Foundations:
Growth versus Governance
Brokerage versus Closure

For text on this session, see Chapters 1, 2, and 3 in *Brokerage and Closure* (including adjunct bits from *Neighbor Networks*).

After you have been through this session, you should be able to appreciate much better the recent HBR article on "Better People Analytics," which is on the Canvas website for the course.

Appendices:

I. Example Network Questionnaire for a Web Survey (pages 41-44, from 2010 *Neighbor Networks*, 2017 *Management and Organization Review*)
II. Measuring Network Closure/Embedding (page 45, from 2007 "Closure & Stability")
VI. Snippets on Business Culture (pages 59-61, 1998 *Financial Times*, other)

This handout was prepared as a basis for discussion in executive education (Copyright © 2018 Ronald S. Burt, all rights reserved). To download work referenced here, or research/teaching materials on related topics, go to http://faculty.chicagobooth.edu/ronald.burt.
Sociogram of Formal Network in a Large EU Healthcare Company (Org Chart)

- 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 1 in Burt and Soda, "The social origins of great strategies" (Strategy Science, 2017)
Rule 1 of Social Capital

RULE 1: For bottom-line growth, closed networks facilitate and maintain trust and reputation within the network, promoting reliable, efficient operations within the network (Sherif, 1935; Festinger et al., 1950; Asch, 1951; Katz and Lazarsfeld, 1955; Granovetter, 1985, 1992; Burt, 1987; Coleman, 1988; Ellickson, 1991; Bernstein, 1992, 2001; Krackhardt, 1992; Barker, 1993; Putnam, 1993; Uzzi, 1997; Burt, 2005:Chps. 3-4).
Trust Builds within Relationships Slowly

TRUST — committing to an exchange before you know how the other will behave.

REPUTATION — extent to which you are known as trustworthy.

I. Good Behavior as the Source of Trust
third parties irrelevant to trust & distrust too slow (graph to right), too dangerous (Burt, 1999, "Private games are too dangerous")

II. Network Closure and Structural Embedding as the Source, Bandwidth Story
third parties enhance information and enforcement, and so facilitate trust (next page)

from Figure 3.2 in Brokerage and Closure
Closed Networks within the Clusters Facilitate Trust and Shared Beliefs

More connections allow more rapid communication, so poor behavior can be more readily detected and punished. Bureaucratic authority was the traditional engine for coordination in organizations (budget, head count). The new engine is reputation (e.g., eBay). In flattened-down organizations, leader roles are often ambiguous, so people need help knowing who to trust, and the boss needs help supervising her direct reports. Multi-point evaluation systems, often discussed as 360° evaluation systems, gather evaluative data from the people who work with an employee. These are "reputational" systems in that evaluations are the same data that define an employee's reputation in the company. In essence, reputation is the governance mechanism in social networks.

Figure 3.1 in *Brokerage and Closure* (for discussion, see pages 105-111). See Appendix III on network embedding in the theory of the firm.
Closure creates "bandwidth:" more channels of communication allow more accurate and rapid communication, so poor behavior is more readily detected and managed.

1985: Granovetter (1985 AJS) on the risk of trust reduced by third-party enforcement (discussed as structural embeddedness, 1992:44): "My mortification at cheating a friend of long standing may be substantial even when undiscovered. It may increase when the friend becomes aware of it. But it may become even more unbearable when our mutual friends uncover the deceit and tell one another." (also Tullock, 1985 QJE, pp. 1076, 1080-1081)

1988: Coleman (1988:S107-108 AJS, 1990 book) on the risk of trust reduced by third-party enforcement (discussed as network closure) with respect to rotating-credit associations: "The consequence of closure is, as in the case of the wholesale diamond market or in other similar communities, a set of effective sanctions that can monitor and guide behavior. Reputation cannot arise in an open structure, and collective sanctions that would ensure trustworthiness cannot be applied." E.g., Putnam's (1993 book) explanation of higher institutional performance in regional Italy attributed to the trust, norms, and dense networks that facilitate coordinated action.

1989: Maghribi traders in North Africa during the 1000s, respond to strong incentives for opportunism in their trade between cities by maintaining a dense network of communication links which encouraged them to protect their positive reputations and facilitated their coordination in ostracizing merchants with negative reputations (Greif, 1989 JEH; and for other applications, such as guilds, see Greif, 2006, *Institutions and the Path to the Modern Economy*).
"Reputation cannot arise in an open structure."
(AJS, Coleman, 1988:S107)

Closure-Trust Associations, Management

Dots are average Y scores within intervals of X. Graph A describes 46,231 observed colleague relations with analysts and bankers over a four-year period (adapted from Burt, 2010: 174-175). Vertical axis is the proportion of relations cited next year as good or outstanding. Horizontal axis is number of mutual contacts this year. Logit z-score test statistics are estimated with controls for differences in network size and adjusted for autocorrelation between relationships (Stata "cluster" option). Graph B describes for the bankers subsample correlations between positive (above average) and negative (below average) reputations this year and next year (adapted from Burt, 2010:166; routine t-tests reported across 1,179 banker-year observations).

And the Same Holds for Online Social Relationships

Dots are average Y scores within intervals of X. *Second Life* trust is friendship rights granted to contact as predicted in Table 3.1 by Model 2. *EverQuest II* trust is housing rights granted to contact as predicted in Table 3.2 by Model 4 for social relations and Model 5 for economic relations. Standard errors in parentheses are adjusted for autocorrelation between relations from same character using STATA “cluster” option.

from Burt (2019, *Structural Holes in Virtual Worlds*).
The Learning Curve: Build for Network Closure to Cut Costs, Delivering on a Known Value Stream

LEARNING CURVE (also known as experience curve) — increased efficiency associated with cumulative volume produced by group (e.g., timing & locating supplies, scheduling, tacit knowledge between colleagues, etc.). THE MECHANISM — With its dense social ties providing wide bandwidth for information flow, closure enhances communication and enforcement within a group, (1) which creates reputation, facilitating trust within a group division-of-labor, (2) which enhances performance as people become self-aligning between tasks, pushing one another to extraordinary efforts down the learning curve. The result is lower costs, and so higher productivity. Reputation is the engine. Closure delivers value through peer pressure on reputation within a group (else exogenous shocks disrupt the alignment of even personally dedicated individuals).

“Costs characteristically decline 20 to 30 percent in real terms each time accumulated experience doubles. This means that when inflation is factored out, costs should always decline.”

Associated with BCG and Bruce Henderson (1974, “The experience curve reviewed: why does it work?” reprinted in Stern and Stalk, 1998, Perspectives on Strategy), but more with Liberty Ships, e.g., Rapping, "Learning and World War II production functions"(1965, Review of Economics and Statistics) and Argote et al., "The persistence and transfer of learning in industrial settings" (1990, Management Science). Also see Thurstone "The learning curve equation" (1919, Psychological Monographs). For review of industrial research largely preceding Henderson, see Yelle "The learning curve" (1979, Decision Sciences). For discussion, see Appendix V on closure and example learning curves.
Bottom-Line Performance Advantage of Closed Networks: Reputation Mechanism Generates Trust and Efficiency

By creating a wide bandwidth for information flow, closure enhances communication and personal visibility within a group,

(1) which creates reputation costs for individuals who express opinion or behavior inconsistent with group standards,

(2) which makes it less risky to trust within the group,

(3) which enhances productivity as people become self-aligning in extraordinary efforts (lowering costs for labor, monitoring, quality, and speed).

Reputation is the mechanism by which closure has its effect. Closure delivers value by creating a reputation cost for deviation from cooperative, extraordinary effort. In other words, closure grows the bottom line. As illustrated by the examples just discussed, you often see closure in the teamwork associated with successful efficiency programs such as TQM, Six Sigma, and Lean Manufacturing.
Stratified Random Sample of 700 Chinese Entrepreneurs from Seven Cities in Three Provinces of China’s Yangtze Delta Area.

(20% 2013 China GDP, 32% 2013 China imports/exports)
65% entirely self-funded start-ups
29% partial (avg 58% self, 12% fam, 10% frnd)
6% no self-funding (avg 65% bank funds)

<table>
<thead>
<tr>
<th>Sample Characteristics</th>
<th>N</th>
<th>%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Small (10 - 100)</td>
<td>468</td>
<td>67%</td>
</tr>
<tr>
<td>Medium (101 - 300)</td>
<td>169</td>
<td>24%</td>
</tr>
<tr>
<td>Large (&gt; 300)</td>
<td>63</td>
<td>9%</td>
</tr>
<tr>
<td>Textiles</td>
<td>170</td>
<td>24%</td>
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<tr>
<td>Transportation Equipment</td>
<td>171</td>
<td>24%</td>
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<tr>
<td>Machinery</td>
<td>180</td>
<td>26%</td>
</tr>
<tr>
<td>Pharmaceuticals</td>
<td>77</td>
<td>11%</td>
</tr>
<tr>
<td>Electronics</td>
<td>102</td>
<td>15%</td>
</tr>
<tr>
<td>Respondent is Founder</td>
<td>559</td>
<td>80%</td>
</tr>
<tr>
<td>Year Born</td>
<td>1967 median, 8.4 sd, 1938-1988</td>
<td></td>
</tr>
<tr>
<td>Yr Founded</td>
<td>2001 median, 4.6 sd, 1982-2011</td>
<td></td>
</tr>
</tbody>
</table>

The map is taken from the Wikipedia entry for “Yangtze River Delta” with the delta proper indicated in green. Bold lines separate provinces. Bars indicate small, medium, and large firms in the sample 100 entrepreneurs from each city (respectively, light, dark grey, and black areas of city bar). This is Figure A1 in Burt and Burzynska, 2017 Management and Organization Review (MOR).

Figure A1 in Burt and Burzynska, "Chinese entrepreneurs, social networks, and guanxi," (2017 Management and Organization Review)
Network Closure and Trust in China

NOTE — Dots are average Y scores at each level of X. Graph A describes 46,231 observed colleague relations with analysts and bankers over a four-year period (adapted from Burt, 2010:174-175). Vertical axis is proportion of relations cited next year as good or outstanding. Horizontal axis is number of mutual contacts this year. Graph B describes 4,464 relationships cited by the 700 Chinese entrepreneurs. Vertical axis is mean respondent trust in the contact, measured on a five-point scale. Horizontal axis is the number of other people in a respondent’s network connected with the contact being evaluated for trust. Test statistics are estimated in both graphs with controls for differences in network size and adjusted for autocorrelation between relationships.

Figure 4 in Burt and Burzynska, "Chinese entrepreneurs, social networks, and guanxi," (2017 Management and Organization Review)
Over the Longer Run, Closure Slows Decay, Especially in New Relations.

Here, closure has its effect through the first two years of a relationship.

These are decay functions for colleague relations with investment bankers and analysts during the 1990s. Logit z-scores in parentheses below (based on 46,231 relations).

from Figure 4.8 in Brokerage and Closure. For general discussion of structural embedding primarily facilitating the formation of relations rather than their long-term survival, see Dahlander & McFarland (2013 ASQ), “Ties that last: tie formation and persistence in research collaborations over time.”
SOCIAL CAPITAL, Rule 1

Trust and coordination are facilitated by reputation costs in closed networks.

GUANXI
- Familiarity, intimacy
- Trust
- Mutual obligation

Respondent Trust in Contact
- 5 for high, down to 1 for low

Guanxi Ties (C & D on page 13)

Other Ties (A & B on page 13)

Network Closure
Number of Third Parties Linking Respondent with Contact

Illustrative Comparative Network Analysis

from Burt and Batjargal, "Comparative network analysis" (2019, Management and Organization Review)
Same Network Mechanism, with Different Mixtures, Can Define Different Business Environments

NOTE: Grey area is current contacts (contacts cited this year by analyst or banker, contacts cited as current or met daily by Chinese entrepreneur). Red area is proportional to number of guanxi ties (known for more than two years for analyst or banker, most valued help in significant event for Chinese entrepreneur). Overlap indicates guanxi ties in current network.

QUESTIONS: Guanxi ties are more prevalent in China and critical to network advantage in China (there is no evidence of network advantage associated with success absent guanxi ties not cited as current contacts).

- Is the China difference a substantive difference between China and the West, or a methodological artifact?
- How prevalent are guanxi ties in the West (now we know what to look for), how often are they active as current contacts, and to what extent does success in the West depend on them?

from Burt and Batjargal, "Comparative network analysis" (2019, Management and Organization Review)
People in Closed Networks Are Less Likely to Cooperate with Outsiders

The more closed the inside, the more suspicious the outside,
Especially for people who have been successful with a closed network.

A Behavioral Measure of Cooperation

"Like you, the other player is CEO of a Chinese firm, and a citizen of China."

<table>
<thead>
<tr>
<th>Move by Other Player</th>
<th>Your Move: Cooperate</th>
<th>Defect</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cooperate</td>
<td>250, 250</td>
<td>50, 400</td>
</tr>
<tr>
<td>Defect</td>
<td>400, 50</td>
<td>100, 100</td>
</tr>
</tbody>
</table>

Observations are averages for 5-point intervals on X, with tails of X truncated for infrequency. Correlations are computed from data in the graph. Hollow dots are averages for all observations. Solid dots are averages for more successful entrepreneurs (distinguished by above median profit last year).

From Figure 4 and Table 1 in Opper, Burt, and Holm (2018), "Social network and cooperation with strangers."
Homophily: Relations develop more easily as a by-product of felt similarity.

When two people feel they are socially similar on certain issues, they can more easily interact on other issues potentially difficult.

Graph shows that the potential for discussion across political differences occurs primarily in online groups where politics is not the purpose of the discussion space. Horizontal is purpose of discussion space. Vertical axis is an index of extent to which space draws many users, often discussing politics, and encountering high levels of political disagreement. Leisure includes groups based on shared hobbies/activities, social support, socializing, romance, fan groups for a TV show, actor, musical group, or sports team, and general trivia groups. Responses are from a national probability sample of 1028 people who report participating in one or more chat rooms or message boards.

From Figure 3 in Wojcieszak & Mutz (2009, *J of Communication*), “Online Groups and Political Discourse: Do Online Discussion Spaces Facilitate Exposure to Political Disagreement?” For a review of relations associated with people sharing similar backgrounds or interests, see McPherson, Smith-Lovin & Cook (2001, *Ann. Rev. Sociology*), “Homophily in social networks” (usual dimensions are people in the same place at the same time, same age, gender, religion, occupation, income, social class). For some tactical guidance on your network, see Uzzi & Dunlap (2006, *HBR*), “How to build your network,” and Cassario et al. (2016, *HBR*), “Learn to love networking.”
Rule 2 of Social Capital

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

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.

DENSITY = ____________

SOCIOGRAM
graphic image of a network in which dots represent nodes (a person, group, etc.) and lines represent connections

Appendix I contains an illustrative survey webpage used to gather network data.
First, establish the empirical fact that the people we will discuss 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.

Circles are average z-score performance (Z) for a five-point interval of network constraint (C) within each of eight study populations. Dashed line goes through mean values of Z for intervals of C. Bold line is performance predicted by the natural log of C.

From Figure 1.8 in Brokerage and Closure. Data pooled across eight study-population graphs in Appendix IV on measuring network constraint.
Social Capital of Brokerage
Manifest as better ideas, more-positive evaluations, higher compensation, earlier promotion, and faster teams.

Achievement and rewards are distinguished on the vertical axis, measuring the extent to which a person is doing better than his or her peers.

From Figure 1.8 in Brokerage and Closure. Data pooled across eight study-population graphs in Appendix IV on measuring network constraint.
Social Capital of Brokerage

Manifest as better ideas, more-positive evaluations, higher compensation, earlier promotion, and faster teams.

Brokerage is a large percentage of explained performance differences.

Z = 2.78 – .82 ln(C)

Network Constraint (C)
many ——— Structural Holes ——— few

Circles are average z-score performance (Z) for a five-point interval of network constraint (C) within each of eight study populations. Dashed line goes through mean values of Z for intervals of C. Bold line is performance predicted by the natural log of C.

Brokerage Contributes "Slightly More than Half" of Predicted Variance in Performance Differences between Managers:

Network constraint (white), job rank (red), and other factors (striped). First pie is investment banker compensation and analyst election to the All-America Research Team. Second pie is supply-chain and HR manager compensation in corporate bureaucracies. Third pie is early promotion to senior job rank in a large electronics firm.

Data are pooled across eight management populations. Pie charts are from Figure 2.4 in Neighbor Networks. On causal order, see Appendix VII.
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 Evident Online in the Network-Achievement Connection within 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 (2019, Structural Holes in Virtual Worlds).
Returns to Brokerage Are Evident in Low Returns to Student Specialization

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, Keinbaum (2012, *ASQ*) “Organizational misfits,” shows with email data that managers with unusual patterns of communication are most likely to emerge the valued network brokers.
In Sum, Business Success Decreases as the Network Around a Person Closes

Scores are averaged within each study population for each five-point interval of the network metric.

Correlations are based on the plotted data.

Citations to the source data and individual-level analyses are given in notes to Figure 1 in Burt, "A Note on the Networks and Success of Female Entrepreneurs in China."
HOW IT WORKS: Recombinant Sticky Information
Contacts as Source vs. Portal

Network A

Network B

Network C

Redundancy by Cohesion
Contact Redundancy
Redundancy by Structural Equivalence (cf. felt similarity on page 18)

Person 3: $\frac{.402}{(.25+0)^2 + (.25+.084)^2 + (.25+.091)^2 + (.25+.084)^2}$

Robert: $\frac{.148}{(.077+0)^2 + (.154+0)^2 + (.154+0)^2 + (.154+0)^2 + (.154+0)^2 + (.154+0)^2 + (.154+0)^2}$

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>Person 3</td>
<td>5</td>
<td>25</td>
<td>100</td>
<td>0</td>
</tr>
<tr>
<td>Robert</td>
<td>0</td>
<td>29</td>
<td>0</td>
<td>100</td>
</tr>
</tbody>
</table>

Network Constraint

$C = \sum_{j} c_{ij} = \sum_{j} (p_{ij} + \sum_{q} p_{ij} p_{jq})^2, i,j \neq q$
Network Constraint
\( C = \sum c_{ij} = \sum [p_{ij} + \sum q_{i}p_{iq}q_{j}]^2, \ i, j \neq q \)

person 3: \( .402 = (.25+.0)^2 + (.25+.084)^2 + (.25+.091)^2 + (.25+.084)^2 \)

Robert: \( .148 = (.077+.0)^2 + (.154+.0)^2 + (.154+.0)^2 + (.154+.0)^2 + (.154+.0)^2 + (.154+.0)^2 \)

From Figure 1.1 in Brokerage and Closure. For an HBR treatment of the network distinction between Robert and James, see in the course packet Kotter’s classic distinction between “leaders” versus “managers.” Robert ideally corresponds to the image of a “T-shaped manager,” nicely articulated in Hansen’s HBR paper in the course packet.
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

Here is the core network for a job BEFORE and AFTER the employee expanded the social capital of the job by reallocating network time and energy to more diverse contacts.

It is the weak contact connections (structural holes) in the AFTER network that provides the expanded social capital.

The employee AFTER is more positioned at the crossroads of communication between social clusters within the firm and its market, and so is better positioned to craft projects and policy that add value across clusters.

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, and Pfeffer’s note in packet for a readable overview.
Competitive Advantage in Social Networks Begins with 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 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."

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 = $\sum_i \sum_{j>i} \left(\frac{[z_{ei} z_{ej} - z_{ij}]}{\sum_{k} z_{ki} z_{kj}}\right)$, $k \neq i, j$. Scores are on page 51 in Appendix IV.
Network Metrics for More Usual Network


Network Betweenness
Network Constraint

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

_____ Size
_____ Density
_____ Betweenness
Strategic Leadership Foundations (page 34)

**HOW IT WORKS: Creativity and Innovation Are at the Heart of It**

1. **Creativity & Innovation** (What should be done?)
2. **Adaptive Implementation** (How to frame it & who should be involved?)
3. **Achievement & Rewards** (What benefits?)
4. **Brokerage across Structural Holes**

- **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)

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Illustration: Where did the M-16 come from?

Discussion Question*

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

\[ Y = a + b \ln(C) \]

<table>
<thead>
<tr>
<th>Judge</th>
<th>( \hat{a} )</th>
<th>( \hat{b} )</th>
<th>( t )</th>
</tr>
</thead>
<tbody>
<tr>
<td>Judge 1</td>
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<td>-1.04</td>
<td>-5.8</td>
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<tr>
<td>Judge 2</td>
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<td>-3.9</td>
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<tr>
<td>Combined</td>
<td>5.51</td>
<td>-0.91</td>
<td>-7.4</td>
</tr>
</tbody>
</table>

“...for those ideas that were either too local in nature, incomprehensible, vague, or too whiny, I didn’t rate them”

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).
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.
Network Constraint (lack of structural holes within and between producer-director-writer teams in which person worked)

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).
Four Summary Points on Foundations

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: Closure-Trust Association

Network closure enhances communication and individual visibility within a group, (a) which creates reputation costs for individuals who express opinion or behavior inconsistent with group standards, (b) which makes it less risky to trust within the group, (c) which enhances productivity as people become self-aligning in extraordinary efforts. Value comes from lower costs for labor, management, and time. Closure delivers that value by creating a reputation cost for deviation from colleague opinion and practice. Over time, information becomes “sticky” within clusters, different between clusters.

RULE 2: Brokerage-Achievement Association

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 innovation leaders, better compensated than peers, more widely celebrated than peers, and promoted more quickly to senior rank.

Three Points Follow from the Link between Network Brokerage and Good Ideas

- Closed networks do not identify unintelligent managers so much as expert specialists.

- Innovation is an import/export process. Value is not created at the innovation source. It is created each time productive knowledge produces innovation in a target audience.

- Innovation depends on the network as well as the person. Innovation 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.
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.

### Network Diagnostic Survey

1. Who is your immediate supervisor? (person most responsible for your annual review and initial salary-promotion recommendations) Please enter the person's first and last name, then the approximate years for which you have known the person, and the typical frequency with which you have direct contact with the person (not email lists).

<table>
<thead>
<tr>
<th>Name (enter full first and last name, e.g., John Smith)</th>
<th>Years Known</th>
<th>Contact Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>About Once a Week</td>
</tr>
</tbody>
</table>

5. More generally, who are the seven or eight people with whom you have had the most frequent and substantive work contact over the last six months? Limit yourself to people with whom you have had direct contact (not email lists). Include any of the people you named above if they qualify under the "most frequent and substantive contact" criterion. And once more, please enter first and last names, then the approximate years for which you have known each person, and the typical frequency with which you have direct contact with the person.

<table>
<thead>
<tr>
<th>Name (enter full first and last name, e.g., John Smith)</th>
<th>Years Known</th>
<th>Contact Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>About Once a Week</td>
</tr>
</tbody>
</table>

Click the SUBMIT button for the final question.
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

“O”ften 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.

“S”ome” 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.

“R”are” indicates, again as best you know, that the two people speak infrequently or not at all to one another.

“D”ifficult” 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 | 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.

![Network Diagram]

Click the SUBMIT button to save all your data.
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.

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 Network Closure/Embedding

Let a 2-step connection refer to a connection between two people through a mutual contact. For example, the “1” under “D” for Jim in the first row of the table refers to person 4 in the sociogram. Person 4 is the only contact linked directly to Jim and person 1. The “3” underneath the “1” in the table refers to three mutual contacts between Jim and person 2. The mutual contacts are persons 4, 6, and 7. Two-step connections are this chapter’s measure of direct structural embedding. Indirect structural embedding is measured in this chapter with 3-step connections. For example, the “1” under “I” for Jim in the second row of the table refers to persons 5 and 3 in the sociogram. Jim’s connections to 2 through persons 4, 6, and 7 are 2-step connections.

Jim’s fourth contact, person 5, is not connected to person 2, but is connected to 3 who is connected to 2, so Jim has a 3-step connection to person 2 via person 5. In graph theoretic terms, I am looking for geodesics linking two people through one intermediary (direct structural embedding) or two intermediaries (indirect structural embedding). Since I want to know how indirect embedding adds to direct embedding, I only count distant connections in the absence of closer connections. For example, Jim is connected to person 6 who is connected to 3 who is connected to 2, which is an 3-step connection between Jim and person 2. However, Jim reaches 2 through 6 directly, so the table reports one 3-step connection (the 5-3-2 connection).

This is Figure 2 in Burt, "Closure and stability" in The Missing Links: Formation and Decay of Economic Networks, edited by J. Rauch (2007 Russell Sage Foundation). For elaboration and illustration of indirect connections, see Chapter 7 in the on-line network textbook, Introduction to Social Network Methods, by Robert A. Hanneman and Mark Riddle (http://faculty.ucr.edu/~hanneman/nettext).
Appendix III: Closure/Embedding and the Theory of the Firm

The Source is John Commons’ Five-Player Unit for Transactional Analysis

(1) MAY — range of behaviors allowed in relationship
(2) MUST — minimum obligations of relationship
(3) CAN — minimum rights in relationship
(4) CANNOT — behaviors prohibited in relationship

Graphic is from Figure 7.1 in Structural Holes (Burt, 1992), see John R. Commons (1924), Legal Foundations of Capitalism, chapter on transactions, which set a stage for Coase’s (1937) nobel-winning “The Nature of the Firm” in Economica, and subsequent work on “competitive strategy.”
Appendix IV: 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): $c_{ij} = (p_{ij} + \sum_{q} p_{iq} p_{qj})^2$, for $q \neq i,j$, where $p_{ij}$ is the proportion of i’s network time and energy invested in contact
Constraint measures the extent to which a network doesn't span structural holes.

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.

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

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></td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>B</td>
<td>1</td>
<td></td>
<td>0</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>C</td>
<td>0</td>
<td>0</td>
<td></td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D</td>
<td>0</td>
<td>1</td>
<td>0</td>
<td></td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>E</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
<td>0</td>
</tr>
<tr>
<td>F</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
</tbody>
</table>

Gray dot: $1 \times 1 = 1$

total 39.9 = aggregate constraint ($C = \sum_j c_{ij}$)
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, $\Sigma_j c_{ij}$, 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: $\Sigma_j (p_{ij})^2 + 2\Sigma_j p_{ij}(\Sigma_q p_{iq} p_{qj}) + \Sigma_j (\Sigma_q p_{iq} p_{qj})^2$. 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 51 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 (that 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 \((\Sigma q_p q_r p_q j)\). 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.
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

<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>

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 V: Closure and Learning Curves
by Michael Rothschild

Bruce Henderson certainly didn’t look like a revolutionary. No tattered army fatigues. No fiery rhetoric. He favored starched white shirts and pinstripe suits. He spoke softly, in the measured, almost halting, manner of a southern gentleman. But Bruce Henderson had the “right stuff” of a revolutionary — profoundly new ideas that change the way society works. The originator of modern corporate strategy and founder of The Boston Consulting Group (BCG), Bruce Henderson died this summer in his hometown of Nashville, Tennessee. He was 77.

Trained as an engineer, Bruce Henderson became fascinated with economic ideas for terribly practical business reasons. Back in the days before he established the discipline of corporate strategy, making the big decisions about a company’s long-term future was pretty much a “seat of the pants” affair. The CEO, with perhaps a few senior executives and board members, would sit around and talk until they came up with a plan that seemed sensible. “Bet-your-company” decisions like launching a new product line, acquiring a subsidiary, or shutting down a factory, were made on little more than intuition.

A rigorous analytical approach to making key decisions was impossible, because there were no guiding strategic principles, no theories that could be turned into quantifiable models. Standard economic models existed, of course, but every sophisticated businessman knew that the economists’ mythical kingdom of “perfect competition” bore no relationship to reality. To turn corporate strategy into a credible discipline — and consulting assignments that major clients would pay major money for — Henderson had to find a hard link between business and underlying economic forces.

Henderson’s search began with highly detailed analyses of production costs. Early in his career, while a purchasing manager for a Westinghouse division, he wondered why suppliers who produced their goods in virtually identical factories often put in bids at dramatically different prices. Economic theory said it wouldn’t happen. Producers using similar capital equipment were supposed to have similar unit costs and offer roughly the same prices. But economic theory was wrong. In case after case, actual unit costs varied dramatically among suppliers. Henderson didn’t know why, but he had zeroed in on the crucial question.

Then, in 1966, shortly after he founded BCG, a study for Texas Instruments’ semiconductor division revealed the answer. When TI’s unit cost data for a particular part was plotted against the company’s accumulated production experience, the cost of the part declined quite predictably. For example, if the 1000th unit off the line had cost $100 to make, the 2000th unit would cost 80% as much, or $80. By the time the 4000th unit was produced, it would cost just $64 ($80 x 80%). Every time cumulative experience doubled, unit costs dropped about 20%. Though it’s “old hat” among today’s high-tech managers, the notion of predictably declining costs was a radical concept when Bruce Henderson began teaching companies about the “experience curve” a quarter century ago.

This article appeared in a longer form in UpSide (December 1992, Copyright 1992 The Bionomics Institute).
During the 1970s, Henderson’s concept became the foundation of modern corporate strategy. For the first time, it was possible to explain why building a factory just like your competitor’s didn’t mean you could match his costs. If he had a head start in experience, you could wind up chasing him down the experience curve. If you both sold at the market price, he’d make money on every unit, while you’d be lucky to break-even.

Once the experience curve was understood, the importance of being the first one to enter a new market became clear. Properly executed, the preemptive strike could mean long-term market leadership and long-term profits. Similarly, the experience curve explained why defending market share mattered. Raising prices to boost short-term profits sold off market share, slowed experience growth, and often handed over low cost leadership to an aggressive competitor. It’s a scenario that’s been played out hundreds of times as “experience conscious” Japanese competitors overtook their “profit conscious” American rivals.

Simply put, Bruce Henderson’s experience curve explained how an industry’s past shapes its future. Where conventional economics banished history by blithely assuming that “technology holds constant,” Henderson used the experience curve to show how the new insights generated by practical experience translated into higher productivity and lower costs. Where conventional economics taught the “law of diminishing returns,” Bruce Henderson taught the “law of increasing returns.” Where mainstream economics taught that marginal unit costs must rise at some point, Henderson showed that marginal unit costs can continually fall.

When the cost/performance potential of a particular technology is nearly exhausted, an industry will shift to a substitute technology and begin a new “experience curve.” For example, even as the airlines have shifted from one aircraft technology to the next, their cost/seat-mile keeps falling, opening up air travel to the entire population. By substituting new knowledge for labor and materials, experience-driven innovation keeps pushing costs down. As Henderson put it, when a firm is properly managed, its “product costs will go down forever.”

Though he concentrated on the practical problems of clients, Henderson knew full well that the experience curve had undermined the intellectual foundation of mainstream economics. In 1973, he wrote: The experience curve is a contradiction of some of the most basic assumptions of classical economic theory. All economics assumes that there is a finite minimum cost which is a function of scale. This is usually stated in terms of all cost/volume curves being either L shaped or U shaped. It is not true except for a moment in time. . . Our entire concept of competition, anti-trust, and non-monopolistic free enterprise is based on a fallacy.

I’m often asked whether the work of the great Austrian economist F.A. Hayek inspired me to write Bionomics. Despite my unending admiration for Hayek, the short answer is no, I’d never read him. Bruce Henderson inspired me to rethink the received economic wisdom. Without his “experience curve,” there is no final and fully satisfying explanation for falling costs, rising incomes, and the phenomenon of economic growth. More than anyone else, he made it both possible and necessary for economic thinkers to break free of the static, zero-sum mentality that has gripped the “dismal science” for 200 years. Bruce Henderson gave us the key to “positive-sum” economics. Thanks for the revolution, Bruce.
Detail on Learning Curves, Productivity on the WW II Liberty Ships

Stern of the SS John P. Gaines in the Aleutian Islands

Texas (Todd Houston)
Georgia (Southeastern)
Florida (St. Johns River)

Days from Start to Delivery

Month that Work on Ship Began
(Keel Laid)

0 50 100 150 200 250 300
1941 1942 1943 1944 1945

Sequence of Ship in Shipyard Production

0 50 100 150 200 250 300 350 400

- California (Permanente Metals #2, 4-day Robert E. Peary)
- Maine (New England)
- Maryland (Bethlehem Fairfield)
- Oregon (10-day Joseph N. Teal)
- Other (Florida, Georgia, Texas)

from Figure 3.7 in Brokerage and Closure (see pages 50-61 below for Financial Times piece on kinds of industries in which a strong culture is a competitive advantage.
Some Example Learning Curves

Source: Graphs to the left are from Stern and Stalk (1998: pp. 14, 19), Perspectives on Strategy. The one below is from Thurstone (1919, p. 45) "The learning curve equation," Psychological Monographs. The association below can be described as \( Y = aX^b \), where \( Y \) is words typed in four minutes, \( X \) is cumulative words typed (at 250/page), and the estimated slope \( b \) is .42 (cf. slope estimates of .11 to .29 for ship production in Rapping, 1965, p. 65, "Learning and World War II production functions" Review of Economics and Statistics).

Research on semiconductor learning curves shows 20% decrease in cost with cumulative volume doubling, learning three times faster from one's own experience than from experience in another organization, and spillovers between organizations as likely within as between countries (Irwin and Klenow, "Learning-by-doing spillovers in the semiconductor industry," 1994, Journal of Political Economy).
Appendix VI: Snippets on Business Culture

Kotter and Heskett mailed questionnaires in the late 1970s and early 1980s to measure relative strength of culture. To evaluate the relationship between culture and performance, they used a simple regression equation:

\[ Y = \beta_0 + \beta_1 X \]

where \( Y \) represents the relative return on invested capital, and \( X \) is the corporate culture rating. The equation shows a predictable shift from culture being economically irrelevant to it being a competitive asset. Nineteen industries in total showed a correlation on the vertical axis of Graph 3 by the correlation between performance and culture. Apparel is at the bottom with its correlation of .00, while Utilities at the top with its correlation of .76. The industries with the highest correlation are Utilities, followed by Communications and Beverages.

Graph 1 contains pharmaceutical firms, along with sample firms from beverages, personal care, and communications — a total of 30 firms. No extreme cases obscure an otherwise linearity of the data. The point is the lack of association between performance and culture; the stronger the corporate culture, the higher the return on invested capital.

For example, Johnson & Johnson enjoyed a return on invested capital of 15% from 1977 to 1988. For illustration here, I use average return on invested capital from 1977 to 1988, income growth from 1977 to 1988, average return on sales from 1977 to 1988, and average return on assets from 1977 to 1988. The horizontal axis of Graph 3 is a measure of economic performance, and the vertical axis represents the relative return on invested capital.

Evidence is mixed when it comes to whether corporate culture can be a powerful advantage over competitors. The complication is that in other industries, culture is irrelevant to performance. The trick is to know when culture is a competitive asset and when it is not.

Appendix VI: Snippets on Business Culture

When is Corporate Culture a Competitive Asset?

Corporate culture refers to the informal control mechanism that coordinates employee effort. Employees deviating from accepted practice can be detected and admonished. Corporate culture is not a competitive asset if it is socially constructed by them, so employee autonomy is high. Corporate culture can be a powerful advantage over competitors. The complication is that in other industries, culture is irrelevant to performance. The trick is to know when culture is a competitive asset and when it is not.

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<table>
<thead>
<tr>
<th>Industry Category</th>
<th>Weight</th>
</tr>
</thead>
<tbody>
<tr>
<td>Furniture (not household)</td>
<td>0.48</td>
</tr>
<tr>
<td>Heating, plumbing &amp; structural metals products</td>
<td>0.48</td>
</tr>
<tr>
<td>Fabrics, yarn &amp; thread mills</td>
<td>0.79</td>
</tr>
<tr>
<td>Textile goods &amp; floor coverings</td>
<td>0.79</td>
</tr>
<tr>
<td>Electronic components &amp; accessories</td>
<td>0.75</td>
</tr>
<tr>
<td>Apparel</td>
<td>0.74</td>
</tr>
<tr>
<td>Glass &amp; glass products</td>
<td>0.74</td>
</tr>
<tr>
<td>Transportation &amp; warehousing (not airlines)</td>
<td>0.47</td>
</tr>
<tr>
<td>Wholesale trade</td>
<td>0.44</td>
</tr>
<tr>
<td>Printing &amp; publishing</td>
<td>0.39</td>
</tr>
<tr>
<td>Paper &amp; allied products (not containers)</td>
<td>0.43</td>
</tr>
<tr>
<td>Footware &amp; other leather products</td>
<td>0.69</td>
</tr>
<tr>
<td>Machines, general industry</td>
<td>0.67</td>
</tr>
<tr>
<td>Household appliances</td>
<td>0.65</td>
</tr>
<tr>
<td>Machines, metalworking</td>
<td>0.66</td>
</tr>
<tr>
<td>Engines &amp; turbines</td>
<td>0.27</td>
</tr>
<tr>
<td>Aircraft &amp; parts</td>
<td>0.22</td>
</tr>
<tr>
<td>Drugs, cleaning &amp; toilet preparations</td>
<td>0.22</td>
</tr>
<tr>
<td>Stone &amp; clay products</td>
<td>0.20</td>
</tr>
<tr>
<td>Electric, gas, water &amp; sanitary services</td>
<td>0.58</td>
</tr>
<tr>
<td>Food (not beverages)</td>
<td>0.57</td>
</tr>
<tr>
<td>Plastics &amp; synthetic materials</td>
<td>0.57</td>
</tr>
<tr>
<td>Food (beverages)</td>
<td>0.16</td>
</tr>
<tr>
<td>Rubber &amp; miscellaneous plastic products</td>
<td>0.53</td>
</tr>
<tr>
<td>Office, computing &amp; accounting machines</td>
<td>0.53</td>
</tr>
<tr>
<td>Finance (banking)</td>
<td>0.49</td>
</tr>
<tr>
<td>Lumber &amp; wood products (not containers)</td>
<td>0.49</td>
</tr>
<tr>
<td>Paints &amp; allied products</td>
<td>0.49</td>
</tr>
<tr>
<td>Scientific &amp; controlling instruments</td>
<td>0.49</td>
</tr>
</tbody>
</table>

The strength of corporate culture and the reliability of firm performance, as well as the relationship between market competition and economic performance, are both captured in the contingency function. This function relates the degree of market competition (represented on the horizontal axis) to the relative return on invested capital (represented on the vertical axis). The equation for this relationship is:

\[ Y = 0.941 + 0.312 \ln(1 - X) \]

where \( Y \) is the relative return on invested capital and \( X \) is the degree of market competition. The coefficient for the degree of market competition is negative, indicating a negative relationship between market competition and relative return on invested capital.
Distinctions Between Inside and Outside the Firm

(colleague relations pre-dating entry into the firm)

<table>
<thead>
<tr>
<th>Years in the Firm</th>
<th>Number Colleagues</th>
<th>% Known Before Firm</th>
<th>Mean Years Known</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 10</td>
<td>105</td>
<td>26%</td>
<td>5.2</td>
</tr>
<tr>
<td>11 to 20</td>
<td>160</td>
<td>15%</td>
<td>8.2</td>
</tr>
<tr>
<td>Over 20</td>
<td>391</td>
<td>5%</td>
<td>10.3</td>
</tr>
<tr>
<td>Total</td>
<td>656</td>
<td>11%</td>
<td>9.0</td>
</tr>
</tbody>
</table>

French Managers

<table>
<thead>
<tr>
<th>Years in the Firm</th>
<th>Number Colleagues</th>
<th>% Known Before Firm</th>
<th>Mean Years Known</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 to 10</td>
<td>691</td>
<td>81%</td>
<td>12.6</td>
</tr>
<tr>
<td>11 to 20</td>
<td>875</td>
<td>42%</td>
<td>13.5</td>
</tr>
<tr>
<td>Over 20</td>
<td>129</td>
<td>6%</td>
<td>14.9</td>
</tr>
<tr>
<td>Total</td>
<td>1695</td>
<td>55%</td>
<td>13.0</td>
</tr>
</tbody>
</table>

American Managers

from Burt, Hogarth, and Michaud "The social capital of French and American managers" (2000, Organization Science)
Appendix VII: 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 (2019, *Structural Holes in Virtual Worlds*)
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 (2019, *Structural Holes in Virtual Worlds*)
Network Worksheet

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

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

<table>
<thead>
<tr>
<th>size (degree)</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>density (# / #possible)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>betweenness (holes)</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>