Intraorganizational Networks

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The adage 'its not what you know but who you know' has taken on an unfortunate ubiquity humbling the terms "network" and "networking" to broadly used buzzwords. References to networking activities abound in business periodicals, corporate newsletters and the like. We witness networking groups and mentor programs with networking intentions, the "young professional's networking group" convening interested residents of a local condominium building, and such popular press books as *Savvy Networking* (RoAne, 1993) or *Power Schmoozing* (Mandell, 1996). While there is great virtue in the message that individuals and organizations ought to be cognizant of the role networks play in organizational life, these well meaning but often cursory efforts to encourage proactive use of one's social network belie the richness of available theory and research about those networks.

We do not quibble too much with the popular adage: networks do matter and this, in fact, may be the only claim that would not engender academic debate. Empirical research accumulated over the last two decades demonstrates that social networks are associated with outcomes relevant to individuals and organizations, including what O'Reilly (1991) identifies as issues central to organization behavior studies: motivation, leadership, job design, turnover and absenteeism, and work attitudes (Krackhardt and Brass, 1994). Illustrations of these network effects include: access to labor market information (Granovetter, 1973), deal-making (Mizruchi and Stearns, 2000), career advancement (Lin 2001; Podolny and Baron, 1997), identity formation (Ibarra, 1992), trust building and cooperation (Burt, 2000; Labianca et al., 1998; Coleman 1988); commitment and retention (Krackhardt and Porter, 1986), opinions about organizations (Galaskiewicz and Burt, 1991), group and team performance (Ancona and Caldwell, 1992; Rosenthal, 1996), performance evaluations and compensation (Burt, 2000; Meyerson, 1994), and behavior at the top of the firm such as use of poison pills (Davis and Greve, 1997), to name merely a few.

This chapter is organized around the intuitions social network theory brings to bear on intraorganizational phenomenon. Work in social network theory is characterized by its emphasis on structural form (patterns and positions) or relational content

(qualities of network ties), as well as by its level of analysis. These broad distinctions form the foundation of the framework for our review of the central questions addressed in this field. Key elements of central studies we highlight are summarized in Table 2.1.

Literature Review

STRUCTURE AND RELATIONS

A common sense explanation for why persons behave the way they do is to individualize. This is akin to what social psychologists refer to as the fundamental attribution error where we are likely to explain behavior in others by personality attributes rather than by situational constraints. A first step in correcting the bias is to consider people in terms of their relationships with other people. Social network theory does this by attributing behavior to the social context in which an actor is embedded. Some take a *structural* approach and focus on the pattern of relations in a social network. In this tradition, behavior, attitudes, or beliefs (outcomes) are attributed to network form: the position or location of an actor in its social network. There are essentially two kinds of mechanisms rooted in the form of the network: reach and demand.

The earliest studies focused on demand: actors differentiated by status orderings such as prestige. It was obvious – people are concerned about who has more, who is higher up. We refer to this as a demand mechanism because the differentiation among social actors is attributed to the demand on those actors – popularity – such as how many people cite them as friends. Network studies refer to this as the in-degree – the number or volume of the ties *to* a person. Early on in this research tradition, social demand was linked to esteem (Moreno, 1960) and innovativeness (Rogers, [1962] 1995). Within community structures and organizations demand is an index of power and influence (Brass, 1985, 1992; Hunter, 1953; Laumann and Pappi, 1976).

Perhaps the most elegant theoretical statement of these models is Coleman's (1990) model of prominence in exchange systems. Coleman disaggregates relationships into a definition of intertwined interest and control, where the relationship from one person to another increases with the extent to which the first person is interested in what the second person has. Once the demand structure is known in a social system, the relational structure can be imputed and an equilibrium in the system defined; see for example, Taylor and Coleman (1979). Podolny's (1993, 2000) work on status is a recent renaissance of demand models.

Demand models are distinguished from reach models by their emphasis on the actor as the object of relations; reach models are about social access. Reach models are concerned with how many people are you connected to or what sort of resources you access by virtue of those connections. Foundations in this area include Granovetter's (1973) work on weak ties; Freeman's (1977) work on betweeness centrality, and Burt's (1980 and 1992) work on autonomy and structural holes. Granovetter looks at how weak relationships access novel information (in job searches) or access external constituents (in the case of community organization). Ties can vary in their strength. Strong ties are those to people we feel closest to, see most frequently, or have known the longest. Strong ties are typically embedded in dense, overlapping networks, such that

Table 2.1 Selected studies of intraorganizational networks

Reference	Key concepts	Key variables	Key findings or predictions	Key contribution	Sample
Granovetter, 1973	Value of weak ties	Tie strength	Weak ties are entry to disparate social structures and therefore provide access to novel information	Illustrates how relational closeness or distance affects information flow in egocentric networks	100 interviews and 182 mail surveys of professional, technical, and managerial workers in Newton, MA
Freeman, 1977	Centrality	Betweeness	Centrality is associated with better access to resources, information	Illustrates how network position affects	
Burt, 1992	Structural holes	Network constraint	Low constraint networks (many holes) are a competitive advantage	Reveals how structure and network position affect outcomes such as speed of promotion and profit margins	A stratified random probability sample (N = 284) of the top 3305 managers in a large computer manufacturer
Podolny and Baron, 1997	Relational content	Task-advice network Strategic information network Buy-in network Mentor relation Social support network	Social capital value of structural hole networks contingent on type of network tie	For buy-in networks, closeness has a positive effect on job mobility	236 employees in a high-technology firm
Mizruchi and Stearns, 2000	Uncertainty and use of social networks Relational content Network structure	Density Hierarchy Risk Complexity	Low density deal approval networks associated with likelihood of deal closing	Networks effects predictably contingent on characteristics of transaction	91 bankers in the global banking unit of a large bank
Coleman, 1988	Social capital as cohesion and network closure	Closure	Drop out rates inversely related to social capital of student	Integration and trust emerging from network closure	Random sample of 4000 public school students
Burt, 2000	Social capital as brokerage	Autonomy	Higher rates of return (bonus compensation, job mobility) to structural hole networks	Coordination and control emerging from network brokerage	186 senior bankers in a large financial institution

weak ties more so than strong ties are portals to information or social worlds that are not already reached by one's closest friends.

Centrality refers to the extent to which an actor in the network is involved in relationships in a network. The most central person in a network is the person on the shortest path between all pairs of other positions in the network, the person the fewest steps away from reaching all persons in a network. Centrality is a mechanism for accessing resources insofar as the actor located at the crossroads of others in a network is positioned to disproportionately (and most quickly) amass information circulated in the network and to influence the network by gatekeeping the information in the network. Burt's (1992) Structural Hole theory attributes to structural positions of brokerage (ties to disconnected others) better access to information (and control of its dissemination), or control of the form of projects that connect people on other sides of a hole. These resources are linked to outcomes such as job promotions or compensation; for review, see Burt (2000).

The structural form of the network is predictive for both reach and demand models. A second broad approach within social network theory is *relational*, which emphasizes the content of relations as predictive. The emphasis in this stream of research is the content of the ties in a network. To put the distinction between these approaches another way, questions on a sociometric questionnaire that are "name generators" (e.g. List the people to whom you go for advice at work) are about the form of the network. "Name interpreters" in such questionnaires (e.g. How frequently do you talk to each of the people you named (the alters)? or data about those named contacts, such as age, education) are about the content of the network. Content-based studies look at the substance of the ties: friendship, kinship, work, advice, mentorship or at characteristics of alters in the network: demographics such as age, race, gender or education or opinions and beliefs such as commitment to the organization.

LEVELS OF ANALYSIS

One of the unique and powerful aspects of social network theory is that it is applicable at multiple levels of analysis and aggregation. It can be used to study individuals, dyads, and groups. These three levels of analysis are viable across kinds of actors: individuals, groups, and organizations, such that network theory can study, for example, the ego networks of organizations and even industry classifications (see Gulati, Dialdin, and Wang; and Baker and Faulkner, this volume). The three intraorganizational levels that are our focus are given in the rows in Table 2.2. The columns in Table 2.2 are the two approaches of network studies discussed above.

The simplest level of analysis is the dyad, a pair of actors. In dyadic network studies an important variable is some aspect of the relationship between two social actors, such as the kind of ties (friend, coworker, kin, boss, subordinate) or the strength of relationship. Studies in the alliance literature that focus on the pair of alliance partners are similarly dyadic in nature.

The second level of analysis is the network of an individual actor, referred to as an ego network or egocentric network. Here, the focal variable of study is derived from the complete network of an individual, aggregated across dyads within the network. Size, centrality, density, constraint, and range are examples of network properties used frequently in egocentric network studies.

Table 2.2 Framework of intraorganizational network studies

	Network form/Structural	*Network content/Relational*
Dyad	Etiology of relations	Homophily Effects of kinds of relations
Individual or ego network	Behavioral and opinion implications of variation in basic network parameters such as density, hierarchy, size	Network composition
Group	Group attitudes and behaviors	Group composition

The third level of analysis is the group as a whole, an aggregation of egocentric networks: a system of N actors yields one observed value to analyze. At this most aggregate level of analysis, the focus is on characteristics of a network as a whole, such as density (density is also used in studies of egocentric networks), connectedness, and 'averages' (summary measures to aggregate across egocentric networks, such as average constraint).

Central Questions

Central questions in intraorganizational network studies fall into one or another of the cells in Table 2.2. The columns of Table 2.2 correspond to the distinction between the structural approach of network form and the relational approach of network content. The rows of Table 2.2 correspond to the three levels of analysis. What follows here is a discussion of the theoretical ideas underlying the main questions in each of those partitions.

DYAD

Dyad studies that look at the *structure* of relations are concerned with the central question of 'where do ties come from?' The etiology of relationships has been the subject of countless studies across disciplines such as anthropology, sociology, and social psychology. Within social network studies, a prolific line of work on this topic springs from the observation that network ties tend to be between similar kinds of people, that they are homophilous. Homophily refers to the proclivity for relationships, particularly friendships, to form between people with the same gender, race, age, or occupations, for example. There are both structural form and relational content explanations for homophily.

Structural explanations focus on the contextual reasons homophilous ties form. The predominant explanation here is that colocation causes similar people to be in the same place at the same time and exposure to potential network relationships are circumscribed by this artifact. Feld (1981) takes the contextual explanation a step further and suggests that institutional constraints explain colocation. Organization demographics

limit the possibilities for the kinds of networks observed (Blau, 1977). For example, in an organization comprised mostly of men, the networks of women in the organization are likely to be less homophilous than those of the men given the different proportions of the genders in the organization population. Relational content explanations for homophily include interpersonal attraction and comfort (Marsden, 1988). From this perspective, colocation is an outcome of similar or at least like-minded people selecting the same venues.

In addition to research aimed at understanding why certain kinds of ties form, *content-based* approaches to studying network dyads also consider the effects of particular kinds of ties or relational content. Examples of studies that inspect closely the content of dyadic relationships include Douthit's (2000) study of managers in financial organizations that examines whether subordinate performance is linked to qualities of the boss–subordinate relationship, and Reagans' (2000) study of how the social similarity between colleague dyads influences the performance ratings they give one another. Higgins and Kram's (2001) work on mentoring relationships calls for identifying developmental relationships, and joint consideration of tie strength and structure for understanding the role of networks on career advancement and job satisfaction.

Egocentric or Individual Network

Structural form approaches at the egocentric network level of analysis focus on whether, and how, characteristics of an individuals' network affect outcomes such as behavior or beliefs. Often cited examples of this stream of theory and research include the network form studies introduced in the first section of this chapter: Granovetter's ([1974] 1995) research on how weak tie networks help individuals find job faster; Burt's (1992 and 1997) studies linking manager autonomy to rate of promotion and compensation.

Granovetter ([1974] 1995) studied people who changed jobs and asked those who found their new job through a network contact how frequently they interacted with that person. Operationalizing the strength of a network tie as the frequency of seeing an alter, Granovetter reports that most – more than 80 percent – of the people who used a contact to find a job saw that person only occasionally. The theoretical implication is that people we see infrequently are an important source of unique information.

Burt's (1992) theory of Structural Holes focuses directly on the structure of networks and maintains that there is a competitive advantage (information and control benefits defined earlier) to networks where the ego is connected to disconnected others. Burt's initial empirical research on individual careers and structural holes was a study of senior managers in a large electronics and computer manufacturer; see Burt (1983) for an early incarnation of this line of work on autonomy and constraint applied at the interorganizational level. Burt's key predictor variable is the measure of network constraint, the extent to which ego is tied to alters who are themselves connected: the greater the constraint, the less the autonomy, the fewer the structural holes. The main finding is that managers are promoted more quickly when they have lower constraint networks, see Burt (2000) for review.

Egocentric studies which emphasize *network content* consider network properties similar to network-form studies, but focus on qualities of the tie rather than on structure alone. There are many studies that look at the same sorts of questions as above in

network form. Podolny and Baron (1997), for example, study of the effects of networks on job mobility in a large high-technology engineering and manufacturing corporation. The authors distinguish among respondent's networks five kinds of ties – task-advice, strategic-information, buy-in, mentor, and social support – and examine whether the density of connections among kinds of alters affects job grade mobility.

Mizruchi and Stearns (2000) distinguish advice networks and approval networks in their study of deal closings in a large bank. The bankers in their study use networks to gather information from others in the organization about the client or about the financial product involved. The bank requires deals be approved by at least three officers, so each banker also needs to invoke their approval network to get the signatures necessary to close a deal. They find that managers instinctually turn to their closest contacts when gathering information (and ties among ones closest contacts are likely to be dense) yet managers with low density approval networks are more successful in closing deals. When due diligence in the approval process involves disparate, disconnected networks, there are "a diversity of views, and potential criticisms, that compel the banker to create a higher-quality product," which is likely to lead to a closed deal.

In addition to the type of tie, there is broad interest in how networks affect the transmission of beliefs or practices. So-called contagion studies look at how relationships or structures affect the diffusion of knowledge and the adoption of change (Coleman et al., 1966; Burt, 1987). For Coleman et al. (1966), the researchers were interested in predicting the prescribing of a new medication by a network of physicians. They report that the uncertainty about whether or not to prescribe the new medication was addressed via conversations with colleagues. In other words, they report that the mechanism for contagion was direct social influence, that people adopted an innovation if their "friends" had adopted it. Burt (1987), looking at the same data as Coleman et al., considered and found support for an alternate mechanism: individual physicians turn not necessarily to their close colleagues for advice, but look at the behavior of other physicians that are "like themselves" in the sense that they occupy the same position in the social structure. This is akin to mimetic processes in institutional theory.

To see how the contagion process affects organizational behavior, consider Krackhardt and Porter's (1986) study of turnover in an organization. Their analysis reveals that turnover begets turnover in patterned ways. They begin with the concern that when someone similar to you in the advice network leaves, you take that as relevant information and may leave also and their findings are consistent with this: when one person leaves, others who occupy positions in the network similar to the person who left (role equivalent people in the organization) tend to leave shortly thereafter. When someone like you leaves an organization, this is a cue to you that either the organization is inimical to persons like you, or that persons like you can find more rewarding opportunities elsewhere. This results in clusters of kinds of people leaving who are similar to each at work.

The influence of opinions and beliefs of others affects the functioning of an organization as is illustrated by Krackhardt and Porter (1985), this time looking at network content – friendship ties – to predict job satisfaction. Turning attention to the survivors (those remaining in the organization after the wave of departures) and organizational aftershocks, the authors distinguished survivors by whether or not they had friendship networks comprised mostly of people who had left the organization. Somewhat counterintuitively, they find that those who had friendship networks comprised mostly

of people who left were *more* satisfied with their jobs than survivors whose friends were mostly people who had stayed. Krackhardt and Porter call this the "rotten apple theory." because friends who left were sources of negative information about the job, about the supervisor, and about the organization itself. These sources of negative information shared their negative views with their friends. Individuals with networks rife with people who eventually left had received an earful of complaints about the place ("this place stinks;" "other opportunities are more attractive;" etc.). Once those friends left, their negativity about the job left with them and one's job satisfaction increased. Those who did not have friends who left had been insulated from hearing negative views about the organization, and therefore did not experience the post-departure boost in their satisfaction.

GROUP

Studies looking at a network as a whole address the same issues, as do studies of egocentric networks. The difference here is that the researcher has data on the egocentric networks of an entire system, such as an organization or work group, and can study the relationship of the aggregate network to phenomenon of interest.

An interesting structural-form example of research at this level of analysis is Baker's study of a national securities market (Baker, 1984). Baker looks at options trading among brokers on the floor, operationalizing tie strength as the volume of trade between two brokers. Baker takes price volatility as a dependent variable and considers whether it is affected by the network structure of the brokers. When the trading floor has dense networks, he finds, there is improved communication which dampens variation in price.

To illustrate intraorganizational network studies at the group level of analysis that emphasize relational content, we turn again to Krackhardt's research (Krackhardt and Hanson, 1993). In this study, the central protagonist is a set of union organizers. Krackhardt studied the efforts of a union to organize a group of high-tech information system installers. The union used the formal authority network proscribed by the firm's organization chart and chose Hal to represent the union in the certification campaign and to lead the meetings at which unionization would be discussed. Hal, while quite vocal, even emphatic, in his support of the union, had little influence base through his network ties. His rousing rhetoric wore thin on many of his coworkers. Ultimately, the union ended up losing the certification vote by 12 to 3, an overwhelming defeat since they started with 75 percent of the people signing union interest cards.

Krackhardt gathered data on the informal social network at this firm. At the center of the friendship network in this group was Chris, who was not only an informal leader among the installers but also had strong ties to people outside of his local group of installers. Not surprisingly, given the outcome, Hal was on the periphery of this friendship network. Chris was positively disposed toward the union but not as vehemently supportive as Hal was. Chris was ignored by the union, and he kept his own thoughts to himself rather than use his influence to sway any votes in the certification campaign. Chris, who had the natural power base because of his position in the friendship network, sat idly by. Hal, whose enthusiasm for the union was second to none, had no power base in network terms. Because the union failed to elicit Chris' support and instead relied on Hal to mobilize support for the certification campaign, the campaign faced an uphill climb.

Contemporary Issues and Debate

COMPETING MECHANISMS OF BROKERAGE AND COHESION AS DEFINING SOCIAL CAPITAL

The idea of social capital is that social networks can be productive resources, much like other forms of capital (Coleman, 1988; Burt, 2000); see Lin (2001) for comparative account and critique. Social capital has been of particular interest to organizational behavior studies because it is an important resource that differentiates individuals and organizations, offering some a competitive advantage over others. What constitutes productive social capital is a point of contention within network theory. One school of thought, the Coleman School, holds that social capital occurs in networks with closure where the value of the social capital resource is communication among members of a network that both reduces information asymmetries and makes sanctions more possible because dishonorable or deviant behavior is observable. As a result, trust is less risky and therefore more likely. The other school of thought, the Burt School, holds that social capital occurs in networks without closure where the value of the social capital resource is derived from brokering information and exercising control. For Burt, information asymmetries are opportunities for individuals to build valuable social capital.

We do not resolve this debate about how social networks influence relevant outcomes but rather point out a few nuances relevant to how these perspectives are interpreted and applied. First, if usage of the term social capital is accompanied by clear meaning as to what constitutes social capital (lest it too becomes a vacuous network metaphor), we can leave the idea of social capital as "network as productive resource" without committing *by definition* to a particular kind of network structure. Second, the value of certain network structures may be context-specific. The empirical research sites in which Coleman and Burt examine their theoretical ideas could not be more different. Coleman studied the value of cohesive ties among parents and community for encouraging scholastic achievement among high school students, finding lower dropout rates when there is more social capital in the community. Burt studied the value of brokerage networks for persons working in for-profit business organizations, finding such outcomes as speed of promotion and bonus compensation. Third, the value of social capital ought to be considered at different levels of aggregation and from the perspectives of different actors in a social system. Coleman makes explicit the value of social capital as closure accrues to both individuals and the group: trust and information symmetries in closed, cohesive systems are virtues to the network and its individual constituents. Burt argues that system-wide benefits accrue from brokerage networks particularly in complex or rapidly changing organization environments because brokers access and assimilate diverse information, they are an elastic coordination mechanism unfettered by bureaucratic rigidity or the insularity of closed networks.

CONTINGENCY

At the intersection of structural and relational approaches is a growing body of research on network contingency. So-called contingency approaches take a primary network

effect and demonstrate how the mechanism-to-outcome link is contingent upon ego or organizationally relevant variables. These studies establish important distinctions to the general network effects. For example, a contingency effect is a central contribution of the Podolny and Baron (1997) work on network content and job mobility. Their main finding is that for those with fate control over the respondent (the people named as necessary for "buy-in" for projects initiated by the respondent), cohesion rather than holes was associated with advancement. While the other kinds of network ties evidence effects consistent with the structural hole model, managers benefit from cohesive ties among their authority relations. Cohesion, they explain, offers "a clear and consistent set of expectations and values in order to be effective in one's role," and enable "trust and support from others that is necessary to access certain crucial resources (political aid, sensitive information, etc.) and to implement strategic initiatives" (Podolny and Baron, 1997, p. 676). They conclude that the value of the kinds of social capital is contingent on the kind of relationship at question.

Studies that look at the effects of particular kinds of ties will be about contingency to the extent they make more specific earlier research that had generalized across kinds of relationships. Other kinds of contingency applications look at demographic aspects of the ego, exemplified here by gender, and or look at aspects of the dyad, illustrated here by homophily.

GENDER

The adage "it is not what you know . . ." keeps good company with the similarly ubiquitous phrase "old boy network." There is a long historical antecedent of business organizations and economic institutions being predominately comprised of men such that business or work-related networks were also predominately populated by men (Kanter, 1977). With the demography of business organizations now including increasing proportions of women, the "old boy network" is to social network studies what the glass ceiling metaphor is to studies of career mobility and stratification. If social networks influence career success, do some people, particularly woman and minorities, have limited access to this valuable social capital? Research indicates women do have different networks in terms of homophily or instrumental effectiveness, (Brass, 1985; Ibarra, 1992, 1997) although men and women build similar kinds of networks if one looks at structural properties such as size and density (Aldrich et al., 1989; Ibarra 1997).

Burt (1998) considered gender differences in a reanalysis of his finding that low network constraint (a structural hole network) is associated with faster promotion (Burt, 1992). He found the effect holds more strongly for men in the organization studied than for woman or even for newly hired men. Burt (1998) argues that the structural hole effect is contingent on the legitimacy of the focal actors. In the firm he studied, groups with minority status (woman and newly hired men) did not experience the positive promotion effect of structural hole networks as seen for men in that organization. Rather, Burt explains, groups disadvantaged by the demography of an organization – in his data, this is women and recently recruited men, but as likely other demographic groups in different organization populations – experience a positive promotion effect if they have social networks built around a mentor who introduces the protégé to others in the organization. These protégé networks do not appear to be a structural hole network because sociometrically the tie to the mentor is a high constraint relationship.

HOMOPHILY

Apart from homophily being an interesting proclivity in how friendship choices are made, it is also thought that it engenders preferential behaviors, going out of one's way for someone like oneself. The contingent effect of network homophily is evidenced by Reagans' (2000) study in a financial organization. Using peer ratings (dyads) which determine year-end bonus compensation, Reagans looks at how the level of ratings between homophilous dyads is a function of the overall homophily in the various business units within the organization: where a dyad of similar age, or race, or gender, is embedded in a broader social structure of others of dissimilar age, or race, or gender, the peer ratings are *higher* than if the homophilous dyad were embedded in a broader social structure of similar others. Reagans concludes that the partiality expected between homophilous dyad is stronger when in minority standing and therefore salient (much like Kanter's (1977) observation that a token few will be highly visible in an organization.)

NETWORK AUTOCORRELATION

Research in social networks is a rare case in the social sciences where the theoretical needs of researchers required the development of a specialized methodology (see also Baker and Faulkner, this volume). Along with this methodology came specialized software and lexicon.[1] Although we do not elaborate on the methodological aspects of network studies, it is worth pointing out the central methodological challenge here: the problem of network autocorrelation.

There is a fundamental difference between data observations in the majority of social sciences and the field of network analysis. In other social science studies, observations (which, once measured, become variables) are about the actor. These observations are collected into vectors, which fit neatly into econometric analysis programs. In network analysis, the basic unit of observation is the dyad, a relationship between two actors. Thus, rather than stringing observations together into vectors, each variable in network analysis is better represented as a matrix where each row and each column represent actors and the cells of the matrix represent the measured relational state between the two actors.

This basic structure of observations creates a fundamental problem for the statistical analysis of network data. The observations in standard econometric analysis are assumed to be independent of one another. More specifically, the error terms are assumed independent. But in a matrix of dyadic observations, each dyad is explicitly not independent of other dyadic observations. Some people are popular. Some women prefer to interact with other women or perhaps other people of the same age. Some people prefer to like only those who have shown affection for them. Each of these social facts is reflected in strong degrees of non-independence among cell values. Consequently, there may be strong autocorrelation among the error terms in the econometric model of these data. As such, it is risky to apply standard econometric statistical testing in such cases. Even moderate amounts of autocorrelation in network data can drastically bias hypothesis tests (Krackhardt, 1988).

One approach to address the problem is to use a test that is robust against varying degrees of autocorrelation. For example, Krackhardt (1988) suggests adapting the Quad-

ratic Assignment Procedure (QAP) to multiple regression problems with network data. The MRQAP, as it is called, replaces the ordinary regression statistical tests with permutation-based tests of significance. Krackhardt (1988) has shown with a set of Monte Carlo simulations that these tests are unbiased under a wide variety of network autocorrelation conditions.

Another approach is to explicitly model the extent of autocorrelation in the data and proceed with more sophisticated analyses to take these parameters into account (e.g. Lincoln, 1984). Perhaps the most advanced of the specific modeling approaches is p-star, which allows a wide variety of autocorrelation parameters to be investigated (Anderson et al., 1999; Pattison et al., 2000; Crouch et al., 1998; Wasserman and Anderson, 1995; Pattison and Wasserman, 1995). P-star models are particularly attractive because they allow the researcher to answer a much larger set of statistical and modeling questions in network data than the simpler and older MRQAP. For example, while MRQAP provides significance levels for the regression coefficients, p-star allows one to calculate standard errors and confidence intervals. These p-star models work well if the model correctly matches the particular form of autocorrelation in the population. However, frequently the researcher does not know the exact form of autocorrelation that may exist in his or her data. The MRQAP test, on the other hand, has been shown to be robust against a wide variety of common network autocorrelation structures without having to model them explicitly.

Future Directions

NETWORK AND TASK FIT

A clear theme in the network literature in organizations has been that network structures themselves have predictable effects on organizational behavior. Often, however, scant attention is paid to the fact that networks do not occur in a vacuum. People who are tied together have particular tasks to do, and network effect depends in part on the relationship between the participants and the tasks they are responsible for. Initial efforts to link networks to task include Hansen et al. (2000) who attribute the speed of project completion to the match between the social structure of product teams and the uniformity of the technical problems assigned to the teams (teams with cohesive networks who are assigned more uniform problems complete projects faster, teams working on more complex problems benefit from brokerage networks). Mizruchi and Stearns (2000), in their study described earlier, find that when loans are risky, loan officers are more likely to seek advice and approval from their closest ties despite the paradox that they are more likely to get approval when they invoke disparate contacts. Similarly, but taking the firm as the focal actor, Podolny (2000) links the effectiveness of the due diligence task required of venture capital firms in IPOs to brokerage network structures. Gargiulo and Benassi (2000) juxtapose the Burt and Coleman theories of social capital and find that managers with fewer structural holes were less able to make needed adaptations in their communication networks in response to changes in task interdependencies at work.

Some people in organizations have access to more resources or to particular resources that are valuable in accomplishing tasks and therefore access to different resources

moderates the network effect. Krackhardt and Carley (1998) describe a formal model for addressing these relationships. They start by noting three central domains of interest in organizations: individuals, tasks, and resources. Further, they argue, understanding organizational design amounts to understanding the relationships among the elements of these domains. The complex nature of interactions among people, tasks and resources in the organization is harnessed by a set of simple mathematical rules that can yield powerful explanations and predictions; see Carley, this volume.

TRANSLATION TO POLICY AND PRACTICE

On a final note, there is value to add by integrating social science into practice. Wayne Baker (1994, 2000) is one of the few scholars in this area who has been able to bridge this divide. The need is out there. For example, we have observed a bevy of organizations implementing mentor programs with the best of intentions to shepherd junior employees, or to better acculturate new members of the organization, to decrease employee turnover, to encourage promotion of a greater diversity of people. With the best of intentions, many programs match the mentor only by gender or race similarity. While it is productive for junior employees to learn from someone like themselves, academic research on intraorganizational networks calls into question the generality of assumptions used in the design of such programs. Homophily-based mentorship matches may not be sufficient entree to the kinds of social networks that are most beneficial to the protégé or the organization, but rather, can propagate the very stratification such mentoring programs seek to overcome.

Connections Across Levels

The three chapters in this volume illustrate consistency across the broad field of network studies. Each of the three chapters on networks recognizes that the theories and methods apply to multiple levels of analysis, distinguishes among kinds of relations, and recognizes the split between structural and relational approaches.

Baker and Faulkner emphasize the relational dimension of network studies. We use the term content or relation as a general category that encompasses what Baker and Faulkner distinguish as domains in which organizations have ties to other organizations – such as market exchange, strategic alliances, or director interlocks; and what they distinguish as populations – producers, suppliers, and buyers. From this relational springboard, however, they introduce a structural conceptualization of interlocking markets emphasizing network-form properties such as structural equivalence, position, and concentration.

Baker and Faulkner's three-dimensional depiction of organizational networks highlights the complexity of interorganizational networks, and makes this complexity tractable by breaking down the universe of those networks into populations (kinds of actors or positions), domains (kinds of ties), and reference groups (their vertical and horizontal slices). When they ask in future directions "what is an organization's network?" Baker and Faulkner remind us of an unsettled aspect of network studies: the boundary of a network. Questions about where to draw the line is reflected in methodological debate

about the ideal form for network questionnaires: how many alters do we elicit from respondents? Even intraorganizational studies that include as respondents all members of the organization face a network boundary question because the ties in the social networks of the organizations' constituents are typically not limited to other members of the organization.

Gulati et al. begin with an emphasis on network-form, even defining social networks as a pattern of relations. This is what we refer to as network form or network structure. Although they focus on structure, the authors incorporate relational aspects in alliance studies when they consider "partner profiles" (characteristics of alters) or "configuration of ties" (composition of relationships). For example, the similarity between alliance partners in their innovation activities, technological distance, is analogous to the concept of homophily used in intraorganizational network studies. Lastly, Gulati et al. call for further study of the role of network content on alliances, particularly the role of relationship qualities between organizations for trust building and conflict management.

So diverse is the work in social network theory that is relevant to networks in organizations that writing this chapter was a welcomed occasion to pause and articulate a general overview of this subfield.

Conclusion

The field of intraorganizational networks is diverse: it crosscuts multiple levels of analysis, and its principles and insights are applied to a broad range of phenomena. We make this heterogeneity tractable with a framework that divides the field into levels of analysis (dyad, egocentric networks, and groups), and that distinguishes relational from structural approaches. This schematic can be both a starting point for persons newly interested in this field, and a useful springboard of reflection for those already familiar with work in this area.

Network theory and methods adroitly move across levels of analysis and kinds of actors, and the different foci of the three chapters are complementary. For example, we summarize the concept of centrality as one of the three foundations of demand models of network form, yet Gulati et al. overview different operationalizations of that same concept. We encourage readers who may be particularly interested in one or another of the levels of analysis around which the *Companion* is organized to consider the sister chapters: the three chapters on networks are complementary, their few redundancies reinforcing and their many differences enriching.

Acknowledgments

Note

1 Basic software for estimating common network measures are listed at http://www.heinz.cmu.edu/project/INSNA/soft_inf.html

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