

## APPENDIX: RESEARCH DESIGN IMPLICATIONS

The review in “The network structure of social capital” was written for the broad audience of people interested in social capital. This appendix is for those few interested in designing research on the phenomenon. Tables and figures in the review chapter are referenced here by their number, and chapter text is referenced as “the text.” Section A1 is about selecting a study population to get rich data on social capital and its effects (focus on places where competitive advantage would result from better access to, and control over, information). Section A2 is about network measures of social capital. Section A3 is about positional measures (contacts are sorted into kinds, relations between contacts are typically unknown, and social capital is inferred from relations with kinds of contacts). Section A4 is a caution about predicting change (social capital is more often a by-product than a goal).

### A1. STUDY POPULATION

The contingent value of social capital means that alternative study populations are not equally productive sites for research on social capital. As concluded in the text, “The information and control benefits of brokerage are more valuable to people working on more unique tasks, which means tasks on which they have few peers, and so tasks in which there is uncertainty about how to proceed. This is the point illustrated by the performance surfaces in Figure 5 and Figure 6. Performance increases more steeply from point B to A at the back of the graphs (few peers, high task uncertainty) than it does from point C to point D at the front of the graphs (many peers, low task uncertainty).”

The implication is that more will be learned about social capital in a study population of people working against few peers and under high task uncertainty. Research design often involves a choice about which ranks of people, or kinds of groups, to include in a study. Focus on people who are more the authors of their own jobs. Focus on groups and organizations working with less familiar technologies, on less clearly-defined problems, for less familiar markets. There is a criterion question to ask when selecting between alternatives: “Where is there more of a competitive advantage for a person having better access to, and control of, information?”

There is also implication for research on a study population in which one has as no choice about who to include: Be sure to obtain data on peers (e.g., rank, function, and location data can be used to measure how many people do the same work) and task uncertainty (e.g., code whether the work involves new or familiar technology, whether there are clear benchmarks for work quality, and whether the work is for a new or a familiar market). The peer and uncertainty data can be used as contingency control variables to get an accurate estimate of social capital effects in the study population.

## A2. NETWORK MEASURES

The data for relational measures are generic network data: a square matrix in which element  $z_{ij}$  is the strength of relationship from  $i$  to  $j$ , only in this case the network is limited to the contacts around a specific individual or organization (sometimes discussed as a personal network or an ego-network). The data can be obtained from archival records, or direct observation, or any other of the usual sources, but they are most often obtained in a survey. A first design question is to ask how many and which name generators should be used to measure social capital. Name generators are the sociometric questions that elicit the names of contacts in a network (e.g. “Who have been your most valued contacts?”). Some often-used generators were discussed in Figure 4. More generators mean larger networks at a cost of interview time and respondent patience (see Marsden, 1990, for general

review; Burt, 1984, for considerations that went into the selection of a name generator for the General Social Survey; Burt, 1997, for practical guidelines on manager networks in particular). An implication of the review is that personal discussion relations should be a first priority. These are the informal relations through which the information and control benefits of structural holes most clearly operate. Though formal and informal work authority relations have not shown the same strength of effects, they are an important second priority because the intersection of personal and work relations can be significant, and the jury is still out on how performance is affected by structural holes in the authority network. Name interpreters are the questions used to elicit information on the relationships elicited by name generators. The most important name interpreter for social capital research asks about relations with contact and between contacts. Again, Burt (1984) reviews the pros and cons of several name interpreters considered for the General Social Survey, and Marsden (1990) provides a general review. An illustrative questionnaire can be downloaded from my webpage (<http://gsbwww.uchicago.edu/fac/ronald.burt/research>).

### *A2.1. Bridges*

An intuitively appealing measure is to count bridges. The relationship with a contact is a bridge if there are no indirect connections to the contact through other contacts, and simple counts of bridges have the predicted association with performance — people with more bridge relationships do better (e.g., Burt, Hogarth, and Michaud, 2000:Appendix; Burt, 2000: Table 1, for alternative coding schemes).

The simplicity of this measure highlights an assumption underlying it and other measures below: social capital is assumed to increase with the number of bridges. In fact, some bridges have no value because there is no value in moving information between some groups (e.g., explain to your grandmother the latest technological development in your line of work), and the performance gains from social capital can occur with just one key bridge relationship (e.g., 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 still another from history). It could be argued that people with more bridges are more likely to have one that is valuable and to understand how to use bridges to add value, but the point remains that each additional bridge in a network is not a unit increase in social capital. The practical implication is to check for nonlinear associations between performance and social capital measures. Performance could be higher after the first bridge relationship.

### *A2.2. Network Constraint*

As a summary measure of social capital, I use a network constraint index,  $C$ , that describes the extent to which a network is concentrated in redundant contacts (Burt, 1992:Chap. 2). Network constraint is one of many concentration measures that could be used to the same end.

The index begins with a measure of the extent to which person  $i$ 's network is directly or indirectly invested in a relationship with contact  $j$ :  $c_{ij} = (p_{ij} + \sum_q p_{iq}p_{qj})^2$ , for  $i, j$ , where  $p_{ij}$  is the proportion of  $i$ 's network time and energy invested in contact  $j$ ,  $p_{ij} = z_{ij} / \sum_q z_{iq}$ , and variable  $z_{ij}$  is the strength of relationship between contacts  $i$  and  $j$ . 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 and report integer scores.

As a frame of reference, network constraint scores have a 27.9 mean and 10.5 standard deviation across the 841 observations in the five study populations in the text (Figure 3, Tables 1 and 2). The network around Robert in Figure 2 is less constrained than the average ( $C = 15$ ). The network around James is slightly more constrained than average ( $C = 31$ ).

Association between performance and network constraint is a summary test between the two leading network mechanisms argued to provide social capital. More constrained networks span fewer structural holes, which means less social capital according to the hole argument. If networks that span structural holes are the source of social capital, then performance should have a negative association with network constraint. More constraint means more network closure, and so more

social capital according to the closure argument. If network closure is the source of social capital, then performance should have a positive association with constraint.

### A2.3. Network Size

More specifically, network constraint varies with three qualities of a network: size, density, and hierarchy.<sup>1</sup> Network size, N, is the number of contacts in a network. For example, Robert and James in Figure 2 have 7 contacts each (versus an average size of 14.7 in the five study populations in the text). 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. With respect to measurement, 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 (-.66 correlation between network constraint and size across managers in the five study populations in the text). If networks that span structural holes are social capital, there should be a positive association between performance and network size. Numbers of contacts are not a variable in the closure argument, but it seems reasonable to expect that more contacts would be advantageous as long as they do not weaken closure. Association between performance and network size is not a powerful evidential criterion for distinguishing the closure and hole arguments.

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<sup>1</sup> Burt (1998:Appendix) reports similar size, density, and hierarchy results with the familiar network measures used here and corresponding measures implicit in the constraint index. Given contact-specific constraint,  $c_{ij}$ :

$$(p_{ij})^2 + 2p_{ij}(q_{pi}q_{pj}) + (q_{pi}q_{pj})^2,$$

where  $q_{ij}$ , the aggregate constraint index, C, is a sum of three variables:

$$i(p_{ij})^2 + 2 \sum_j p_{ij}(q_{pi}q_{pj}) + \sum_j (q_{pi}q_{pj})^2.$$

The first variable 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 variable, 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 variable, 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) and Borgatti, Jones, and Everett (1998) for further discussion of the components in network constraint.

#### A2.4. Network Density

Density,  $D$ , is the average strength of connection between contacts:  $\sum z_{ij} / N*(N-1)$ , where summation is across all contacts  $i$  and  $j$ . Density is sometimes discussed as a proportion because in studies limited to dichotomous network data (people are connected or not), the average strength of connection between contacts is also the proportion of contact pairs connected. For the purposes here, relations are scaled to vary between 0 and 100 and integer values of density are reported. Dense networks are more constraining since there are more indirect connections among contacts ( $\rho_{ij} = \rho_{ji}$  in the constraint equation). Across the five study populations in the text, density has an average value of 36.7, and a .71 correlation with network constraint.

———— Figure A1 About Here ————

Hypothetical networks in Figure A1 illustrate how constraint varies with size, density, and hierarchy. Relations, usually continuous, often asymmetric, are simplified in Figure A1 to binary and symmetric. The graphs only display relations between contacts. Relations with the respondent are not presented. The first column contains sparse (minimum density) networks. No contact is connected with other contacts. The second column of the figure contains maximum-density networks. Every contact has a strong connection with each other contact. At each network size, constraint is lower in the sparse-network column.

Density is only one form of network closure, but it is a form often discussed as closure. Contacts in a dense network are in close communication so they can readily enforce sanctions against individuals who violate shared beliefs or norms of behavior. If network closure is the source of social capital, performance should have a positive association with network density. At the same time, strong connections between contacts increase the probability that the contacts know the same information, and the direct connections eliminate opportunities to broker information between contacts. Dense networks offer less of the information and control advantage associated with spanning structural holes. If networks that span structural holes are the source of social capital, performance should have a negative association with network density.

### *A2.5. Network Hierarchy*

Density is a form of closure in which contacts are equally connected. Hierarchy is an alternative form of closure in which a minority of contacts, typically one or two, stand apart as the source of closure. In the extreme case, a network is hierarchical to the extent that it is 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 often built around the boss.

Where network constraint measures the extent to which contacts are redundant, network hierarchy,  $H$ , measures the extent to which the redundancy can be traced to a single contact in the network. As a form of network closure, hierarchy should have a positive association with performance if closure provides social capital. In contrast, 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. In short, the manager whose network is built around a central contact runs a risk of playing Tonto to the central contact's Lone Ranger. If networks that span structural holes are the source of social capital, performance should have a negative association with network hierarchy. 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 (the central point in "The Social Capital of Outsiders" in the text).

The Coleman-Theil inequality index has attractive qualities as a measure of hierarchy (Burt, 1992:70ff.). Applied to contact-specific constraint scores, the index is the ratio of  $\sum_j r_j \ln(r_j)$  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 two columns of Figure A1, no one contact is more connected than others, so all of the hierarchy scores are zero. Robert and James in Figure 2 both have low hierarchy in their networks because their contacts are equally central, or peripheral, in their networks (respective scores of 3 and 4, versus a 7.6 average in the five study populations in the text).

Non-zero hierarchy scores occur in the third column of Figure A1, where one central contact is connected to all others who are otherwise disconnected from one another. The hierarchy can be seen in the relative levels of constraint posed by individual contacts. Contact A poses more severe constraint than the others because network ties are concentrated in A.

Note that constraint increases with hierarchy and density such that evidence of density correlated with performance can be evidence of a hierarchy effect (as illustrated in the text, see “The social capital of outsiders”). 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. In short, density and hierarchy are correlated, but distinct, components in network constraint. Across the five study populations in the text, for example, constraint has a strong correlation with density (.71) and a strong correlation with hierarchy (.56), but the correlation between density and hierarchy is in comparison low (.18, see Burt, 1992: 143, for illustrative graph).

An intuitively appealing alternative to the Coleman-Theil index is Freeman’s (1977) index of betweenness centrality. Betweenness measures the extent to which one contact stands between all others. Computed for the networks in Figure A1, betweenness equals zero for all networks in the first two columns, and equals its maximum of one for the networks in column three because contact A is the only connection between other contacts (of course, excluding the respondent not



displayed).<sup>2</sup> In contrast, the Coleman-Theil index increases with the number of people connected to the central contact (the difference between minimum and maximum constraint is larger in larger hierarchical networks). Hierarchy is 7 in the third column of Figure A1 for the three-contact hierarchical network, 25 for the five-contact network, and 50 for the ten-contact network. This feature turns out to be important for measuring the social capital of outsiders because it measures the volume of social capital borrowed from a sponsor and that strengthens the association with performance (Burt, 1998:Table 1).

### A3. POSITIONAL MEASURES

There is a temptation to skip the data on relations between contacts because they are the difficult and time-consuming to obtain. Moreover, useful work on social capital can be published that does not take into account ties between contacts. For example, Meyerson (1994) predicts executive salary in a selection of Swedish firms from a count of an executive's sociometric contacts outside the firm, and the proportion of the cited relations that are strong. Executives with stronger ties outside the firm enjoy higher salaries.<sup>3</sup> Uzzi (1996) predicts failures among New York apparel contractors from distributions of business across contacts.<sup>4</sup> Failure is less

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<sup>2</sup>Let  $b_{jk}$  equal the mean indirect connection from person  $i$  through contact  $j$  between two other contacts  $k$  and  $q$ :  $b_{jk} = \sum_{i \neq k, q} z_{ij}z_{jk}z_{jq} / ((N-1)[N-2])$ ,  $j = k, q$  and  $k \neq q$  and relations scaled to vary from 0 to 1. Betweenness hierarchy is the ratio of  $b_j$  ( $b_{\max} - b_j$ ) divided by  $N-1$ , where  $b_{\max}$  is the largest value of  $b_j$  in the network. One contact will have  $b_j$  equal to  $b_{\max}$ . When all other  $b_j$  are zero, the  $(b_{\max} - b_j)$  sum to  $N-1$  and the index is 1.0. When all  $b_j$  are equal, the  $(b_{\max} - b_j)$  sum to 0.0 and the index is 0.0.

<sup>3</sup> Strong relations are the contacts cited for informal socializing or discussing personal matters (Meyerson, 1994: 391). There is a measure of nonredundancy in the analysis (NONREDUNDANTIE), but the redundancy is between networks of separate executives, not within each executive's network (Meyerson, 1994: note 12).

<sup>4</sup> Uzzi's measures of embeddedness warrant a caution because they might be seen as measuring the extent to which relations are embedded in dense networks, whereupon their association with survival would be misinterpreted. The measures are computed from data that describe contractor sales of apparel components to manufacturers who assemble and market finished clothing (Uzzi, 1996: 696). Both network variables discussed as embeddedness are associated with contractor survival (a third, "social capital embeddedness," a dummy variable distinguishing contractors affiliated with a business group, has a negligible association with survival). Uzzi (1996:686, italics in original) begins with an

likely for contractors that have exclusive business relationships. There has even been productive work at the radical extreme of measuring social capital without any network data. Belliveau, O'Reilly, and Wade (1996) infer relations from background similarities between people, as do Ancona and Caldwell (1992) and Reagans and Zuckerman (1999) in their suggestive work on the external networks of teams. Perhaps most prominent is Coleman's (1988; 1990, pp. 590-597) analysis of social capital in which he infers network structure from family demography (children in families with two parents and few children are less likely to drop out of high school), family mobility (children who have lived in the same neighborhood all their lives are less likely to drop out of high school), and school (children in Catholic and other religious private high schools are less likely to drop out).

Inferences about social capital can be made in the absence of data on relations between contacts if data are available on the positions contacts hold in the broader social system beyond the network under analysis. People who occupy the same position in the broader social system are exposed to similar ideas, skills, and resources, and so are to some extent redundant contacts; they are redundant by structural equivalence. Therefore, social capital can be inferred from the positions to

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exclusive contractor-manufacturer tie; "The degree to which a firm uses embedded ties to link to its network is measured with the variable first-order network coupling." The variable is a Herfindahl index of concentration (sum of squared proportions) measuring the extent to which all of a contractor's sales are to a single manufacturer (Uzzi, 1996: Eq. 1). The other network variable (Uzzi, 1996:687) measures the average extent to which the contractor (focal firm) is the only contractor selling to its manufacturers (network partners); "Second-order network coupling measures the degree to which a focal firm's network partners maintain arm's length or embedded ties with their network partners." The variable is a Herfindahl index measuring the extent to which all of a manufacturer's purchases are from the contractor, averaged across the manufacturers to which the contractor sold goods (Uzzi, 1996: Eq. 3). The two Herfindahl indices are associated with contractor failure: failure is less likely to the extent that a contractor sells exclusively to a single manufacturer, and the manufacturers to which it sells only buy from that contractor. Thus my summary statement in the text that failure is less likely for contractors that have exclusive business relationships. Relations between manufacturers and between contractors are unknown, so there is no measure of the density and hierarchy of the network in which contractor-manufacturer relations were embedded. Uzzi's (1996) results are conceptually the same as, though substantively more detailed than, Meyerson's (1994) and Gabbay's (1997) results showing how important it is to span a structural hole with a strong, reliable relationship. The structural hole from which Uzzi's contractors and manufacturers profit is the division between people who make garment components and people who assemble the components into clothing.

which a person is connected. This is the foundation for positional measures of social capital.

Positional measures are defined in two steps. The first is to sort potential contacts into kinds according to their position in some broader social system. For example, contacts in different occupational statuses have access to different resources (Laumann, 1966; Lin, Ensel, and Vaughn, 1981; Lin and Dumin, 1986; Erickson, 1996), relations in broken homes are different from relations in intact families (Coleman, 1990), people long with the firm are different from new hires (Ancona and Caldwell, 1992; Reagans and Zuckerman, 1999), contacts inside a firm are different from contacts outside the firm (Meyerson, 1994), contacts in one division or function of a company are different from contacts in another division or function (Ancona and Caldwell, 1992; Hansen, 1999), contacts in one academic school of thought are different from contacts in another school (Collins, 1998), alliances can be distinguished by kind of alliance partner (Baum, Calabrese, and Silverman, 2000; Koput and Powell, 2000), or positions can be inferred from patterns of interaction (Walker, Kogut, and Shan, 1997, map contacts into structural equivalence categories). This first step for positional measurement is akin to the name generators in survey network data. Contacts are elicited for kinds of relationships by name generators and research design involves selecting an appropriate set of generators. Here, contacts are elicited for kinds of positions and research design involves selecting an appropriate set of positions.

The second step is to ask people about their connection with each position. Specific contacts are sometimes known, but often not. Nan Lin has been a leading advocate for positional measures of social capital, and offers an example survey item in which positions are defined by an assortment of occupations from high to low socioeconomic status (Lin, 2001:Table 5): “Here is a list of jobs (show card). Would you please tell me if you happen to know someone (on a first-name basis) having each job?” If the respondent knows more than one contact in a category, he or she is asked to “think of the one person whom you have known the longest (or the person who comes to mind first).” When a respondent answers “yes,” there are follow-up questions asking how long he or she has known the contact, the nature of

the relationship with the contact, and so on. Often-used measures of social capital are the heterogeneity of contacts (number of occupations is akin to number of bridges assuming that contacts in different occupations are non-redundant, see Erickson, 1996; 2001, for two productive applications) and “upper reachability,” which is the highest status in which the respondent has a personal contact.

This is not the place to offer a critique of positional measures, though a rigorous comparison of positional and network measures based on authoritative data would be welcome. What can be said by way of summary critique is that positional measures have at least two virtues: An obvious one is that they are inexpensive: it is easy and quick for a survey respondent to provide the data. Second, they generate results. Lin (1999; 2001; Forthcoming) provides review. Their primary disadvantage is not a defect so much as a risk: positional measures are heavily leveraged against the accuracy of the first step, the delineation of positions. For example, scholars outside the United States are following Lin’s lead in using positional measures of social capital based on translated American occupational categories. Such use poses no problems as long as the American categories correspond to structurally equivalent contacts in the application country. However, if there is structural variation within a category (e.g., lawyers whose clients are major corporations might have access to resources different from those to which personal injury lawyers have access, or professors at a nationally prominent university differ in some ways from professors at a community college), then the assumption that contacts are redundant within positions is violated and the inference from positional contact to social capital is unclear. A strength of Walker, Kogut, and Shan’s (1997) analysis is that they study structural equivalence to identify the positions in terms of which their study population is stratified before computing positional measures.

It might seem that positional measures are hopelessly flawed by their lack of data on the relations between contacts. For example, Robert and James in Figure 2 have the same number of contacts (seven) and the same distribution of network time and energy across their contacts (six strong, one weak). The social capital difference between them is only apparent from the difference in the structure of

relations among their contacts. More generally, positional measures cannot distinguish the columns in Figure A1; a sparse network is the same as a clique, and both are the same as a hierarchical network. However, turn the situation around and consider Figure A1 in light of positional distinctions. If a manager cited the three contacts at the top of the middle column and they were all three from the same segment of a company, then the manager indeed would have no social capital as is implied by the network constraint scores. But what if each contact worked in a different function, or a different division, or in a different company? Then the dense network among them would reinforce the strength of their bridge relationships with one another and the manager would be, in contrast to the high constraint score, rich in social capital.

#### A4. A CAUTION ABOUT PREDICTING CHANGE

Little is known about social capital etiology or decay since almost all research to date relies on networks measured at a single point in time. However, given the accumulating evidence of social capital benefits, it is a short step to talk about people strategically building relationships to increase the benefits. I use language to that effect in discussing Figure 8 with respect to the implications for managers building a network optimized for social capital (cf. Burt, 1992: 45n, 159ff), and in discussing holes disappearing on the path to equilibrium (pp. 11-13 in the text). Coleman (1990: 303) illustrates his argument with an anecdote about geographic mobility motivated by a desire for the greater social capital expected at the new location.

The heuristic language can be misleading. It is not obvious that people intentionally build social capital so much as social capital is a by-product of pursuing other ends. For one thing, social capital is not all that obvious. People vary in their ability to detect holes in social structure (Janicik, 1998; Freeman, 1992), and inaccurately diagnose the value of their network (Burt, 1998:Figure 8). More, relationships emerge from people being proximate while they pursue other interests. As Coleman (1990: 312, also pp. 313, 317-318) puts it, "A major use of the concept

of social capital depends on its being a by-product of activities engaged in for other purposes.” Key references for the fact that relations tend to develop between people brought together for other reasons are Festinger, Schachter, and Back’s (1950) description of friendships in a student housing project, Blau’s (1977, 1994) explanation of relations forming as a function of structural opportunities for relations, and Feld’s (1981) related explanation of relations clustering around predictable social foci in schools, neighborhoods, and work. In short, the natural evolution of networks is toward redundancy (Burt, 1992: 20); relations tend to develop between people who are already related in some way (redundancy by cohesion) or who have mutual friends, enemies, or acquaintances (redundancy by structural equivalence).

The distinction between by-product and end-goal is important for models of network change. For example, Contractor et al. (2000) describe change over the course of two years in the communication network within a public-works organization. They find that bridge relationships develop less often than relations with friends of friends, from which they conclude that the hole argument might not apply to networks of cooperative relations. More precisely, what they found is the expected tendency for networks to evolve toward redundancy, in their case toward redundancy by cohesion. Not knowing how performance varies across the network, it is impossible to test for social capital effects, but the hole argument predicts that individuals with networks that span structural holes do better precisely because they rise above the natural evolution toward redundancy in networks.

In their innovative paper on organization networks, Walker, Kogut, and Shan (1997) report a similar evolution toward redundancy in cooperation agreements between start-up firms and their partners in biotechnology. The agreements are joint ventures, licensing, and other long-term contracts in place at any time from 1984 through 1988 (Walker et al., 1997: 122). Walker et al. (1997: 109) extrapolate from social capital arguments that network change is motivated by individuals seeking social capital. From the hole argument, for example, Walker et al (1997: 111) infer that the, “structure is not strengthened, but repeatedly reshaped. The early pattern of relationships is blurred as more organizations are linked together.” The strongest empirical results are that the start-ups responsible for a large portion of density

variance (deemed social capital, Walker et al., 1997: 115-116) are more likely to form new partnerships, and are likely to form them with partners structurally equivalent to the partners with whom other start-ups equivalent to themselves formed relations — which illustrates the evolution of networks toward redundancy. Ties that replicate existing ties between equivalent kinds of organizations are more likely because they are a routine part of the business, so their properties are already known, so they are less costly to create and sustain. Innovative in illustrating evolution toward redundancy, the results again do not bear on social capital arguments because the performance implications of network change are not explored.

The summary point is that the network closure and brokerage models of social capital are about the consequences, not the causes, of social structure. Predicting structural change requires careful thought about the factors other than social capital that shape social structure, especially the endogenous tendency for networks to drift into redundancy.

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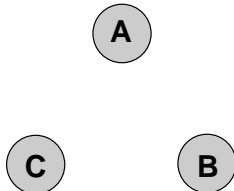
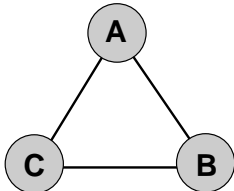
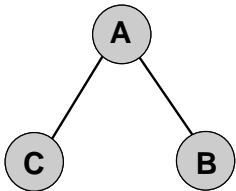
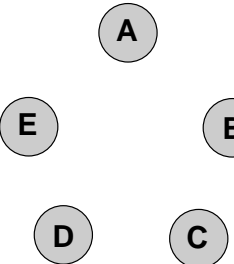
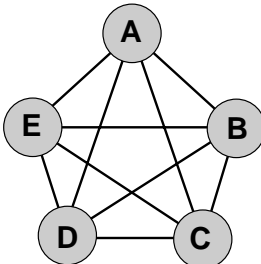
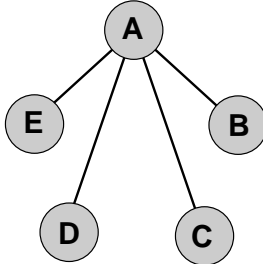
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# Figure A1. Network Constraint, Size, Density, and Hierarchy.

	Sparse Networks	Dense Networks	Hierarchical Networks
<b>Small Networks</b>			
size	3	3	3
density	0	100	67
hierarchy	0	0	7
constraint	33	93	84
from:			
A	11	31	44
B	11	31	20
C	11	31	20
<b>Larger Networks</b>			
size	5	5	5
density	0	100	40
hierarchy	0	0	25
constraint	20	65	59
from:			
A	4	13	36
B	4	13	6
C	4	13	6
D	4	13	6
E	4	13	6
<b>Still Larger Networks</b>			
size	10	10	10
density	0	100	20
hierarchy	0	0	50
constraint	10	36	41

NOTE — Network scores other than size are multiplied by 100.