<td>Prestige</td>
<td>-.01</td>
<td>.03</td>
<td>.09</td>
</tr>
<tr>
<td>(.12)</td>
<td>(.10)</td>
<td>(.10)</td>
<td>(.19)</td>
</tr>
<tr>
<td>Tenure</td>
<td>.004</td>
<td>.01</td>
<td>.02*</td>
</tr>
<tr>
<td>(.01)</td>
<td>(.01)</td>
<td>(.01)</td>
<td>(.01)</td>
</tr>
<tr>
<td>Education</td>
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<td>(.07)</td>
</tr>
<tr>
<td>DEPT2</td>
<td>.17**</td>
<td>.05</td>
<td>.05</td>
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<tr>
<td>(.09)</td>
<td>(.07)</td>
<td>(.08)</td>
<td>(.14)</td>
</tr>
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<td>DEPT3</td>
<td>.14</td>
<td>.01</td>
<td>.14*</td>
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<tr>
<td>(.08)</td>
<td>(.07)</td>
<td>(.08)</td>
<td>(.14)</td>
</tr>
<tr>
<td>Rank</td>
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<td>.08***</td>
</tr>
<tr>
<td>(.03)</td>
<td>(.02)</td>
<td>(.02)</td>
<td>(.04)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>.55***</td>
<td>.48***</td>
<td>.47***</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>.46</td>
<td>.37</td>
<td>.37</td>
</tr>
<tr>
<td>AVHomophily</td>
<td>-.110*</td>
<td>-.62</td>
<td>-1.22**</td>
</tr>
<tr>
<td>(.50)</td>
<td>(.45)</td>
<td>(.43)</td>
<td>(.81)</td>
</tr>
<tr>
<td>Multiplexity to same sex</td>
<td>.06</td>
<td>.05</td>
<td>.04</td>
</tr>
<tr>
<td>(.05)</td>
<td>(.05)</td>
<td>(.04)</td>
<td>(.08)</td>
</tr>
<tr>
<td>$R^2$</td>
<td>.61***</td>
<td>.51**</td>
<td>.60***</td>
</tr>
<tr>
<td>$\Delta R^2$</td>
<td>.06*</td>
<td>.03</td>
<td>.13***</td>
</tr>
<tr>
<td>Adjusted $R^2$</td>
<td>.50</td>
<td>.37</td>
<td>.49</td>
</tr>
</tbody>
</table>

* $p < .10$; **$p < .05$; ***$p < .01$; ****$p < .001$.
* Unstandardized regression coefficients; standard errors are in parentheses.
Hypothesis 5 (continued):

Table 7

Tests of Equality of Regression Slopes across Sex Groups ($N = 79$)*

<table>
<thead>
<tr>
<th>Interaction terms</th>
<th>Communication</th>
<th>Advice</th>
<th>Support</th>
<th>Friendship</th>
</tr>
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<tbody>
<tr>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Sex * Professional activity</td>
<td>-</td>
<td>.03**</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td></td>
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<td>(.06)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sex * Rank</td>
<td>-</td>
<td></td>
<td>.03*</td>
<td>-</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>(.02)</td>
<td></td>
</tr>
<tr>
<td>Sex * AVHomophily</td>
<td>.85*</td>
<td>-</td>
<td>1.19***</td>
<td>1.68**</td>
</tr>
<tr>
<td></td>
<td>(.48)</td>
<td></td>
<td>(.43)</td>
<td>(.79)</td>
</tr>
<tr>
<td>$\Delta R^2$</td>
<td>.014*</td>
<td>.02*</td>
<td>.04***</td>
<td>.04**</td>
</tr>
</tbody>
</table>

* $p < .10$; **$p < .05$; ***$p < .01$.

* Unstandardized regression coefficients; standard errors are in parentheses. Control variables are the same as in Table 6.

Interaction of sex and professional activity and sex an rank explains centrality for the advice network.
Conclusion

“Sex differences in homophily and rates of return to individual and positional resources operate to create and reinforce gender inequalities in the organizational distribution of power” (pg.444)

• There is a relationship between network structure and female exclusion.
• Men are more likely to form homophilous and multiplex networks while women are more likely to relate with men for their instrumental relations and women for their expressive relations.
• These dynamics place men on more central positions in the support networks.
• Men get higher returns (measured in centrality) to their investments on human capital.
Introduction

• This article explores the relationship between structural variables (at the individual level) and the influence of individuals in networks.

• Focuses specifically on structure characteristics as determinants of individual influence rather than individual attributes.

• Evaluates the structural positions of the individuals within different social networks (workflow network, communication network and friendship network) and relates them with influence.
Method

• Surveys of 140 nonsupervisory employees and their supervisors were conducted in an advertising company.
• The researcher observed the interactions of the employees to make sure the data was reliable.
• The nonsupervisory questionnaires gathered information to assess the individual position in the network structure (independent variable).
• Three different networks (workflow network, communication network and friendship network) are analyzed using different units of reference (workgroup, department and organization).
• The supervisors questionnaires and information about the promotion of employees (three years after the survey was conducted) are used to measure the influence (dependent variables)
Independent Variables

• Centrality: Closeness (access) and betweenness (control)
• Department membership
• Contacts beyond workflow
• Relation with dominant coalition
• Criticality of task
• Transaction alternatives
• Distance from boundary
Dependent Variables

- Supervisory evaluations of influence
- Nonsupervisory evaluations of influence
- History of promotions
### Results (zero-ordered correlations and coefficients)

#### Relationships between Structural Measures and Measures of influence

<table>
<thead>
<tr>
<th>Structural measures</th>
<th>Supervisors’ ratings of influence</th>
<th>Nonsupervisors’ listings</th>
<th>Promotion</th>
</tr>
</thead>
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<td><strong>Workflow</strong></td>
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<tr>
<td>Criticality</td>
<td>52**</td>
<td>(.480)**</td>
<td>36**</td>
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<tr>
<td>Transaction alternatives</td>
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<td>(.265)**</td>
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<td>Access</td>
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<tr>
<td>Access</td>
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<td>06</td>
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<tr>
<td>Control</td>
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<td>(-.094)</td>
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<td><strong>Organization</strong></td>
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<tr>
<td>Access</td>
<td>-08</td>
<td>(.258)**</td>
<td>-07</td>
</tr>
<tr>
<td>Control</td>
<td>-19*</td>
<td>(.079)</td>
<td>-04</td>
</tr>
<tr>
<td><strong>Distance from organizational boundary</strong></td>
<td>-16</td>
<td>(.101)</td>
<td>-17*</td>
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</table>

#### Communication

| Workgroup                    |      |      |      |      |      |      |
| Access                      | 17*  | (.151) | 18*  | (.070) | 20*  | (-.047) |
| Control                     | 06   | (-.073) | 13   | (-.060) | 25** | (.165)* |
| **Department**              |      |      |      |      |      |      |
| Access                      | 35** | (.331)* | 35** | (.116) | 28** | (.092)  |
| Control                     | 33** | (.013) | 46** | (.235) | 62** | (.875)** |
| **Organization**            |      |      |      |      |      |      |
| Access                      | 12   | (-.150) | 25** | (.115) | 17*  | (.010)  |
| Control                     | 22** | (.077) | 35** | (-.060) | 33** | (-.457)** |
| **Dominant coalition**      |      |      |      |      |      |      |
| Access                      | 46** | (.261)** | 39** | (.196)* | 28*  | (.038)  |
| Control                     | 26** | (-.025) | 41** | (.165) | 36** | (.027)  |
| **Contacts beyond workflow**|      |      |      |      |      |      |
| 24** | (.011) | 21** | (-.236)* | 10   | (-.084) | 18   |      |

| Department membership*     | 46** | (.011) | 21** | (-.236)* | 10   | (-.084) | 18   |      |

| Adjusted $R^2$             | 56** | 40** |

*p ≤ .05; **p ≤ .01;
*Represents a multiple correlation.
### Table 3

**Comparison of Relationships with Influence for Boundary Spanning and Technical Core Positions**

<table>
<thead>
<tr>
<th>Structural Measures</th>
<th>Boundary Spanning (n=76)</th>
<th>Technical Core (n=64)</th>
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<tbody>
<tr>
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<td>Control</td>
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<td>29**</td>
</tr>
<tr>
<td>Contacts beyond workflow</td>
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</table>

\*p ≤ .05; \**p ≤ .01.
Conclusion

• “Overall, the results of this study provide strong support for viewing individual influence from a structural perspective” (pg. 534). The numerous significant variables suggest that there are several structural sources of influence.

• In other words, “being in the right place” matters.