Network Brokerage and Competitive Advantage: First Two Rules of Social Capital

Appendices:


II. Measuring Access to Structural Holes (pages 50-56, from 1992, Structural Holes, 2010 Neighbor Networks)


IV. Assignments for Second Class Session (pages 59-60)

For text on this session, see Chapters 1 and 2 in Brokerage and Closure (including adjunct bits from Neighbor Networks).
This is Generic Organization Chart Showing the Formal Network in a Hypothetical Company

CEO

COO

CFO

HR

Americas

Asia

Europe

North

South

Seeds

Crop Protection

Seed Treatment

Farm Management

Corn

Soybeans

Other
Sociogram of Formal Network in a Large EU Healthcare Company

- **CEO**
- **C-Suite**
- **Heir Apparent**
- **Other, Respondent**
- **Other, NonRespondent**
Social Network at the Top of the Company

Lines indicate frequent and substantive work discussion; heavy lines especially close relationships.

Figure 2 in Burt, "Network disadvantaged entrepreneurs" (Entrepreneurship Theory & Practice, 2019)
To begin, the "network" around a person is a pattern of relationships with and between colleagues.

This worksheet is completed in four steps:

(1) In the oval, write the name of a significant colleague. The colleague could be your most valuable subordinate, your most difficult, your boss, an important source of support, or a key contact in another organization. Who doesn't matter. It just has to be someone you know well enough to know their key contacts.

(2) In the squares, write the name of the five contacts with whom the person in the oval has the most frequent and substantial business contact.

(3) Draw a line between any pair of contacts that are connected in the sense that the two people speak often enough that they have some familiarity with current issues in one another's work.

(4) Compute network density (# / #possible). Count the number of lines between contacts. Divide by the number possible (n[n-1]/2, where n is number of contacts, which is 5 if you entered five contacts). Multiply by 100 and round to nearest percent.

\[ \text{DENSITY} = \frac{\text{# lines}}{\frac{n(n-1)}{2}} \times 100 \]

SOCIOGRAM graphic image of a network in which dots represent nodes (a person, group, etc.) and lines represent connections.
Network & Information
Contacts as Source vs. Portal

Network A

Network B

Network C

Redundancy by Cohesion

Contact Redundancy

Redundancy by Structural Equivalence

from Figures 1.1 and 1.3 in Burt (1992, Structural Holes) and Figure 1.2 in Brokerage and Closure
Network Constraint
\[ C = \Sigma c_{ij} = \Sigma_j [p_{ij} + \Sigma_q p_{iq}p_{qj}]^2, \ i, j \neq q \]

Density Table

<table>
<thead>
<tr>
<th></th>
<th>Group A</th>
<th>Group B</th>
<th>Group C</th>
<th>Group D</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>100</td>
<td></td>
<td></td>
</tr>
<tr>
<td>25</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>85</td>
<td>5</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

person 3: \[.402 = [.25+0]^2 + [.25+.084]^2 + [.25+.091]^2 + [.25+.084]^2\]

Robert: \[.148 = [.077+0]^2 + [.154+0]^2 + [.154+0]^2 + [.154+0]^2 + [.154+0]^2 + [.154+0]^2 + [.154+0]^2\]

Network indicates distribution of sticky information, which defines advantage.
Network models of advantage are grounded in two facts about the social distribution of information from the 1950s “golden age” of social psychology (e.g., Festinger, Schachter & Back, 1950; Asch, 1951; Leavitt, 1951; Katz & Lazarsfeld, 1955): (1) **people cluster into groups as a result of interaction opportunities defined by the places where people meet**, and (2) **communication is more frequent and influential within than between groups** so that people in the same group develop similar views.

People tire of repeating arguments and stories explaining why they believe and behave the way they do. Within a group, people create systems of phrasing, opinions, symbols and behaviors defining what it means to be a member. Beneath the familiar arguments and experiences are new, emerging arguments and experiences awaiting a label, the emerging items more understood than said within the group. What was once explicit knowledge interpretable by anyone becomes tacit knowledge meaningful primarily to insiders. With continued time together, information in the group becomes “sticky” – nuanced, interconnected meanings difficult to understand in other groups (Von Hippel, 1994). Much of what we know is not easily understood beyond the colleagues around us. Holes tear open in the flow of information between groups. These holes in the social structure of communication, or more simply “structural holes” (Burt, 1992), are missing relations indicating where information is likely to differ on each side of the hole and not flow easily across the hole. In short, the bridge and cluster structure in social networks indicates where information is relatively homogeneous (within cluster) and where information is likely to be heterogeneous (between clusters).

From Burt, "Network disadvantaged entrepreneurs" (Entrepreneurial Theory and Practice, 2019, page 22)
JIM is a WARLORD in US BUSINESS, Illustrating Rule 3 of Network Advantage:
Close the network around your contacts to promote trust and efficiency.
NETWORK BROKERS, Illustrating

BOB and YANJIE Are

Rule 1: Broaden your network across structural holes between groups (creating information advantages of breadth, timing, and arbitrage across groups) to promote innovation and growth.

(Huateng "Pony" Ma, founder-CEO Tencent)
Create Value by Bridging Structural Holes

STICKY INFORMATION
Information expensive to move because: (a) tacit, (b) complex, (c) requires other knowledge to absorb, or (d) interaction with sender, recipient, or channel.

STRUCTURAL HOLE
disconnection between two groups or clusters of people

BRIDGE
relation across structural hole

NETWORK ENTREPRENEUR
or "broker," or "connector:" a person who coordinates across a structural hole

BROKERAGE
act of coordinating across a structural hole

Research shows that employees in networks like the AFTER network, spanning structural holes, are the key to integrating operations across functional and business boundaries. In research comparing senior people with networks like these BEFORE and AFTER networks, it is the AFTER networks that are associated with more creativity, faster learning, more positive individual and team evaluations, faster promotions, and higher earnings.

*Network scores refer to direct contacts.

From Figure 1.4 in Burt (1992 Structural Holes), and Figure 1.2 in Brokerage and Closure. See Appendix I on survey network data, Appendix IV on measuring network constraint.
MEASUREMENT: contrast is between people rich in access to structural holes versus people without

(cosmopolitans vs locals in Merton 1949; opinion leaders vs followers in Katz & Lazarsfeld 1955; extensive vs intensive search in Rees 1966; leaders vs managers in Kotter 1990; exploration vs exploitation in March 1991; cultural omnivores vs univores in Peterson 1992; open vs closed networks, on the edge of worlds vs at the center; and of course, Schumpeter's 1911 touchstone image of entrepreneurial "leaders" bringing together elements from separate production spheres within which people live by routines)

Disconnected contacts provide rich access to structural holes

Here network constraint – the extent to which a person’s network is limited to a single group, which means they have no access to structural holes (other popular measures are size, density, and ego-network betweenness).

Data are easily available from surveys, 360°, email, and other electronic trace (badges, chat rooms, social media, virtual worlds, etc.).

See Appendix I on network survey data, and Appendix IV on measuring access to structural holes.
In-Class Worksheet for Network Metrics

Ego is not presented. These are just ego's key contacts. All connections are symmetric and binary ($z_{ei} = z_{ej} = 1$).

EgoNetwork Betweenness = $\sum_i \sum_{j>i} \frac{[z_{ei} z_{ej} - z_{ij}]}{\sum_k z_{ki} z_{kj}}$, $k \neq i, j$, and index $k$ includes ego $e$. Scores are on page 54.

<table>
<thead>
<tr>
<th>Size (degree)</th>
<th>Density (# / #possible)</th>
<th>Betweenness (holes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>____</td>
<td>____</td>
<td>____</td>
</tr>
<tr>
<td>____</td>
<td>____</td>
<td>____</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Size (degree)</th>
<th>Density (# / #possible)</th>
<th>Betweenness (holes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>____</td>
<td>____</td>
<td>____</td>
</tr>
<tr>
<td>____</td>
<td>____</td>
<td>____</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Size (degree)</th>
<th>Density (# / #possible)</th>
<th>Betweenness (holes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>____</td>
<td>____</td>
<td>____</td>
</tr>
<tr>
<td>____</td>
<td>____</td>
<td>____</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Size (degree)</th>
<th>Density (# / #possible)</th>
<th>Betweenness (holes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>____</td>
<td>____</td>
<td>____</td>
</tr>
<tr>
<td>____</td>
<td>____</td>
<td>____</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Size (degree)</th>
<th>Density (# / #possible)</th>
<th>Betweenness (holes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>____</td>
<td>____</td>
<td>____</td>
</tr>
<tr>
<td>____</td>
<td>____</td>
<td>____</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Size (degree)</th>
<th>Density (# / #possible)</th>
<th>Betweenness (holes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>____</td>
<td>____</td>
<td>____</td>
</tr>
<tr>
<td>____</td>
<td>____</td>
<td>____</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Size (degree)</th>
<th>Density (# / #possible)</th>
<th>Betweenness (holes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>____</td>
<td>____</td>
<td>____</td>
</tr>
<tr>
<td>____</td>
<td>____</td>
<td>____</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Size (degree)</th>
<th>Density (# / #possible)</th>
<th>Betweenness (holes)</th>
</tr>
</thead>
<tbody>
<tr>
<td>____</td>
<td>____</td>
<td>____</td>
</tr>
<tr>
<td>____</td>
<td>____</td>
<td>____</td>
</tr>
</tbody>
</table>
Network Metrics for More Usual Network

Graph plots ego-network betweenness scores against network constraint scores for a probability sample of 700 Chinese entrepreneurs (see slide 34 and results in second course handout, "Brokerage Contingencies").

Network Betweenness

few ——— Structural Holes ——— many

Network Constraint

many ——— Structural Holes ——— few

Ego is not presented.
These are just ego’s six key contacts.

_____ Size
_____ Density
_____ Betweenness
Now to establish the empirical fact that the people known as "network brokers" enjoy achievement and rewards higher than their peers.

Brokers are to the left on the horizontal axis contrasting open with closed networks.
Achievement and rewards are distinguished on the vertical axis, measuring the extent to which a person is doing better than his or her peers.
Business Success Decreases as the Network Around a Person Closes

Define Z-Score

Z-Score Relative Performance

Raw Performance Indicator (compensation, evaluation, promotion rate)

Manager Background (e.g., job rank, age, geography, kind of work, organization division, education, etc.)

Bob's performance is higher than expected
Jim's performance is lower than expected

Managers in the U.S. (n = 2085, 7 study pops, r = -.75)

Network Constraint (x 100)
many ——— Structural Holes ——— few

NOTE — Plotted data are average scores within five-point intervals of network constraint within each study population (2018 survey added to Burt, Social Networks 2019: Figure 1; see footnote 2 there for data sources; cf. Figure 1.8 in Brokerage and Closure). Correlations are computed from the plotted data using log network constraint. Inset graph to the upper left contains hypothetical data illustrating computation of z-score relative performance.
Business Success Decreases as the Network Around a Person Closes

Define Z-Score

Manager Background (e.g., job rank, age, geography, kind of work, organization division, education, etc.)

- Managers in the U.S. (n = 2085, 7 study pops, r = -.75)
- Managers in Europe (n = 1094, 3 study pops, r = -.73)

NOTE — Plotted data are average scores within five-point intervals of network constraint within each study population (2018 survey added to Burt, Social Networks 2019: Figure 1; see footnote 2 there for data sources; cf. Figure 1.8 in Brokerage and Closure). Correlations are computed from the plotted data using log network constraint. Inset graph to the upper left contains hypothetical data illustrating computation of z-score relative performance.
Business Success Decreases as the Network Around a Person Closes

Define Z-Score

Raw Performance Indicator (compensation, evaluation, promotion rate)

Manager Background (e.g., job rank, age, geography, kind of work, organization division, education, etc.)

Bob’s performance is higher than expected

Jim’s performance is lower than expected

Managers in the U.S. (n = 2085, 7 study pops, r = -.75)

Managers in Europe (n = 1094, 3 study pops, r = -.73)

Managers in Asia, mostly China (n = 1342, 3 study pops, r = -.78)

NOTE — Plotted data are average scores within five-point intervals of network constraint within each study population (2018 survey added to Burt, Social Networks 2019: Figure 1; see footnote 2 there for data sources; cf. Figure 1.8 in Brokerage and Closure). Correlations are computed from the plotted data using log network constraint. Inset graph to the upper left contains hypothetical data illustrating computation of z-score relative performance.
Returns to Brokerage Aggregate to Companies, Industries, and Communities

People with phone networks that span structural holes live in communities higher in socio-economic rank

Networks are defined by land-line & mobile phone calls (map to left). Socio-economic rank is UK government index of multiple deprivation (IMD) based on local income, employment, education, health, crime, housing, and environmental quality (graph below). Units are phone area codes.

figures from Eagle, Macy, and Claxton (2010 Science), “Network diversity and economic development”
Returns to Brokerage Are Also Evident in Online Networks.

These are the returns to brokerage in two virtual worlds.

Dots are average Y scores within integer (left) or five-point (right) intervals on horizontal axis. *EverQuest II* achievement variable is the predicted character level in Model 8, Tables 3.4 and 3.5. *Second Life* achievement is the canonical correlation dependent variable in Model 15, Tables 3.5 and 3.6.

from Burt (2020 *Structural Holes in Virtual Worlds*).
Returns to Brokerage Are Evident in Low Returns to Over-Specialized Students

Recent scholarship on the returns to labor market specialization often claims that being specialized is advantageous for job candidates. We argue, in contrast, that a specialist discount may occur in contexts that share three features: strong institutionalized mechanisms, candidate profiles with direct investments that signal their value, and a high supply of focused candidates relative to demand. We then test whether there is a specialist discount for graduating elite MBAs, as it is a labor market that exemplifies these conditions under which we expect specialists to be penalized. Using rich data on two graduating cohorts from a top-tier U.S. business school (full-time students, 2008-2009), we show that elite MBA graduates who established a focused (specialized) market profile of experiences relating to investment banking before and during the program were less likely to receive multiple job offers and were offered less in starting-bonus compensation than similar MBA candidates with no exposure or less-focused exposure to investment banking. Our theory and findings suggest that the oft-documented specialist advantage may be overstated.

Figure 1 displays predicted (marginal) probabilities of receiving multiple offers for candidates who have mean values for each of the control variables but different profiles.

Figure 2 compares the starting bonuses of hypothetical job candidates with different profiles. Each hypothetical candidate is a single white male who graduated from a top-20 undergraduate institution, has above a 3.8 GPA, received more than one job offer, has the mean age and work experience characteristics (months, number of firms), accepts a job in I-banking, and earns the mean base salary for I-banking jobs in his 2008 cohort year. The only difference is the candidate’s profile in terms of exposure to I-banking.

FOCUSED (career history in finance before mba, concentration in finance, joined an i-banking club during mba, and i-banking internship; 61% of students who graduate to a job in I-banking were focused on I-banking)

NON-SEQUENTIAL exposure (neither of the above categories, but some mba program contact with I-banking)

PARTIAL sequential exposure (prior experience in finance + concentration in finance or participation in I-banking club)

PRE-MBA exposure (only exposure before mba program)

Figures and text are from Merluzzi and Phillips (2016 Administrative Science Quarterly), “The Specialist Discount.” For more applied discussion, see Merluzzi, (June 2016 HBR), “Generalists get better job offers than specialists.” Looking later in the career, Kleinbaum (2012 ASQ) “Organizational misfits,” shows with email data that managers with unusual patterns of communication are most likely to emerge the valued network brokers.
Competitive Advantage in Social Networks and Stigler’s “Economics of Information,” *JPE* 1961*

"The expected saving from given search will be greater, the greater the dispersion of prices." When price varies greatly between sellers, it is worth a buyer’s time to search for the lowest price. It makes no sense to search for the lowest price of a commodity good; all prices are similar.

The potential value of search is an incentive for entrepreneurs to aggregate price information by enforcing localized transactions, as in medieval markets, or by becoming "specialized traders whose chief service, indeed, is implicitly to provide a meeting place for potential buyers and sellers."

In short, the value of search is proportional to information variation, and search is more productive for people more exposed to the variation.

As referenced in Stigler’s 1982 Nobel acceptance speech: "The proposal to study the economics of information was promptly and widely accepted, and without even a respectable minimum of controversy." "All I had done was to open a door to a room that contained many fascinating and important problems."

*Discussed in Burt and Soda, "The social origins of great strategies" (*Strategy Science*, 2017). Photo is from University of Chicago Photographic Archive [apf1-07960], Special Collections Research Center, University of Chicago Library.
Evidence of Slightly-Sticky Information: Variation in fish prices before and after cell phones are available to fishermen and wholesalers.

Weekly surveys were conducted with sample wholesalers in three regions for a common category of fish sold (sardines). Regions are administrative districts in the Indian state of Kerala.

Figure 4 in Jensen, "The digital divide: information (technology), market performance, and welfare in the south Indian fisheries sector" (2007 Quarterly Journal of Economics).
HOW IT WORKS: Creativity and Innovation Are at the Heart of It

Brokerage across Structural Holes

Creativity & Innovation
(What should be done?)

Adaptive Implementation
(How to frame it & who should be involved?)

Achievement & Rewards
(What benefits?)

What in your work improves the odds that you will discover the value of something you don't know you don't know?

Alternative Perspective
(how would this problem look from the perspective of a different group, or groups — thinking “out of the box” is often less valuable than seeing the problem as it would look if you were inside a specific “other box”)

Best Practice
(something they think or do could be valuable in my operations)

Analogy
(something about the way they think or behave has implications for how I can enhance the value of my operations; i.e., look for the value of juxtapositioning two clusters, not reasons why the two are different so as to be irrelevant to one another — you often find what you look for)

Synergy
(resources in our separate operations can be combined to create a valuable new idea/practice/product)

Illustration: Where did the M-16 come from?

Consequential ideas are typically attributed to special people, geniuses, in part to make us feel less uncomfortable about our own ideas. True to form, an American armament expert describes Eugene Stoner, the engineer who developed the M-16 assault rifle, as "an engineering genius of the first order." Another describes him as "the most gifted small-arm designer since Browning." (Browning patented the widely-adopted BAR and 45 automatic.)

1. Based on the brief history video, how would you describe Stoner's genius?
2. What circumstances might allow you or your colleagues to be as creative?

*Photos are from the video shown during the session. For discussion and references, see page 73 in Brokerage and Closure. For sampling on the dependent variable, see Rosenzweig, "Misunderstanding the nature of company performance: the halo effect and other business delusions," 2007 California Management Review.
Brokerage, Good Ideas, and Innovation, Digging a Little Deeper

from Figure 2.1 in Brokerage and Closure (or Figure 5 in Burt, "Structural holes and good ideas," 2004 American Journal of Sociology, point is elaborated in Burt and Soda, "The social origins of great strategies," 2017 Strategy Science).
## Network Brokers Use More Familiar Language

<table>
<thead>
<tr>
<th></th>
<th>Network Brokers:</th>
<th>Clique Managers:</th>
<th>Probability</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Relatively</td>
<td>Average</td>
<td>Relatively Closed</td>
</tr>
<tr>
<td></td>
<td>Open Networks</td>
<td>Networks</td>
<td>Networks</td>
</tr>
<tr>
<td>Familiar Text</td>
<td>56.32</td>
<td>46.67</td>
<td>34.34</td>
</tr>
<tr>
<td>Idea Dismissed</td>
<td>14.38%</td>
<td>36.94%</td>
<td>43.42%</td>
</tr>
</tbody>
</table>

NOTE — Columns distinguish the bottom, middle, and top third of supply-chain managers on network constraint (horizontal axis in the two graphs on the previous page). “Familiar Text” is the number of words in a manager’s text that are familiar in the sense that they are found in the LIWC language software dictionary. Probability test is based on a -9.49 z-score from a Poisson regression of word count over the three network categories (-1, 0, and 1), controlling for number of words in the manager’s idea text. “Idea Dismissed” is the percent of managers whose idea is dismissed by the executives as not worth rating. Probability test is based on a 5.14 chi-square with 2 degrees of freedom, controlling for number of words in the manager’s idea text.

Table 1 in Burt, “Social network and creativity” (Handbook of Research on Creativity and Innovation, 2020). For more general results on broker advantage depending on brokers using familiar language, see Goldberg, Srivastava, et al., “Fitting in or standing out?” (2016, American Sociological Review).
Three Team Histories for Person A

Relatively closed team history (Ca score of 92.6 is a z-score of 0.8)

Further Back

Prior

Final

Colleagues = 3
Constraint = 92.6

About average team history

Colleagues = 5
Constraint = 59.9

Relatively open team history (Ca score of 33.1 is a z-score of -1.2)

Colleagues = 8
Constraint = 33.1

NOTE — Persons B, C, and D are members in A’s final team. Each dot is a different person in prior teams. Colleagues is the number of people with whom A has worked. Constraint is 100 x A’s network constraint score (horizontal axis in Figure 2B).

Figure 3 in Burt, "Social network and creativity" (Handbook of Research on Creativity and Innovation, 2020).
Maximum Career Creativity by Career Access to Structural Holes

Graph is from Soda, Mannucci, and Burt (2018). The observations are all 200 people who worked as producers, directors, or writers in any of the 273 episodes of the BBC series, Dr. Who. The horizontal axis is a person’s network constraint score for the network of people with whom the person worked. High scores indicate the person worked with people who primarily worked with one another. Low scores indicate the person worked with many different people, who themselves came together from working with many different people. Constraint and creativity are averaged within 5-point intervals on the horizontal axis (two intervals containing a single person are combined with the closest adjacent interval). Creativity is measured on the vertical axis in two ways: (1) maximum creativity score a person ever received for an episode on which s/he worked (mean 1-5 creativity score from two expert critics, hollow circles), and (2) maximum creativity score a person ever received for his or her role as producer, director, or writer (mean 1-5 creativity score from two expert critics, hollow squares). The table to the right contains OLS regression models showing the strong creativity-network association after holding constant the number of episodes on which a person worked, and the person’s number of episodes during a fallow period in the Dr. Who series (coefficients presented with test statistics in parentheses). Picture is an evil alien in the series.
Graph is from Soda, Mannucci, and Burt (2018). The observations are all 200 people who worked as producers, directors, or writers in any of all 273 episodes of the BBC series, Dr. Who. The horizontal axis is a person’s network constraint score for the network of all people with whom the person worked. High scores indicate the person worked with people who primarily worked with one another. Low scores indicate the person worked with many different people, who themselves came together from working with many different people. Constraint and creativity are averaged within 5-point intervals on the horizontal axis (two intervals containing a single person are combined with the closest adjacent interval). Creativity is measured on the vertical axis in two ways: (1) number of a person’s episodes that were judged highly creative by one or both of two expert critics (hollow circles), and (2) number of episodes in which a person was judged by either or both of the two expert critics to have played their role as producer/director/writer in a highly creative way (hollow squares). To be highly creative in multiple episodes, one has to work on multiple episodes, so the table to the right contains Poisson regression models showing the strong creativity-network association after holding constant the number of episodes on which a person worked, and the person’s number of episodes during a fallow period in the Dr. Who series (coefficients presented with test statistics in parentheses).
Social Network at the Top of the Company

Lines indicate frequent and substantive work discussion; heavy lines especially close relationships.

Access to bridge connections doesn’t guarantee brokerage benefits. Returns are contingent on factors not yet discussed.

Graph A below is from *Brokerage & Closure* and the previous handout showing achievement increasing with more access to structural holes. Circles are z-score residual achievement for 1,986 observations averaged within five-point intervals of network constraint in each of six management populations (analysts, bankers, and managers in Asia, Europe, and North America, see discussion of Figure 2.3 in Chapter 2; heteroscedasticity is negligible, $X^2 = 2.97$, 1 d.f., $P ~ .08$). Bold line is the vertical axis predicted by network constraint.

Graph B to the right shows the raw data that were averaged to create Graph A. Vertical axis is wider to accommodate more variable achievement. Heteroscedasticity is high due to achievement differences between advantaged individuals ($X^2 = 269.5$, 1 d.f., $P < .001$), but the association between achievement and network advantage remains statistically significant when adjusted for heteroscedasticity (Huber-White, $t = -8.49$).

A. Achievement Scores for People in Open Networks Are Higher than Peers on Average ($r = -.58$, $t = -6.78$, $n = 85$)

B. But Vary Widely between the Advantaged Individuals (overall $r = -.24$, $t = -9.98$, $n = 1,989$)
If you run an entrepreneurial venture in China, for example, what is your social standing with the Party?

\[
Y = 1.97 - .55 \log (NC) \\
\quad (-3.78) \\
+ .33 \text{PC} \\
\quad (4.95) \\
- .03 [\text{PC} \times \text{Network}] \\
\quad (-.10) \\
- .09 \text{PD} \\
\quad (-1.43) \\
+ 0.65 [\text{PD} \times \text{Network}] \\
\quad (3.05) \\
+ \sum \beta_j \text{Control}_j + \text{residual}
\]

NOTE — Y is z-score business success in Table 3. Vertical axis in graph is Y adjusted for control variables in Table 3, so axis measures success relative to similar businesses. Plotted scores are averages on vertical axis within five-point intervals of network constraint. Rare levels of constraint over 80 points are truncated to 80 points for the graph. Regression lines in the graph are based on the plotted data. In the OLS regression equation to the left (53 R²), NC is network constraint, PC is a dummy variable distinguishing politically connected CEOs, and PD is a dummy variable distinguishing politically disconnected CEOs. Test statistics are in parentheses. Reference group is entrepreneurs who have a zero on PC and PD. The two interaction variables are a dummy variable times (log network constraint minus its mean).


![Graph showing network constraint and z-score relative business success]
When a broker proposes something new, there is no guarantee that the proposal will work in our market, with our company processes, staffed by our people. There is risk to accepting the proposal. Chains of command broken in service of company interests can just as easily be broken in service of personal interests, or in service of well-intentioned but strategy-eroding interests. How will you be viewed in the target audience as the proposal source?

For Example, Are You the Right Age To Be Accepted as the Source of a Proposal?

The graphs plot averages across 2,206 senior managers in six organizations in electronics, finance, software, and supply chain. The top graph shows the age at which people have the most access to structural holes (more open networks at the top).

The bottom graph shows the age at which people have the greatest returns to brokerage. Vertical axis is test statistic for the strength of association between a manager’s relative achievement and his or her network constraint (calculate for each age group the returns to brokerage graph).

Figure 4.2 in Burt, “Life course and network advantage” (2019 Social Networks and the Life Course).
Age is Not a General Caution; More a Function of Company Culture: "Peak" Periods in Manager Life-Cycle

Manager Age (returns increase with age)

Manager Age (returns decrease with age)

Manager Age (returns increase & decrease)

Figure 3 in Burt (2018, "Life course and network advantage")
RULE 2: Broker Job Status Reassures, or Lack of It Concerns, the Target Audience

Which means the network around a senior person is especially important for his or her achievement.

<table>
<thead>
<tr>
<th>Salary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manager 1 ..........</td>
</tr>
<tr>
<td>Manager 2 ..........</td>
</tr>
<tr>
<td>Manager 3 (reference) ..........</td>
</tr>
<tr>
<td>Sr. manager ..........</td>
</tr>
<tr>
<td>Executive ..........</td>
</tr>
<tr>
<td>Purchasing ..........</td>
</tr>
<tr>
<td>Age ..........</td>
</tr>
<tr>
<td>Bachelor ..........</td>
</tr>
<tr>
<td>Graduate ..........</td>
</tr>
<tr>
<td>Hightech ..........</td>
</tr>
<tr>
<td>Lowtech ..........</td>
</tr>
<tr>
<td>Urban 1 ..........</td>
</tr>
<tr>
<td>Urban 2 ..........</td>
</tr>
<tr>
<td>Network constraint ..........</td>
</tr>
<tr>
<td>Mgr2 $\times$ constraint ..........</td>
</tr>
<tr>
<td>Mgr3 $\times$ constraint ..........</td>
</tr>
<tr>
<td>SrMgr $\times$ constraint ..........</td>
</tr>
<tr>
<td>Executive $\times$ constraint ..........</td>
</tr>
<tr>
<td>$N$ ..........</td>
</tr>
</tbody>
</table>

Graphs for executives, managers, and junior managers to the right show z-score compensation relative to peers (controlling for background differences) across levels of network constraint. Not only do more senior people have more open networks (on average), they earn higher returns to having open networks (also pay more if they don’t have an open network).

Table to the left is from page 371 of Burt, "Structural holes and good ideas" (2004, American Journal of Sociology).

See pp. 156-162 and Figure 3.8 in Brokerage and Closure for general discussion showing the form of contingency functions.
RULE 2: Broker Network Status Reassures or Concerns the Target Audience

Network status is on the vertical axis of the top graph. Status is defined in the same way that price is defined in the general equilibrium model: $S_i = \Sigma_j z_{ji} S_j$, where $S_i$ is status of person $i$, and $z_{ji}$ is connection from $j$ to $i$. Like price, status is only meaningful in reference to the status of some numeraire benchmark person. Here, status is normalized at the mean, so a score of 1.0 indicates a person of average status in the network.

$$S_i = \Sigma_j z_{ji} S_j$$

Regions indexed by shading, functions by shape

- Diamonds: Sales
- Circles: Regional Ops
- Triangles: Product Support
- Squares: Administration

Sociogram is Figure 3.2 in Neighbor Networks and the graphs are from Figures 1 and 2 in Burt & Merluzzi discussion of the link between brokerage and network status as a reputation measures (2013, "Embedded brokerage," Research in the Sociology of Organizations)
Returns to Brokerage Contingent on Network Status Can Also Be Found in Online Networks

Results here are from networks and achievement in the virtual world of Second Life. Achievement is the canonical correlation dependent variable in Model 15, Table S5. “High” status is above median. Scores on the y-axis are average achievement scores for avatars within integer intervals of nonredundant contacts (left) or five-point intervals of network constraint (right). Statistics are based on averages plotted in the graph. See Table S8 for regression results with controls showing higher returns to brokerage for individual avatars with high status.

from Burt (2020, Structural Holes in Virtual Worlds).
Reputation Can Substitute for Status, making reputation valuable as the key to being accepted as a broker.

Graph plots investment banker reputation by levels of network status. Reputation is measured by average colleague evaluation. Boxes span 25% to 75% with bold horizontal at the mean. Whiskers extend down to minimum reputation, up to maximum.

Reputation Is Correlated with Status, but Is Distinct

High Status Is a Good Signal of Positive Reputation.

Low Status Is an Ambiguous Signal

 GENERIC DEFINITION: "Differences in detail aside, most social scientists agree upon two aspects of reputation: first, knowing a business partner's past behavior mitigates uncertainty about his future performance; second, reputation demonstrates the person’s credibility as an honest business partner and reduces the uncertainty associated with trusting him." (Hillmann and Aven, 2011, AJS, page 485)

RULE 2: Broker Advantage Is Contingent on Reputation

Graph plots relative banker compensation across levels of constraint in the banker's discussion network. Compensation is averaged within intervals of network constraint, but the test statistic is for all 469 observations, holding constant job rank, peer evaluation, years with the organization, minority, and working in US headquarters (Burt, Neighbor Networks 2010:91-93).

There are two predictions: one for bankers with above-average reputations (solid squares), the other for bankers with below-average reputations (hollow squares). Network status is added to each prediction as a control for a banker's social standing across all senior people in the bank.

As Rider (ASQ 2009:578-579) explains for placement agents: "a broker’s reputation for consistently representing actors of high quality is a valuable, intangible asset that enables a broker to realize future rents on the brokerage position. . . If a positive reputation reduces the costs of assuaging potential exchange partners’ concerns, then the returns to brokerage should be positively related to a broker’s reputation." Similarly, Nee and Opper (Capitalism from Below 2012: 211) describe Chinese entrepreneurs building reputation in the course of brokering connections: "Through personal introductions and fine-grained information passed through social networks, the ‘broker’ typically signals trustworthiness and reputation of the prospective business partners. Moreover, it is in the broker’s interest to make good recommendations, as most business partners will tend to reward their networking contacts in one way or another. Such introductions can span the social gaps, or ‘structural holes’ between groups."

For discussion, see Burt & Merluzzi (2014, “embedded brokerage”). The boutique investment bank, Moelis — "Best Global Independent Investment Bank" in 2010 and "Most Innovative Boutique of the Year" in 2011 — nicely illustrates the competitive advantage of reputation as entree to brokerage opportunities (download free Moelis case from www.sbs.oxford.edu/reputation/cases).
Most important, reputation enables a wider population of people to be brokers.

Horizontal axis ranks banker observations from highest status (hollow dots) or most-positive reputation (solid dots) to the opposite extreme. Vertical axis is the correlation between compensation and log network constraint for a sample of observations adjacent to each banker (24 of higher social standing plus 24 of lower). Displayed data are smoothed by averaging across 24 adjacent observations.

From Burt (2020, Structural Holes in Virtual Worlds).
Three Summary Points

Network Structure Is a Proxy for the Distribution of Information

For reasons of opportunity, shared interests, experience — simple inertia — organizations and markets drift toward the bridge-and-cluster structure known as a “small world.”

RULE 1 of Social Capital: Brokers Do Better

Bridge relations across the structural holes between clusters provide information breadth, timing, and arbitrage advantages, such that network brokers managing the bridges are at higher risk of “productive accident” in detecting and developing good ideas. By clearing the sticky-information market across organizations, brokers tend to be recognized leaders, better compensated than peers, more widely celebrated than peers, and promoted more quickly than peers. Some specifics:

- Closed networks do not identify unintelligent managers so much as expert specialists.
- Creativity and innovation are an import/export process. Value is not at the innovation source. It emerges each time productive new knowledge is adopted in a target audience.
- Creativity and innovation depend on the network as well as the inventive person. It does not depend on individual genius so much as it depends on employees finding opportunities to broker knowledge from where it is routine to where it would create value.

RULE 2 of Social Capital: Contingent Returns to Brokerage

To the extent that a broker is proposing something new, there is no guarantee that the proposal will work in our market, with our company processes, staffed by our people. There is risk to accepting the proposal. Chains of command broken in service of company interests can just as easily be broken in service of personal interests, or in service of well-intentioned but strategy-eroding interests. Social standing in the form of job rank, network status, or reputation is the way would-be brokers overcome the suspicions with which brokers can be viewed. Reputation is particularly valuable. It legitimizes the largest number of people to be successful network brokers.

These are core rules for Leonardi and Contractor's 2018 HBR piece, "Better people analytics," which is on the course Canvas site.
Appendix Materials
Appendix I: Example Network Questionnaire for a Web Survey

for discussion of these slides and how to collect network data, see Appendix A, "Measuring the Network," in Neighbor Networks.

For a similar offline exercise, see Hermi Ibarra's 2008 network exercise on the HBSP website (item 9-497-993).
Network Diagnostic Survey

5. This final question asks for your view of connections among the people you named. Please don't quit here. You are almost finished. The people you cited in the previous page are listed in the table below. The task is to select a letter indicating your view of the connection between each pair of people, where

"Often" means that, to your knowledge, the two people speak often with one another such that they are probably familiar with current issues in one another's operations.

"Some" indicates that you know only that the two people sometimes talk to one another, such that they have some familiarity with current issues in one another's operations.

"Rare" indicates, again as best you know, that the two people speak infrequently or not at all to one another.

"Difficult" indicates that, for reasons that could be no fault of either person, there has been difficulty in coordinating work between the two people.

For example, if you named three people (Jose, John, and Jody) who speak often with one another and haven't had difficulty coordinating their work when they should, the table would look like this:

Jose A
O O John S
O O Jody Y

If you named four people (Jose, John, Jody, and Wen) where Jose and Jody are closely connected, Jose and John have had difficulty coordinating their work, and the others rarely speak to one another, the table would look like this:

Jose K
D John S
O R Jody Y
R R R Wen Q

Here is the table with names of your contacts on the diagonal. People are listed with the default that they speak often. Use the pull-down menus in the cells to indicate your view of the connection between each pair of people. If you wish to change or add names, hit your browser's "Back" button, edit your citations on the previous page, and return here to describe the network.

Click the submit button to save all your data.

Figure A2 in Neighbor Networks
Figure A2. Business Event Name Generator

The next five questions generate a summary picture of the business network. To draw the picture, you will be asked about people, but we do not want to know any one's name. I will go through this network worksheet with you, asking about people who were useful to your business in one way or another. Without mentioning anyone's name to me, please write on your worksheet the names of people who come to mind in response to the questions. We will create a list of names then refer to people by their order on the list. No names. You will keep the worksheet to yourself.

Q1. Let me begin with an example so you can see how the interview protects your confidentiality at the same time that a picture of the business network emerges. Your business time line shows that your firm was founded in _(say founding year)_.

Please think back to your activities in founding the firm. Who was the one person who was most valuable to you in founding the firm?

Q2. Now please do the same thing for each of the significant events you listed on your business time line. The first significant event you listed was _(say first event)_ in _(say year)_.

Who was the person most valuable to you during that event? Please write on the first line below the person's name. The person most valuable in this event could be the same person who was most valuable to you in founding the firm. You would just enter the name again.

from Burt and Burzynska, "Chinese entrepreneurs, social networks, and guanxi" (2018 Management and Organization Review)
Figure A3. Name Interpreters Flesh Out Relationships and Define Connections among Cited Contacts

- Contact Gender (male, female)
- Emotional Closeness to Contact (especially close, close, less close, distant)
- Duration of Connection with Contact (years known)
- Frequency of Contact (daily, weekly, monthly, less often)
- Trust (1 to 5, low to high trust) “Consider the extent to which you trust each of the listed people. For example, suppose one of the people asked for your help. The help is not extreme, but it is substantial. It is a level of help you cannot offer to many people. To what extent would you trust each person to give you all the information you need to decide on the help? For example, if the person was asking for a loan, would they fully inform you about the risks of them being able to repay the loan? If the person was asking you give a job to one of their relatives, would they fully inform you about their relative’s poor work attitude or weak abilities, or other qualities that would make you prefer not to hire the relative?”
- Role (all that apply: family, extended family, neighbor, party, childhood, classmate, military, colleague, business association)
- Matrix of Connections between Contacts (especially close, distant, or something in between)

from Burt and Burzynska, "Chinese entrepreneurs, social networks, and guanxi" (2017 Management and Organization Review)
Appendix II: Measuring Access to Structural Holes*


Network brokerage is typically measured in terms of opportunities to connect people. When everyone you know is connected with one another, you have no opportunities to connect people. When you know a lot of people disconnected from one another, then you have a lot of opportunities to connect people. “Opportunities” should be emphasized in these sentences. None of the usual brokerage measures actually measures brokerage behavior. They index opportunities for brokerage. Reliability and cost underlie the practice of measuring brokerage in terms of opportunities. It is difficult to know whether or not you acted on a brokerage opportunity. One can know with more reliability whether or not you had an opportunity for brokerage. Acts of brokerage could be studied with ethnographic data, but the needed depth of data would be expensive, if not impossible, to obtain by the practical survey methods used to measure networks.

Good reasons notwithstanding, the practice of measuring brokerage by its opportunities rather than its occurrence means that performance has uneven variance across levels of brokerage opportunities. Performance is typically low in the absence of opportunities. Performance varies widely where there are many opportunities: (1) because some people with opportunities do not act upon them and so show no performance benefit, (2) because it is not always valuable to move information between disconnected people (e.g., explain to your grandmother the latest technology in your line of work), or (3) because the performance benefit of brokerage can occur with just one key bridge relationship. A sociologist might do more creative work because of working through an idea with a colleague from economics, but that does not mean that she would be three times more creative if she also worked through the idea with a colleague from psychology, another from anthropology, and another from history. The above three points can be true of brokerage measured in terms of action, but under the assumption that people invest less in brokerage that adds no value, the three points are more obviously true of brokerage measured in terms of opportunities. It could be argued that people more often involved in bridge relations are more likely to have one bridge that is valuable for brokerage, and to understand how to use bridges to add value, but the point remains that the network measures discussed below index opportunities for brokerage, not acts of brokerage.

**Bridge Counts**

Bridge counts are an intuitively appealing measure. The relation between two people is a bridge if there are no indirect connections between the two people through mutual contacts. Associations with performance have been reported measuring brokerage with a count of bridges (e.g., Burt, Hogarth, and Michaud, 2000:Appendix; Burt, 2002).

**Constraint**

I measure brokerage opportunities with a summary index, network constraint. As illustrated on the next page, network constraint begins with the extent to which manager i’s network is directly or indirectly invested in the manager’s relationship with contact j (Burt 1992: Chap. 2): $c_{ij} = (p_{ij} + \sum_{q \neq i,j} p_{iq} p_{qj})^2$, for $q \neq i,j$, where $p_{ij}$ is the proportion of i’s network time and energy invested in contact
Network constraint measures the extent to which your network time and energy is concentrated in a single group. There are two components: (direct) a contact consumes a large proportion of your network time and energy, and (indirect) a contact controls other people who consume a large proportion of your network time and energy. The proportion of i’s network time and energy allocated to j, $p_{ij}$, is the ratio of $z_{ij}$ to the sum of i’s relations, where $z_{ij}$ is the strength of connection between i and j, here simplified to zero versus one.

$$c_{ij} = (p_{ij} + \sum_{q \neq i,j} p_{iq}p_{qj})^2 \quad q \neq i,j$$

**Network data**

<table>
<thead>
<tr>
<th></th>
<th>A</th>
<th>B</th>
<th>C</th>
<th>D</th>
<th>E</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>B</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>C</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>D</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>E</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
<tr>
<td>F</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
<td>0.1</td>
</tr>
</tbody>
</table>

| gray dot | 1 | 1 | 1 | 1 | 1 | 1 |

**Total** 39.9 = aggregate constraint ($C = \sum_j c_{ij}$)
j, \( p_{ij} = z_{ij} / \sum q z_{iq} \), and variable \( z_{ij} \) measures the strength of connection between contacts i and j. Connection \( z_{ij} \) measures the lack of a structural hole so it is made symmetric before computing \( p_{ij} \) in that a hole between i and j is unlikely to the extent that either i or j feels that they spend a lot of time in the relationship (strength of connection “between” i and j versus strength of connection “from” i to j; see Burt, 1992:51). The total in parentheses is the proportion of i’s relations that are directly or indirectly invested in connection with contact j. The sum of squared proportions, \( \sum_j c_{ij} \), is the network constraint index C. I multiply scores by 100 to discuss integer levels of constraint.

The network constraint index varies with three network dimensions: size, density, and hierarchy. Constraint on a person is high if the person has few contacts (small network) and those contacts are strongly connected to one another, either directly (as in a dense network), or through a central, mutual contact (as in a hierarchical network). The index, C, can be written as the sum of three variables: \( \sum (p_{ij})^2 + 2 \sum p_{ij}(\sum q p_{iq} p_{qj}) + \sum (\sum q p_{iq} p_{qj})^2 \). The first term in the expression, C-size in Burt (1998), is a Herfindahl index measuring the extent to which manager i’s relations are concentrated in a single contact. The second term, C-density in Burt (1998), is an interaction between strong ties and density in the sense that it increases with the extent to which manager i’s strongest relations are with contacts strongly tied to the other contacts. The third term, C-hierarchy in Burt (1998), measures the extent to which manager i’s contacts concentrate their relations in one central contact. See Burt (1992:50ff.; 1998:Appendix) and Borgatti, Jones, and Everett (1998) for discussion of components in network constraint.

Size
Network size, N, is the number of contacts in a person's network. In graph-theory discussions, the size of the network around a person is discussed as “degree.” For non-zero network size, other things equal, more contacts mean that a manager is more likely to receive diverse bits of information from contacts and is more able to play their individual demands against one another. Network constraint is lower in larger networks because the proportion of a manager’s network time and energy allocated to any one contact (\( p_{ij} \) in the constraint equation) decreases on average as the number of contacts increases.

Density
Density is the average strength of connection between contacts: \( \Sigma z_{ij} / N^*(N-1) \), where summation is across all contacts i and j. Dense networks are more constraining since contacts are more connected (\( \Sigma q p_{iq} p_{qj} \) in the constraint equation). Contact connections increase the probability that the contacts know the same information and eliminate opportunities to broker information between contacts. Thus, dense networks offer less of the information and control advantage associated with spanning structural holes. Density is only one form of network closure, but it is a form often discussed as closure.

Hypothetical networks in the figure on page 54 illustrate how constraint varies with size, density, and hierarchy. Relations are simplified to binary and symmetric in the networks. The graphs display relations between contacts. Relations with the person at the center of the network are not presented (the person at the center is referenced by various labels such as "you," "ego," or "respondent"). The first column in the figure contains examples of sparse networks (zero density). No contact is connected with other contacts. The third column of the figure contains maximum-density networks (density = 100). Every contact has a strong connection with each other contact. At each network size, constraint is lower in the sparse-network column.
Hierarchy
Density is a form of closure in which contacts are equally connected. Hierarchy is another form of closure in which a minority of contacts, typically one or two, stand above the others for being more the source of closure. The extreme is to have a network organized around one contact. For people in job transition, such as M.B.A. students, that one contact is often the spouse. In organizations, hierarchical networks are sometimes built around the boss.

Hierarchy and density both increase constraint, but in different ways. They enlarge the indirect connection component in network constraint ($\Sigma_q p_{i|q} p_{qj}$). Where network constraint measures the extent to which contacts are redundant, network hierarchy measures the extent to which the redundancy can be traced to a single contact in the network. The central contact in a hierarchical network gets the same information available to the manager and cannot be avoided in manager negotiations with each other contact. More, the central contact can be played against the manager by third parties because information available from the manager is equally available from the central contact since manager and central contact reach the same people. Network constraint increases with both density and hierarchy, but density and hierarchy are empirically distinct measures and fundamentally distinct with respect to social capital because it is hierarchy that measures social capital borrowed from a sponsor.

To measure the extent to which the constraint on a person is concentrated in certain contacts, I use the Coleman-Theil inequality index for its attractive qualities as a robust measure of hierarchy (Burt, 1992:70ff.). Applied to contact-specific constraint scores, the index is the ratio of $\Sigma r_j \ln(r_j)$ divided by $N \ln(N)$, where $N$ is number of contacts, $r_j$ is the ratio of contact-$j$ constraint over average constraint, $c_{ij}/(C/N)$. The ratio equals zero if all contact-specific constraints equal the average, and approaches 1.0 to the extent that all constraint is from one contact. Again, I multiply scores by 100 and report integer values.

In the first and third columns on the next page, no one contact is more connected than others, so all of the hierarchy scores are zero. Non-zero hierarchy scores occur in the middle column, where one central contact is connected to all others who are otherwise disconnected from one another. Contact A poses more severe constraint than the others because network ties are concentrated in A. The Coleman-Theil index increases with the number of people connected to the central contact. Hierarchy is 7 for the three-contact hierarchical network, 25 for the five-contact network, and 50 for the ten-contact network. This feature of hierarchy increasing with the number of people in the hierarchy turns out to be important for measuring the social capital of outsiders because it measures the volume of social capital borrowed from a sponsor, which strengthens the association with performance (this point is the focus of the later session on outsiders having to borrow network access from a strategic partner).

Note that constraint increases with hierarchy and density such that evidence of density correlated with performance can be evidence of a hierarchy effect. Constraint is high in the dense and hierarchical three-contact networks (93 and 84 points respectively). Constraint is 65 in the dense five-contact network, and 59 in the hierarchical network; even though density is only 40 in the hierarchical network. In the ten-contact networks, constraint is lower in the dense network than the hierarchical network (36 versus 41), and density is only 20 in the hierarchical network. Density and hierarchy are correlated, but distinct, components in network constraint.
Network Constraint decreases with number of contacts (size), increases with strength of connections between contacts (density), and increases with sharing the network (hierarchy).

This is Figure 1 in Burt, "Reinforced Structural Holes," (2015, Social Networks, an elaboration of Figure B.2 in Neighbor Networks). Graph above plots density and hierarchy for 1,989 networks observed in six management populations (aggregated in Figure 2.4 in Neighbor Networks to illustrate returns to brokerage). Dot-circles are executives (MD or more in finance, VP or more otherwise). Hollow circles are lower ranks. Executives have significantly larger, less dense, and less hierarchical networks.

To keep the diagrams simple, relations with ego are not presented.
The Network Measures of Access to Structural Holes Are Strongly Correlated

These are network metrics for 801 senior people in two organizations analyzed in Burt, "Reinforced structural holes" (2015, *Social Networks*). One organization is a center-periphery network of investment bankers (circles). The other is a balkanized network of supply-chain managers in a large electronics company (squares). The point is that networks rich in structural holes by one measure tend to be rich in the other measures.
### Structural Folds Indicate Access to Structural Holes

![Network Diagram](image)

<table>
<thead>
<tr>
<th>Kind of Network</th>
<th>Network Size (Contacts)</th>
<th>Effective Size (NonRedundant Contacts)</th>
<th>Network Constraint</th>
<th>Ego-Network Betweenness (Structural Holes)</th>
<th>Reinforced Holes (RSH)</th>
<th>Ego-Network Modularity (Newman Q)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Closed (3, 4, 5, 7, 8, 9, 11, 12, 13, 14, 15, 16)</td>
<td>3</td>
<td>1.0</td>
<td>92.6</td>
<td>.00</td>
<td>.00</td>
<td>0%</td>
</tr>
<tr>
<td>Broker (1)</td>
<td>2</td>
<td>2.0</td>
<td>50.0</td>
<td>1.00</td>
<td>.75</td>
<td>75%</td>
</tr>
<tr>
<td>Broker (2, 6)</td>
<td>4</td>
<td>2.5</td>
<td>58.3</td>
<td>3.00</td>
<td>1.75</td>
<td>29%</td>
</tr>
<tr>
<td>Fold Broker (10)</td>
<td>6</td>
<td>4.0</td>
<td>46.3</td>
<td>9.00</td>
<td>6.00</td>
<td>40%</td>
</tr>
</tbody>
</table>

Log Constraint 1.00
Effective Size -.90 1.00
EN Betweenness -.71 .88 1.00
RSH -.71 .93 .91

This is Figure 3 in Burt, "Reinforced structural holes" (2015, Social Networks), based on the above networks in Figure 1 of Vedres and Stark, "Structural folds: generative disruption in overlapping groups" (2010, American Journal of Sociology). Correlations to the right are across the 801 bankers and managers analyzed in the 2015 article.
Appendix III: Network Endogeneity

The four networks are from the Bavelas-Leavitt experiments on leadership in task groups. The WHEEL is a traditional bureaucracy in which C is in charge. The other three networks involve distributed leadership (all five people in the CIRCLE; B, C, and D in the CHAIN; C and D in the Y-NETWORK). More distributed leadership is associated with more messages, slower task completion, and greater enjoyment. Speed, messages, and enjoyment scores are from Leavitt (1951). Number of contacts (N) and network constraint (NC) are computed from binary ties in the sociograms (number of contacts equals number of non-redundant contacts in these structures).

From Burt (2020, *Structural Holes in Virtual Worlds*), and see the MIT replication with language learning in Reagans, Hagay, and Burt (2020, "When will they (ever) learn?")
Behavioral and Opinion Correlates of Network Brokers

A. Network brokers tend to distribute answers, people in moderately constrained positions tend to be conduits for informational messages.

Data are from Leavitt (1949: Table 30, following page 62).

B. Network brokers are least happy initially, but eventually become the most pleased with the experience.

Data are from Leavitt (1949:Table 29, pages 60-61; "How did you like your job in the group?").

C. The final outcome, by the end of the experiment, is that network brokers are most likely to be recognized as the unofficial group leader.

Data are from Leavitt (1949: Table 8, page 38; “Did your group have a leader? If so, who?”).

From Burt (2020, *Structural Holes in Virtual Worlds*)
Appendix IV: Assignments for Second Class Session

As listed under "DELIVERABLES" on the course syllabus (page 6), below are steps for the "Initial INSEAD Social Capital Report" (to be completed before second class), and the "Network Worksheet" is on the next page (to be completed and returned by email to me before second class, or submitted in class at the start of the second class session).

The final diagnostic analysis of your network (page 7 of syllabus) will involve two INSEAD social capital reports, this one when you enter the course, and a later one near the end of the course.

Students registered for a grade in the course are required to complete this initial report before the second class session. You don't have to turn anything in. I can see from the INSEAD roster who has completed their report.

There are four steps to you obtaining your report:

1. Registered students will receive an invitation from INSEAD at your Booth email address. Auditors who have contacted me will receive an invitation at whatever email address they used to contact me.

2. Go to the URL in the invitation email and use the password, unique to you, to enter your interview.

3. Complete the interview (about 15-20 minutes). ADVISORY: The interview will ask about work relations. That's fine for the evening students, who are currently employed. For people in the full-time program, think about the network you've built up among students and professors at Booth. That is your job for the moment. Who are the people most valuable to your comfort, your stimulation, and your learning? (Evening students might benefit from the same focus on Booth relationships.)

4. When your report is ready, download it, and keep the .pdf copy with you for your final diagnostic analysis. You will receive an email message from the INSEAD URL when your report is ready for download (use the password in your invitation email to access your report). No other student will have access to your report without your INSEAD password. I advise you to keep your INSEAD password confidential.

I'll discuss the initial report briefly in class, but we can't cover all of it without the next few class sessions. The INSEAD report has been a productive exercise in the past. I hope you too find it interesting, and a stimulus to your own learning.
# Appendix IV: Network Worksheet

Enter name and section, fill in the blanks, and turn this in before second class session.
Ego is not presented. These are just ego’s key contacts. All connections are symmetric and binary ($z_{ei} = z_{ej} = 1$).

<table>
<thead>
<tr>
<th>Name, Section</th>
<th>Name, Section</th>
<th>Name, Section</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Ego</strong>: A</td>
<td><strong>Ego</strong>: A</td>
<td><strong>Ego</strong>: A</td>
</tr>
<tr>
<td>B, C, D, E</td>
<td>B, C, D, E</td>
<td>B, C, D, E</td>
</tr>
<tr>
<td>density (# / #possible)</td>
<td>density (# / #possible)</td>
<td>density (# / #possible)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>betweenness (holes)</td>
<td>betweenness (holes)</td>
<td>betweenness (holes)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

- **Size (degree)**: ___, ___, ___
- **Density (# / #possible)**: ___, ___, ___
- **Betweenness (holes)**: ___, ___, ___

![Network Diagrams]

1. **Size (degree)**: ___, ___, ___
2. **Density (# / #possible)**: ___, ___, ___
3. **Betweenness (holes)**: ___, ___, ___