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*Published in:*  
Academy of Management Review

*Publication date:*  
2002

[Link to publication in Tilburg University Research Portal](#)

*Citation for published version (APA):*  
Kenis, P. N., & Knoke, D. (2002). How Organizational Field Networks shape Interorganizational Tie-formation Rates. *Academy of Management Review*, 27(2), 275-293.

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## HOW ORGANIZATIONAL FIELD NETWORKS SHAPE INTERORGANIZATIONAL TIE-FORMATION RATES

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We investigate the impact of communication in field-level networks on rates of formation of interorganizational collaborative ties, such as strategic alliances and joint ventures. After developing the concept of an organizational field network ("field-net"), we derive a set of testable propositions and corollaries that relate field-net properties, such as density, reciprocity, centralization, multiplexity, and hierarchy, to subsequent nonlinear changes in interorganizational tie-formation rates. We conclude by discussing aspects of empirical research for testing the empirical validity of these propositions.

In attempting to explain organizational behavior, many analysts recently have paid greater attention to resource exchange networks and collaborative ventures in which organizations are embedded. However, although networks are frequently mentioned in both academic circles and the business press as influencing organizational behavior, organizational theory still lacks detailed explanations of how and why networks of interorganizational relationships influence organizational characteristics and actions, such as their structural features, behavioral processes, and life chances. Our objective is to contribute to a better understanding of these complex relationships.

Three primary problems motivate our efforts: (1) the general absence of explicit network elements in most neoinstitutional theory, especially from analyses of organizational fields (e.g., Powell & DiMaggio, 1991; Scott, 2001); (2) an apparent shift in the locus of many organizational actions from internal to external origins, par-

ticularly in interorganizational relationships (Auster, 1994; Burns & Wholey, 1993; Nohria & Eccles, 1992); and (3) unresolved general questions about causal relationships among structure and action in diverse social systems (Emirbayer & Goodwin, 1994; Pescosolido, 1992). To advance our understanding of these problems, we develop propositions that link changes over time in properties of interorganizational field networks ("field-nets") focused around communication to changes in rates of formation of collaborative ties among organizations. We hope that explicating the details of these macrolevel processes will ultimately contribute to greater theoretical and empirical knowledge about organizational change.

We define an *organizational field-net* as the configuration of interorganizational relations among all the organizations that are members of an organizational field. Thus, a field-net consists of a particular pattern of both present and absent links among the entire set of organizational dyads occurring in a specified organizational field. Our field-net concept connects an explicit network component to the antecedent concept of an organizational field, which DiMaggio and Powell define as "... those organizations that, in the aggregate, constitute a recognized area of institutional life: key suppliers, producers, regulatory agencies, and other organizations that produce similar services or products" (1983: 148). The organizational field

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We thank P. Devereaux Jennings and the anonymous AMR reviewers for their many useful suggestions for improving the quality of this article. David Knoke's work on this paper was supported by a grant from the National Science Foundation (SBR-9507914) and a Scholar of the College award from the University of Minnesota College of Liberal Arts. Earlier versions of this paper were presented at the EGOS Colloquium in Maastricht, Netherlands, July 1998, and the American Sociological Association meetings in Chicago, Illinois, August 1999. We thank the audiences and commentators for their suggestions.

concept itself differs from the more familiar economic term *industry*, which, in its most narrow construal, refers to a set of equivalent firms that all produce the same product or service (Alter & Hage, 1993: 44–68). The pop music sector is an organizational field, consisting of bands, talent agencies, recording studios, radio stations, publishers and distributors, concert halls, and tour promoters. Other well-known fields include collegiate athletics, fine arts, commercial banking, medicine, national defense, and international tourism.

The organizational field concept is insufficiently attuned to the interorganizational relations among member organizations. That is, in specifying a particular field, an analyst only identifies the set of organizational actors that he or she believes may be relevant to an empirical investigation. In contrast, the organizational field-net concept explicitly focuses analytic attention on the *dyadic relations*—or *ties*—between every pair of organizations in a field. Field-net properties at the meso and macro level are built up from dyadic relations among field members. Combinations of present and absent dyadic relations aggregate into various network substructures—for example, the occurrence of such components as cliques, groups, positions, action sets, and structural holes—as well as into structural attributes of the entire field, such as density, connectivity, and centralization (Wasserman & Faust, 1994). With our propositions we seek to relate variations in organizational field-net properties to the member organizations' actions.

No single type of relationship constitutes "the" network of an organizational field. Multiple types of ties may be relevant in constructing an explanation of structure and action. Which types of networks an analyst should take into account and which ones he or she can safely ignore ultimately depend on the substantive issues driving a specific empirical inquiry. Although the variety of interorganizational relations is potentially inexhaustible, we contend that most of these diverse substantive contents may be classified under five broad substantive headings: information transmissions, resource exchanges, power relations, boundary penetrations, and sentimental attachments (see Knoke, 2001: 65, for formal definitions of these terms).

Although we stress that multiple network ties are often essential for understanding diverse

behaviors, in the formulation of propositions we give a privileged analytical position to interorganizational *information transmission* or *communication*. The primary reason is that communicating preferences, intentions, values, normative expectations, and other varieties of data is a necessary prelude to all other forms of interorganizational interaction. A second reason is that because our propositions concentrate on the rate of tie formation as the organizational behaviors to be explained, communication provides a foundation on which organizational agents build trust relations among partners. Thus, information transmission serves as an indispensable prerequisite before proceeding toward more complex and riskier interactions.

Information transmission takes many forms, ranging from such relatively low-cost interactions as verbal and written messages to more intense commitments of time and resources, such as conferences and clearinghouse operations. Too often researchers measure communication only as a generalized exchange process—for example, by asking informants "With whom do you regularly discuss (business/political/scientific) affairs?" (e.g., Knoke, Pappi, Broadbent, & Tsujinaka, 1996). A distorted picture can emerge from aggregating all respondents' reports to reconstruct the image of a social system's communication network. Depending on the length of time spanned by the measurement instructions, perhaps only a few latent communication links may be operational at any moment.

We reconceptualize this static image as a dynamic sequence of specific communication events or "episodes" (Pescosolido, 1992: 1104). That is, an organizational field's communication network is socially constructed through a series of temporally dated information exchanges, often involving relatively precise and narrow substantive contents. The important thread tying together such dynamic sequences is the thematic consistency of the messages being exchanged. For example, negotiations to acquire a corporate spinoff may involve prolonged discussions, proposals, and counterproposals among the buyers and sellers, banks, unions, government regulators, and other field members. By taking a longitudinal perspective, we can better examine the impact of an antecedent communication network on subsequent relations between organizations.

Our central analytic interest in this article is to explain specifically how properties of the communication network in an organizational field-net influence subsequent rates of collaborative ties among the field member organizations. In the next section, drawing key concepts from quantitative network analysis, we derive a set of testable propositions and corollaries, based on four theoretical assumptions, that relate field-net properties, such as density, reciprocity, centralization, multiplexity, and hierarchy, to subsequent nonlinear changes in interorganizational tie-formation rates. In the concluding section we discuss the underlying assumptions and consider aspects of empirical research for testing the empirical validity of the propositions.

### RESEARCH PROPOSITIONS

The domain of our propositions is delineated by the relationship between the structural attributes of organizational field-nets and subsequent rates of interorganizational tie formation—specifically, the creation of strategic alliances. A central question in any theory construction is why one would expect a relationship between the different factors included; in other words, what is the underlying logic of the propositions (Whetten, 1989: 491)? Theory development requires more than just specifying the relationship between concepts A and B. Every theory is based on several underlying assumptions, which, at best, are explicitly stated or, at worse, only implicitly alluded to. Hence, we state simply here the assumptions on which our propositions are based, to provide a theoretical foundation for expecting those relationships. Our claim that rates of interorganizational tie formation are related to the structure of the field-net is based on four theoretical assumptions: (1) organizations are generally acknowledged by analysts to be influenced by the social contexts in which they are embedded; (2) organizational fields serve as significant environments for their member organizations; (3) the relational properties of organizational fields exert a strong influence on organizational actions; and (4) relational structures per se, and not just the positional attributes of organizations, are critical sources of organizational behavior. After presenting the propositions, we return to these underlying assumptions in the discussion section.

To develop concrete propositions relating organizational field-net dimensions to tie-formation rates that have potentially testable implications, we focus on a somewhat narrow range of relevant phenomena. In particular, we give primacy to interorganizational information transmission or communication as the key macrolevel network that shapes the more microlevel strategies and actions chosen by individual organizations. An information network involves exchanges of substantively important messages among the members of an organizational field. The specific contents flowing through these communication channels may comprise economic, scientific, social, or political data that are relevant both to performing individual organizational tasks and to achieving a field's collective objectives. Variations across several dimensions of a field's communication network structures constitute the propositions' antecedents or independent variables.

The microlevel behavior that we explicitly attempt to explain in the propositions—in effect, the consequent or dependent variable—is the rate of interorganizational tie formation. Interorganizational ties involve the initiation of collaborative activities, where two or more organizations pool resources and coordinate their actions to achieve some joint outcome that might otherwise prove either too difficult or prohibitively costly to achieve by acting alone.

The tie-formation process goes beyond arm's-length market transactions in requiring that the partnering organizations work closely together to attain a common desired objective. Examples of interorganizational ties include relational contracting (Domberger, 1998), strategic alliances (Borys & Jemison, 1989; Dussauge & Garrette, 1998), joint ventures (Barkema, Shenkar, Vermeulen, & Bell, 1997; Bergquist, Betwee, & Meuel, 1995), research and development consortia (Dimanescu & Botkin, 1986), and governmental lobbying campaigns (Knoke et al., 1996; Laumann & Knoke, 1987). The proposition set asserts that the macrolevel relational properties of an interorganizational field's communication network significantly shape the rates at which interorganizational ties form among field members. The unifying question permeating the propositions is "How do structural dimensions of an interorganizational communication network at Time 1 affect the interactions among member

organizations—specifically, their formation of ties to other organizations—at Time 2?”

We assume that organizational participation in both information exchanges and collaborative ties involves explicitly instrumental motives and rational decisions undertaken intentionally to obtain an organizational benefit. Both organizational capacities and informational needs are intertwined in forging and sustaining communication linkages. One organization may initiate contact with another because the agents of the first perceive those of the second to possess important information (e.g., about technologies and production skills, market opportunities, socioeconomic connections, political intelligence) that might enable the initiator to accomplish its tasks and achieve its goals more efficiently. Likewise, the second organization might respond to an overture to exchange information because its agents also believe that linkage offers organizational benefits. Perhaps the initiator can provide complementary data capable of boosting the second organization's performance, or the exchange might be prized because it enhances an organization's reputation and status as a good organizational citizen.

Similarly, we presume such mutual-benefit considerations underlie any decision by two or more organizations to enter into a collaborative relation. Thus, the decisions by potential partners to engage in communication exchanges and to form collaborative ties involve explicit calculations about likely gains and costs from creating, maintaining, and terminating interorganizational interactions.

From a longitudinal perspective, the changing rate of tie formation requires tracking the numbers of new interorganizational relations forming within successive intervals. In a cross-sectional perspective, rates of new collaborations could also be assessed relative to the numbers of existing relations among field members. Both conceptual considerations place important constraints on propositional forms. If attention is restricted only to the creation of new relations ("virgin ties") among previously unconnected organizations, many network properties, such as density, could soon reach a theoretical maximum value, or arrive at an empirical carrying capacity, beyond which further system growth becomes either impossible or unlikely.

Repeated interorganizational ties among already connected organizations initially face

fewer restrictive obstacles. For example, in the global information sector, previously partnered firms frequently announce additional strategic alliances to continue their joint research and development activities (Knoke, 2001: 139–150). However, even recurring collaborations may eventually reach a field's saturation point, thus slowing or blocking the further proliferation of ties. A strong implication is that it would be ill advised to use linear propositional forms to capture these shifting temporal dynamics. To achieve a broader analytic scope—making the propositions more germane to an organizational field's full life span, from birth through maturity and beyond—we intend the propositions to apply to both virgin and repeat ties. In discussing individual propositions below, we consider whether corollaries should attend to possible differences in the formation rates of virgin and repeat ties.

We formulated all propositions in simple bivariate forms that depict nonlinear relationships between field-net communication properties and interorganizational tie-formation rates. Nonlinearity appears more plausible for explaining population dynamics, as demonstrated by numerous empirical studies relating organizational vital rates to changing density dependence (Carroll & Hannan, 2000: 218–219). For example, an initial low density of communication early in the history of a field-net probably impedes virgin tie formation, because information about the advantages of interorganizational cooperation spreads slowly through tenuous indirect connections. But as the density of direct communication ties increases, formation rates of both virgin and repeat ties should accelerate, as laggard organizations more quickly seize the remaining opportunities to collaborate. Finally, as communication density approaches a ceiling beyond which additional ties prove difficult to create and sustain, the tie-formation rate should decelerate. The rate of change may cease if the system reaches its carrying capacity—an equilibrium between forming and breaking relationships.

Hence, despite the absence of empirical support in organization studies, we decided to formulate all propositions as general nonlinear expectations about the dynamic relationship of field-net communication density to interorganizational tie-formation processes. Of course, subsequent empirical studies might conclude that

linear relations account for most of the relevant effects, but our more encompassing nonlinear propositional forms avoid placing premature restrictions on any investigation.

In the following proposition set, we attempt to explain how changes in eight formal aspects of information transmission networks lead to the subsequent formation of interorganizational relations among the members of an organizational field. Field-nets vary in such macrolevel properties as their density, connectivity, centralization, and the multiplexity of ties composing their distinct communication networks. Each dimension may separately affect the tie-formation propensities of a field's members.

Although we present the eight propositions in a bivariate *ceteris paribus* format, the relative magnitude of each macrolevel characteristic in a multivariate analysis can only be answered empirically. The propositions may strike some readers as obvious assertions, because these formal network dimensions were derived directly from network principles (our primary source was Wasserman & Faust, 1994). However, they have never been formally stated for organizational theory. Our intention is to make explicit a set of conjectures that seemed latent in network perspectives on organizations, thereby encouraging organization researchers to examine their empirical validity.

The propositions should be seen, first, as a preliminary attempt at theory construction drawing from institutional and social embeddedness perspectives and, second, as building closely on extant social network analyses. Network analysis is central to these propositions, because in that discipline precise concepts and measures applicable to describing the relational structures of organizational field-nets have been formulated. Whether these measures will ultimately prove the most appropriate ones for proposition testing can only be demonstrated through empirical research. After presenting and discussing each proposition, we conclude with speculations about possible sequences, interactions or conditional effects, and feedback processes among network phenomena.

### Density

Network *density* is a macrolevel property, defined as the proportion of present dyadic ties to all potential ties. The speed with which informa-

tion may be transmitted among the corporate members of a field varies directly with the density of communication ties. A very low-density communication network implies that messages are likely to propagate only slowly through the field via lengthy chains of intermediaries, because relatively few alternative routes are available to link particular dyads indirectly. The average path length (the minimum number of indirect steps necessary to connect a dyad) is likely to be longer in low-density networks, meaning that both the time required to transmit messages and the potential for distorted communication are greater than in high-density networks, whose path lengths are much shorter. Many members of low-density fields may be only tenuously connected to one another, while some organizations may be completely disconnected and, thus, unable to gain access to information available elsewhere in the field (see Proposition 4). In contrast, in higher-density communication networks, average path lengths between pairs of organizations are likely to be much shorter (including more numerous direct ties), multiple alternative routes should link the relatively fewer dyads that lack direct ties, and few or no organizations will likely remain completely out of the field's information loops.

These extreme macrolevel configurations at Time 1 carry quite different implications about the capacity of field members to form both virgin and repeat interorganizational relations at Time 2. As noted above, in our network conceptualization we assume that information transmission is a necessary antecedent to constructing other interorganizational ties, such as resource exchanges, power relations, and boundary penetrations. Thus, an existing macrolevel communication network structure enables a field's participants to learn more quickly from one another about new opportunities for interaction, exchange, and collaboration. A high-density communication net rapidly floods the system with information from numerous, perhaps redundant, sources that offer several alternative channels for filtering and assessing data quality and reliability. Trust sentiments should be easier to establish when an organization's agents can tap other informants capable of verifying the credibility of a potential partner. Perhaps only a small proportion of all extant information linkages may be subsequently transformed into more expensive interorganiza-

tional relations. But the more dense the communication network, the greater the chance that any particular corporation can find other organizations disposed to transact further business. In contrast, the organizations in fields characterized by low-density information transmission networks face greater structural barriers to obtaining timely and useful data from which to construct subsequent instrumental and affective ties.

A dynamic aspect of this process is that as a communication network's density changes, the other types of relations correspondingly rise or fall. Even if the rate at which information transmission promotes other interactions were constant at every density level, an increase in communication network density would raise the sheer volume of new interorganizational relations. More likely, an increasing density initially promotes a subsequent increase in interorganizational tie formation. Across the history of an organizational field, the initial predominance of virgin ties yields to repeat collaborative actions among field members. In an organizational field of fixed size  $N$ , establishing additional communication links eventually enlarges the mean ego-net size, meaning that a modal organization gains access to more sources of information, both directly and indirectly. With information about potential partners multiplying as the field's communication web grows denser, opportunities for every organization to make collaborative deals expand nonlinearly.

As explained earlier, we expect the effects of communication network density on the rate of tie formation to exhibit a curvilinear pattern over the history of an organizational field. An initial slow start in constructing a field's communication network is succeeded by a rapid increase in density and the initiation of virgin collaborative ties among organizations. Subsequently, as communication density continues to rise, both virgin and repeat ties should accelerate, with the rising rate of new ties obviously preceding the formation of repeat collaborations. However, as communication network density approaches a field's carrying capacity, this asymptote or ceiling slows (and may eventually halt) the rate of formation of ensuing interorganizational ties. Presumably, with the rapid dwindling of potential new organizational partners, the virgin tie rate levels off sooner than the repeat tie rate diminishes. We expect these

changing effects of field-net density on interorganizational collaborative actions to produce a cumulative S-shaped growth curve over the full history of an organizational field. Our first proposition reflects these nonlinear temporal dynamics, which we believe will apply to both virgin and repeat ties, considered separately and jointly.

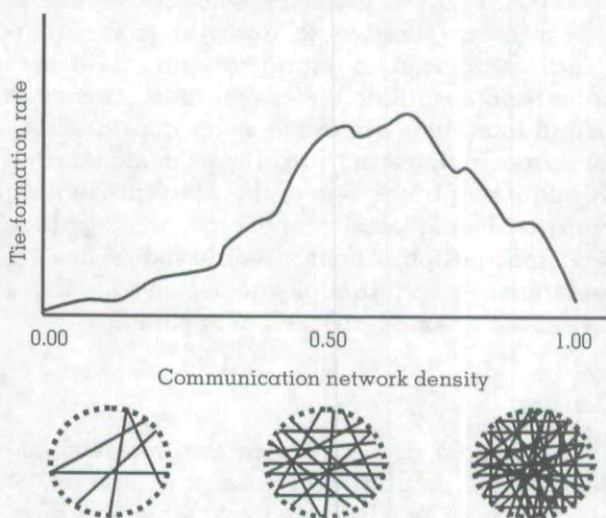
*Proposition 1: As the density of an organizational field's communication network increases, the subsequent rate of interorganizational tie formation initially accelerates and then decelerates toward zero.*

As a visual aid, Figure 1 schematically represents the hypothesized nonlinear relationship between network density and the rate of interorganizational tie formation. When a field-net's density is low, the tie-formation rate is also low. As density increases, the rate accelerates in response to the increased opportunities for collaboration. Finally, as the communication network density reaches saturation, the tie-formation rate declines and eventually reaches zero.

### Reciprocity

Network density refers to the ratio of actual to potential communication ties, without consider-

**FIGURE 1**  
Schematic Representation of Proposition 1:  
Relationship Between Network Communication  
Density and Changing Rate of  
Interorganizational Tie Formation



ation of whether *reciprocity* (mutuality) of information exchanges occurs between both members of a dyad. For example, actor A may send information to actor B, but actor B may not reciprocate. Two organizational fields with identical densities can differ drastically in how their total volume of directed communication is structured at the dyadic level: at one extreme no tie is reciprocated, while at the other extreme every tie is mutual.

An organizational field that sustains a larger proportion of two-way communication channels is more likely to generate more subsequent interorganizational relations than a field whose communications rely predominantly on one-way exchanges. A field whose members are connected by information exchange channels that are open in both directions enables new information to circulate more rapidly and reliably through the system. Hence, its members enjoy a greater capacity to obtain, assess, and act quickly on opportunities for forging additional interorganizational relations. The contrasting situation—an organizational field having largely unreciprocated communication exchanges—suffers from insufficient flows of information that alert members to potential partnership opportunities. To the extent that a field's participants recognize such structural blockages to meeting their needs for more information, they may deliberately cultivate more reciprocal information exchanges over time, which subsequently increases rates of new interorganizational collaborations.

We suspect that the impact of communication reciprocity may be more substantial for virgin interorganizational ties than for repeat ties. Fields characterized by relatively fewer reciprocal communication linkages will suffer from blocked information flows, retarding the subsequent development of virgin collaborative ties among previously unconnected organizations. But if the volume of mutual communication ties increases over time, an initially rising rate of virgin tie formation should be followed by slow-down and stabilization as the field reaches its carrying capacity. In contrast, once a specific dyad forms an initial collaboration, the pair must establish a two-way communication channel that endures as long as that alliance remains active (i.e., two organizations cannot coordinate their joint activities without frequent reciprocal information exchanges). Because mutual communication characterizes most partici-

pants in an initial collaboration, the degree of reciprocity in an organizational field should become less important for the formation of repeated interorganizational ties. Thus, we expect the effect of reciprocal communication to have a greater impact on the rate of virgin tie formation than on repeat collaborations. We formulate an hypothesis and corollary that reflect the nonlinear effects of field reciprocity on rates of tie formation.

*Proposition 2: As the reciprocation of directed communication linkages in a field-net increases, the subsequent rate of interorganizational tie formation initially accelerates and then decelerates toward zero.*

*Corollary 2: The impact of reciprocated communication linkages on the changing rate of interorganizational tie formation is substantially greater for virgin than for repeat ties.*

### Confirmation of Ties

Communication ties are often measured by the self-reports of organizational informants, with the attendant problems of subjectivity and imprecision. Whether a mutual or unreciprocated exchange occurs depends on whether the researcher takes a weak or strong stand regarding the *confirmation* of ties reported by both members of a dyad. For example, an informant for organization A reports sending information to organization B, and the informant for B acknowledges receiving such communication from A. Thus, the  $A \rightarrow B$  channel is confirmed by both parties. However, suppose that although B reports sending information to organization A, the latter denies receiving such communication. In this case the unidirectional  $B \rightarrow A$  channel is unconfirmed. Whether an analyst decides to identify a communication link between organizations A and B as a reciprocated tie thus depends on whether the presence and absence of all four sending-receiving linkages must be explicitly acknowledged by both parties in the dyad.

Kathleen Carley and David Krackhardt (1996) have used structural theory to disentangle cognitive inconsistencies or disagreements potentially arising from informants' disjointed perceptions of their dyadic relationship. In particular, nonconfirmation should be distinguished



from nonsymmetric and nonreciprocated ties, such as those considered in Proposition 2:

Non-confirmations reflect a lack of agreement between the two parties about the existence of a tie from  $i$  to  $j$  (or vice versa). Non-symmetries stem from the perceiver's inconsistency in his or her belief that the tie is reciprocated (resulting in a non-symmetric matrix within his or her cognitive map of the structure). Non-reciprocities (or reflected non-reciprocities) represent a difference between the two parties each sending (or receiving) a relation to (or from) the other (Carley & Krackhardt, 1996: 4).

Because organizational communication depends heavily on fallible humans for information exchanges, a possibility arises that those agents will experience frequent sociocognitive failures either to recognize or to acknowledge communication acts. The proposition below about the consequences of a field's confirmed communication exchanges is based on our assumption that ties confirmed by both parties will exert more powerful effects than will directed ties reported by only one party. Our reasoning applies both to reciprocated and nonreciprocated ties, as well as the symmetric and asymmetric ties examined in Proposition 8.

If both members of a dyad agree that a specific communication link exists—whether it be a uni- or bidirectional channel—information flowing through that channel will have a higher probability of producing interorganizational collaborative relations, compared to information spreading more tenuously through unconfirmed links. Therefore, we speculate that organizational fields composed of higher proportions of confirmed communication ties are more likely to promote nonlinearly increasing interorganizational ties than are networks with more unconfirmed ties. In the two corollaries we explicitly assert that the nonlinear confirmed tie effect occurs equivalently for reciprocated and nonreciprocated communications. However, we offer no speculations about whether these effects differ for virgin and repeat ties.

*Proposition 3: As the proportion of confirmed communication ties in a field-net increases, the subsequent rate of interorganizational tie formation initially accelerates and then decelerates toward zero.*

*Corollary 3a: As the proportion of confirmed reciprocated communication ties increases, rates of interorganizational tie formation increase nonlinearly.*

*Corollary 3b: As the proportion of confirmed nonreciprocated communication ties increases, rates of interorganizational tie formation increase nonlinearly.*

### Connectivity

Another macrolevel network property derived from elementary graph theory concepts is *connectivity* (Wasserman & Faust, 1994: 92–150). A network's connectivity is a function of the number of actors or relations that must be removed in order to leave some members unconnected. Basic to the connectivity concept is a *path* between a pair of organizations. Formally, a path is a sequence of distinct actors linked by directed ties, starting from one member of a dyad and ending at the second member. The *path length* between these two organizations is the number of indirect ties linking them. A network is connected if at least one path exists between each of its ( $N^2 - N$ ) dyads; otherwise, the network is disconnected. If no path exists between a dyad, its two members are mutually "unreachable."

In our discussion about connectivity in an organizational field's communication network, we presume directional relations—that is, a tie is directed *from* one actor in a dyad to the second actor, but a reciprocated relation or indirect path may not occur. (Whether a directed tie is also confirmed or unconfirmed is a separate issue, as discussed above). Researchers may be tempted to treat every tie in an information transmission network as evidence of undirected connections (e.g., by symmetrizing all reported ties). However, assuming that any communication channel permits messages to pass in both directions between indirectly linked pairs may distort a field-net's actual structure. Unreciprocated information exchanges provide evidence of unavailable paths that may have important consequences for network activity. For example, the directed path  $A \Rightarrow B \Rightarrow C$  enables actor A to pass a message to actor C via intermediary B, but the absence of the reverse path  $A \Leftarrow B \Leftarrow C$  prevents a reply. In con-

trast, the reciprocated ties in path  $A \leftrightarrow B \leftrightarrow C$  mean that A and C are mutually reachable.

Analysts should avoid symmetrizing their network data and should retain directed tie information about the connectivity of communication paths between every pair of organizations. Directed ties permit classification of dyads and entire field-nets according to four increasingly strict forms of connectivity: weakly, unilaterally, strongly, and recursively connected networks (see Wasserman & Faust, 1994: 132–133, for formal definitions of connectedness at both dyadic and network levels of analysis). Over time, a field-net may strengthen its connectivity as its member organizations forge increasingly reciprocal communication paths.

The importance of connectivity for an organizational field's communication network lies in its capacity for more speedy and reliable information transmission. In recursively and strongly connected networks, all pairs of participants are mutually reachable through direct communications or via reciprocated indirect paths. Hence, information and data can travel faster with greater accuracy from one actor to another. But in weakly or unilaterally connected networks, or in field-nets that are vulnerable to easy disconnection by uncoupling a few crucial ties, some organizations are unable to send or receive information from others. And, by the definition of a disconnected network, no members of one component can reach the members of other components. The absence of two-way channels or go-betweens (brokers) spanning subsectors of a field at Time 1 means that some dyads remain unreachable. Thus, an organization may be unable to locate and signal potential new partners about its interests in forming virgin interorganizational relations at Time 2. In contrast, fields that are characterized by strongly and recursively connected communication networks and that are not vulnerable to disruption through the disappearance of a handful of ties should experience robust rates of interorganizational collaboration. Organizations should more readily gain low-cost access to candidates willing to exchange resources and form high-risk collaborative relations. Because the creation of an initial interorganizational tie undoubtedly reinforces reciprocal communication paths, we expect that connec-

tivity effects will be stronger for virgin alliances than for repeat collaborations.

*Proposition 4: As the strength of communication connectivity in a field-net increases, the subsequent rate of interorganizational tie formation initially accelerates and then decelerates toward zero.*

*Corollary 4: The impact of communication connectivity on the changing rate of interorganizational tie formation is substantially greater for virgin than for repeat ties.*

### Centralization

The network literature distinguishes between *centralization* as a macrolevel property and ego-centric concepts of "actor centrality" that characterize a specific ego's power relative to other network alters. Analysts conventionally consider three basic types of graph-theoretic centrality: degree, closeness, and betweenness (Freeman, 1977). (A fourth basic form, information, is an extension of closeness [see Stephenson & Zelen, 1989, and Wasserman & Faust, 1994: 169–219].) As an analytic class, centrality concepts capture aspects of an ego-actor's visibility or popularity, as indicated by the actor's involvement in many direct and indirect relations. Variations among the basic centrality measures take into account differences in the directionality of ties (sending or receiving) and the "quality" of the other actors (in terms of *their* own centralities) to which an ego is connected.

Briefly, *degree* simply counts the number of direct ties to or from an organization; *closeness* takes into account both direct and indirect links, representing efficiency or independence from all other network actors; and *betweenness* calculates the extent to which actors fall between other pairs on the shortest paths connecting them (Brass & Burkhardt, 1992: 194–195). Each concept and associated measurement reflects theoretically distinct ideas about important dimensions of network structures, such as the necessary conditions for acquiring systemic power and avoiding dependence, controlling and accessing alternative information sources, or obtaining political support and participating in coordinated collective actions. In the absence of compelling theoretical arguments favoring one

centrality dimension above the other two, we apply all three concepts in formulating the propositions below.

To derive corresponding macrolevel centralization measures, the ego-actor centrality measures can be aggregated, thus revealing the extent to which the information transmission ties in a field-net, tend to concentrate around a single organization, with the other members substantially more peripheral. For example, the maximally centralized "star" network concentrates all relations on one central organization that communicates directly with the others. No direct connections link the  $N-1$  noncentral actors. In contrast, a "circle" network is completely decentralized: each organization communicates with just two partners, each of which also exchanges information with another unique actor, thus forming a closed chain with no central organization.

Freeman (1979) proposed a mathematical definition of a normed group-level centralization index for a network of  $N$  actors. It ranges between 0 and 1, with the lowest score occurring when all actors have the same centrality value and higher scores reflecting the tendency of one actor to predominate in relations with the others. Thus, network centralization reflects the extent of relational inequality in a network (variation or dispersion among the ego-level centralities) and permits comparison of changes over time in one network or differences among several field-nets.

Each of the three basic types of centralization at the field-net level may independently affect the rates of interorganizational tie formation. In general, we expect an inverse relationship, with increasing centralized communication networks reducing the rate of collaborative tie formation. However, the different centralization measures represent divergent processes. Higher levels of degree centralization indicate a growing concentration of information exchanges among a relatively smaller number of organizations. Although these fewer popular egos gain greater access to information held by their numerous alters, the system as a whole is starved for information.

Similarly, higher closeness centralization in a field-net means that fewer organizations have the shorter direct and indirect ties that provide them with greater reachability and capacity to avoid control by others. But the flip side is that most

organizations experience relatively greater dependence on and control by those central actors, which reduces efficiency in finding potential partners with whom to cut deals.

Finally, higher betweenness centralization signifies a growing control over information exchanges and ability to manipulate these patterns for the central organizations' advantages. Such severely impacted information also hinders the less central actors' efforts to develop collaborative relations. Hence, for all three types of systemic centralization, we expect increasing field-net centralization to reduce rates of interorganizational collaboration; however, we have no expectations about differential effects on virgin and repeat ties.

*Proposition 5a: As the degree centralization of a field-net increases, the subsequent rate of interorganizational tie formation decelerates nonlinearly toward zero.*

*Proposition 5b: As the closeness centralization of a field-net increases, the subsequent rate of interorganizational tie formation decelerates nonlinearly toward zero.*

*Proposition 5c: As the betweenness centralization of a field-net increases, the subsequent rate of interorganizational tie formation decelerates nonlinearly toward zero.*

## Multiplexity

Two or more different types of relationships occurring together is network *multiplexity*. Multiplex ties may flow in the same direction or in opposite routes. For example, an organization that transmits scientific-technical data to another organization may also lend personnel to the same company. Typical dyadic market purchases illustrate the other pattern of multiplex exchange relations: goods going to one organization and money returning by the opposite path. Multistranded relations reinforce the ties among a field's members, making them more resistant to complete dissolution than are ties in a single-stranded network. In an important sense, multiplexity indicates the strength of ties binding a field's members together. Frequent and intense encounters spanning a diversity of

interactions should expose the actors' mutual dependencies and obligations, leading them to resist lapses in any of their relations. In contrast, the disappearance of a sole connection between a pair of organizations leaves no remaining links to serve as a reminder that they might consider reestablishing their broken connection.

We are specifically concerned with the effects of communication network multiplexity on the formation of interorganizational collaborations. Up to this point, we have treated the communication network as an undifferentiated type of tie, but here we consider how information transmission may actually encompass various forms and contents, frequencies, and intensities. For example, ties may join organizational agents operating at diverse levels within their organizations, ranging from sales and technical personnel to executive leaders. The information exchange mechanisms they use may vary from superficial public relations announcements to regular committee meetings. The communication contents may involve social, political, economic, and/or scientific data exchanges. Our basic point is that information transmission can encompass a multiplexity of linkages among field members.

An organizational field pervaded by multiplex information ties offers more opportunities for its individual members to develop subsequent relations than a field with only tenuous communication ties. When communication is confined to narrow channels, organizations may acquire only limited knowledge about potential partners capable of providing solutions to organizational dilemmas. For example, if only marketing personnel interact about supplier-customer relations, other key agents may fail to become aware of the full implications of technical problems confronting a pair. But when engineers, accountants, lawyers, and other specialists simultaneously engage in multisided conversations over diverse field issues, then chances increase that important data could reach the most appropriate decision makers.

At the policy-making level, the more tightly complementary communication ties among chief executive officers and board directors weave a field together, the more easily its organizations can socially construct commonalities among their problems, interests, and explanations. Bringing the more disinterested perspectives of third parties, such as banks and

government regulatory agencies, into the information mix may facilitate deals between weakly connected organizations. Third-party interpretations may serve to check tendencies for unvetted information to stampede apprehensive agents into risky ventures.

In effect, a field integrated through a multiplex information network resembles a classic "garbage can" system, whose participants benefit from a continually innovative churning among its components. In contrast, the absence of a strongly reinforced information network offers an impoverished foundation on which to construct secure interorganizational relations.

Multiplex ties are particularly important for explaining the virgin tie formation process. As many-voiced conversations among organizational agents steadily weave multistranded webs of information, potential partners increasingly learn enough about one another's interests and expertise to take a calculated chance on a first alliance. Although an initial collaboration likely contributes to further broadening of the interorganizational communication channels, additional multiplex ties probably yield smaller increments to each partner's familiarity with the other. Hence, we expect that multiplexity should be less important for repeat ties than for initial collaborations.

*Proposition 6: As multiplex communication relations in a field-net increase, the subsequent rate of interorganizational tie formation initially accelerates and then decelerates toward zero.*

*Corollary 6: The impact of multiplex relations on the changing rate of interorganizational tie formation is substantially greater for virgin than for repeat ties.*

## Cohesion

A subset of actors "among whom there are relatively strong, direct, intense, frequent, or positive ties" makes up a *cohesive subgroup* (Wasserman & Faust, 1994: 249). A group that is completely connected by strong mutual ties is a "clique" (i.e., a maximal complete subgraph). A clique imposes a very demanding definition of cohesion: the absence of a single direct tie between any members prevents it from being a

clique. Less strict forms (e.g., "n-cliques" and "k-plexes") relax the clique criterion by requiring relatively short indirect paths to reach all group members.

At the macro level, subgroup cohesion is captured by the extent to which information transmission is concentrated within a subgroup, relative to communication ties between subgroups. Key cohesion indicators characterizing a field-net's structure include the number of subgroups, the number of actors in each subgroup, and the extent of overlap among these subgroups' members. Unless the entire network comprises a single clique, two or more cohesive subgroups may exist. In some networks multiple subgroups occur with substantially overlapping memberships, while in sparser networks less numerous subgroups share relatively few members in common.

At the field-net level, we are primarily concerned about subgroups emerging from a developing communication network, rather than exogenously determined subgroups. (In intraorganizational analyses, formally designated subgroups such as work teams, departments, and functional divisions impose very significant constraints on informal communication patterns.) We also assume that such subgroups maintain relatively high levels of internal communication linkages, approaching if not actually achieving clique status. (The concept of a group whose members are unconnected seems vacuous; see the discussion of between-group hierarchy in the next section.) Two dimensions are important for ascertaining the impact of cohesion at the organizational field level: (1) the number of distinct subgroups and (2) the extent to which communication relations link members of those subgroups.

One extreme configuration is a fragmented field whose many subgroups have no or very few connections to one another. In the absence of bridges and go-betweens that facilitate information exchanges among subgroups, organizations cannot easily learn about their mutual interests, impairing subsequent rates of interorganizational collaboration. If communications are largely confined within numerous small, cohesive subgroups, information becomes severely impacted. That is, organizations in each subgroup lack access to information held by other subgroups. As a result, the field-net suffers from the classic predicament of strong-tie rela-

tions: an incapacity to acquire and apply potential useful information squirreled away in inaccessible locations (Granovetter, 1973).

At the other extreme is a solidary field consisting of a few subgroups with large, cohesive memberships that also maintain substantial intergroup communication relations. Through frequent contacts, subgroups avoid an impacted information situation by offering better opportunities for members from different subgroups to learn about possibilities for interorganizational collaboration. High rates of intergroup contact, especially when they lead to strong ties such as alliances, typically reduce disruptive conflicts and maintain the permeability of group boundaries (Nelson, 1989). Stronger outgroup interactions also may attenuate such negative consequences of within-subgroup intimacy as conformity, radicalism, and hostility. The other two logical combinations (many subgroups with high intergroup information relations, few subgroups with low intergroup channels) probably provide intermediate information about potential partners for different subgroups.

Although organization studies have shown little evidence about the evolution of cohesive subgroups within organizational fields, we speculate that field-nets most likely change from fragmented toward solidary patterns. One consequence would be enhanced interorganizational ties, especially for virgin collaborations.

*Proposition 7: As the numbers of cohesive subgroups in a field-net decrease while intergroup communication relations increase, the subsequent rate of interorganizational tie formation initially accelerates and then decelerates toward zero.*

*Corollary 7: The impact of numbers of cohesive subgroups with high intergroup communication relations on the changing rate of interorganizational tie formation is substantially greater for virgin than for repeat ties.*

## Hierarchy

*Hierarchy* in a network of directed relations requires that, for every dyad, one actor can reach a second actor, but the second cannot reach the first (Krackhardt, 1994: 97). Military chains-of-command and bureaucratic organiza-

tional charts are classic examples of strict hierarchies in which each position directly issues commands only to those positions immediately "below" it. Lower-level subordinates cannot simultaneously exercise authority over their higher-level superiors, but their reporting patterns are a mirror image of the hierarchical command sequence. Thus, any reciprocated or symmetrical relation violates the strict ordering in a hierarchical structure. A somewhat more relaxed hierarchical pattern involves tie transitivity. That is, direct asymmetric ties occur between every "higher" position and *all* the lower positions, but no commands flow from lower to higher positions.

The network structures of most organizations are very unlikely to conform strictly to either ideal hierarchical pattern. For example, in a study of five types of networks in thirty-six social service organizations, researchers measured hierarchy as the ratio of symmetric (tie-reciprocated) and asymmetric (unreciprocated) dyads in each organization (Shrader, Lincoln, & Hoffman, 1989). Consistent with classical hierarchy models, the status-ridden mechanistic organizations' networks exhibited greater asymmetry, but the networks of more egalitarian organic organizations contained more symmetric dyads.

Organizational fields also seem likely to vary in the extent of the hierarchy within their communication networks. Many industries are more heavily regulated by antitrust restrictions on the types of economic information they can exchange, and trade or professional associations may exert strong influence over communication patterns in some fields. Although most fields seem unlikely to develop the hierarchy of a military command, greater or lesser degrees of hierarchical pecking orders in information exchanges can occur when higher-status organizations disdain to reply to communications from lower-status organizations. Organizational reputations probably display such vertical differentiation, given that well-known and well-regarded celebrities receive attention and acclaim from the less renowned, to whom they dare not reply without degrading their own prestige (Fombrun, 1996).

To distinguish hierarchical ties from the reciprocal ties in Proposition 2, we formulate propositions specifically about intergroup ties between the cohesive subgroups discussed in the

preceding section. That is, whereas reciprocity refers to dyadic information exchanges, hierarchy applies only to the extent of symmetry or asymmetry in intergroup ties, without regard to communication structures occurring within subgroups. We speculate that the more closely a field-net communication structure conforms to a hierarchy among subgroups, the less likely organizations are to participate in interorganizational collaborations. Information hierarchy erects substantial barriers to members of one subgroup developing sufficient familiarity about potential partners from other subgroups to risk launching new alliances. The impact of hierarchical constraints is probably much greater for virgin than for repeat ties, on the presumption that well-established subgroups would be less responsive to collaborative overtures from their social inferiors.

*Proposition 8: As hierarchy increases among the subgroups in an organizational field's communication network, the subsequent rate of interorganizational tie formation decelerates nonlinearly toward zero.*

*Corollary 8: The impact of hierarchical communication among subgroups on the changing rate of interorganizational tie formation is substantially greater for virgin than for repeat ties.*

## RELATIONS AMONG NETWORK DIMENSIONS

We do not specify a causal structure or interlocking order among the propositions and corollaries, primarily because we feel that such a step would push field-net ideas prematurely toward more complex processes. Thus, we have simply stated several plausible bivariate relations about the effects of communication network properties on the subsequent nonlinear rates of interorganizational collaboration. We believe these basic propositions together constitute a credible foundation upon which later theorists could construct more elaborate theories about the joint impacts of field-net properties in shaping a field's interorganizational relations. Such an undertaking would benefit from empirical research that tests the basic propositions, in conjunction with logical deductions about interrelations among various network dimensions.

Efforts to disentangle the interplay of network properties would best proceed from a historical perspective regarding the development of organizational fields from their nativity through infancy and adolescence into maturity and ripe old age. The earliest directed communications networks in an organizational field should typically exhibit low levels of density, reciprocity, confirmation, connectivity, centralization, multiplexity, cohesion, and hierarchy. Hence, the subsequent initial rates of interorganizational collaborations, primarily consisting of such virgin ties as R&D alliances and joint ventures, would also likely be low. As a field's information exchanges increase over time, several dimensions of communication network properties should shift upward, thence accelerating the subsequent rates of both virgin and repeat interorganizational ties. For example, as a field-net matures, the growing density of communication links among its members should also raise the field's connectivity, owing to the intimate relationship among these two concepts.

Krackhardt (1994) demonstrated for simulated hierarchical organizations (with "outtree" internal structures) that a closely related concept (connectedness) approached unity at higher levels of network density. Whether similarly robust covariation among these network properties occurs in the information exchanges of less hierarchically structured real-world field-nets is an issue needing examination. Unfortunately, organization studies presently lack empirical evidence and well-honed theoretical arguments about precisely how and when relationships among various network properties would affect one another. We raise three issues to consider for broadening the future theoretical reach.

First, we have not specified the *scope conditions* of the field-net propositions—that is, the situations when and where they apply. Instead, we formulated the proposition set in fairly general terms, without clearly indicating whether it might be restricted to particular times, places, and types of fields. In other words, it now has universal applicability. Of course, if empirical research demonstrated that the field-net relationships applied only under some conditions and not in other circumstances (as other analysts often suggest), then their explanatory power would have a more restricted scope. We primarily had in mind explanations of processes within for-profit business fields, but analysts of nonprofit

social services and governmental sectors may also find these ideas relevant to their research efforts. We consider scope conditions to ultimately be a matter best resolved through empirical investigation than a priori.

Second, the propositions do not include *feedback* processes from interorganizational relations that could restructure a field's communication processes—that is, how does the formation of virgin and repeat collaborative ties among partners subsequently alter the dimensions of information networks? As we noted at the beginning of the proposition section, both organizations' capacities and needs may drive them to seek information exchanges with other field members. But, as briefly mentioned in our discussion of reciprocity (Proposition 2), when a pair of organizations forms an alliance, those organizations most likely engage in increased reciprocal communication. As a field's members gain more experience in forming and implementing alliances, especially those involving repeat ties among previously partnered organizations, the field-net undoubtedly increases in density, reciprocity, and presumably several other dimensions.

Prominent examples of institutionalized mechanisms deliberately developed by organizational fields to foster interorganizational communications around issues of common interest include business trade associations, research consortia, standards committees, and certification boards. The feedback arising from such interorganizational activities to a more elaborate information exchange network suggests a "virtuous cycle" of reinforcing effects over time. Of course, just as in our nonlinear propositions we indicate that all good things never proliferate indefinitely, in feedback loops the constraints on a field-net's carrying capacity should be taken into account.

Third, another intriguing possibility is that two or more field-net properties *interact* in their effects on tie-formation rates—that is, the effect of one network dimension may depend on levels or rates of a second dimension. For example, Propositions 5a through 5c state that as communication centralization in a field-net increases, the subsequent rate of tie formation decelerates nonlinearly. But those effects may depend on concurrent changes in the field-net density—that is, the rate at which rising centralization reduces tie formation may be altered as the field's communication density changes. In that

case, a more complex proposition might, for example, state: "At lower network densities, more centralized communication networks lead to slowly decelerating rates of tie formation, while at higher network densities, more centralized networks result in more rapidly decelerating rates."

Although our propositions all specify nonlinear relations, the possibility of complex interaction effects transcends the current sophistication of most network theories. Hence, we believe that developing formal propositions about interactions among the network dimensions is also theoretically premature and must await a more extensive accumulation of empirical evidence. One further implication arising from potential feedback and interaction effects is that empirical researchers should use dynamic methods of data gathering and analysis, as discussed in the next section.

## DISCUSSION

We have asserted that explanations of interorganizational action must take into account the temporal dynamics of an organizational field-net—a configuration of interorganizational ties among all members of an organizational field. We consider the field-net concept to be a promising analytic tool, because it combines elements from two well-established theoretic concepts: it gives structure to the somewhat amorphous concept of "organizational field," and it provides substantive content to the somewhat abstract concept of "network."

We have indicated the significance of the field-net concept for organization studies, arguing that interorganizational relations can be expected to influence organizations embedded in a field. We also have attempted to demonstrate the fertility of the field-net concept by formulating several testable propositions about the nonlinear relationships among various dimensions of network structure in organizational fields and subsequent rates of interorganizational tie formation. Of course, our efforts are only the first steps toward a theory construction process, and several further inquiries lie ahead. Here we discuss some theoretical, empirical, and practical implications of the proposition set relating network properties to interorganizational collaborations.

## Theoretical Assumptions

At the beginning of this article, we simply asserted that four theoretical assumptions underlie our proposition set. We now provide greater detail and illustrate some contrasts between our structural approach and other macroorganizational theories in order to highlight the contributions of our theory.

The first general theoretical assumption underlying our approach—that organizations are influenced by the social contexts within which they are embedded—was identified by Jeffrey Pfeffer (1997) as the social behavior model. The idea that organizations are influenced by the field-nets in which they are embedded is based on the assumption that action is shaped by the social environment: "social models of behavior emphasize the context of behavior more generally and networks and social actors' positions in them and their social relations more specifically as causal explanations" (Pfeffer, 1997: 55). Although the embeddedness perspective provides one fundamental basis for our propositions, it is not a sufficient foundation. According to some critics, embeddedness says little about how social ties shape social behavior. Consequently, additional theoretical distinctions and assumptions were necessary in order for us to arrive at our field-net propositions.

A second assumption is that organizational fields serve as significant environments for their member organizations. An organizational field approach, however, is narrower than most neoinstitutional conceptions of environment, because it is assumed that the immediate ties are more relevant than broader societal and institutional patterns and that organizational actions are more strongly shaped by concrete communication structures than by diffuse beliefs, norms, and rules. In contrast to neoinstitutionalists, we assume that organizational fields often embody concrete structures and localized cultures that are only loosely coupled to broader national societal contexts. Thus, the field-net propositions should be seen as a specific attempt to articulate a process-oriented approach that treats social structure (field-nets) as both a product of and a constraint on organizational action. Actor behavior is not passively determined solely by the environment; rather, organizations are simultaneously autonomous subjects and dependent objects. Field-nets are produced by human



actions, but they also subsequently assume structural properties. That is, they are socially constructed by organizations acting in particular social contexts. However, once developed and deployed, field-nets tend to become reified, thus losing their connections with and dependence on the human agents who originally constructed them. Hence, field-nets appear to their participants as objective structural properties of an organizational field.

Our third assumption is that the relational characteristics of the organizational field exert primary influence on organizational action. Whereas in resource dependence theory scholars conceptualize environments primarily in nonrelational terms, in the field-net perspective we explicitly assume that what matters most are not a field's characteristic attributes but its interorganizational structures. Structural analysts assume that structured social relationships are more powerful sources of theoretical explanation than are the individual attributes of system members. We view the field-net approach as clearly falling within a structural analysis perspective because both start from a basic assumption that interorganizational relations are more important than organizational attributes for explaining organizational behavior.

The final assumption underlying our structural approach is that the critical sources of organizational behavior are not the positional attributes of organizations but, rather, the relational structures of the field-net *per se*. In our field-net approach, we assume that the macro-level configuration of interorganizational ties among field members serves as an opportunity structure that both constrains and facilitates its member organizations' potential actions. Our propositions emphasize how aggregate relations within a field-net can erect substantial barriers to collective action—for example, more centralized networks provide fewer opportunities for peripheral participants to locate potential partners with whom to forge new collaborative ties.

### Research Implications

Our main task has been to specify and justify the expected relationships between the basic dimensions of communication networks and the subsequent rates of interorganizational tie formation. However, we would be remiss in not

offering some suggestions about research designs that could be used to test these propositions and, hence, contribute to theory building by uncovering evidence that either strengthens or alters our initial claims. Our arguments refer to changing structures and rates that obviously require some form of longitudinal data collection and analysis. Such projects seem to place many daunting demands on researchers' patience in identifying, selecting, accessing, measuring, and analyzing temporal data.

Studying the structures of interorganizational networks is not an impossible undertaking, as exemplified by research on U.S., German, and Japanese national policy domains (Knoke et al., 1996; Laumann & Knoke, 1987); Midwest urban youth services agencies (Shrader et al., 1989); Scottish knitwear producers (Porac, Thomas, Wilson, Paton, & Kanfer, 1995); and New York women's better dress manufacturers (Uzzi, 1996, 1997). Joseph Galaskiewicz's study of Twin Cities, Minnesota, philanthropy provides a paradigmatic research design for a panel of corporations and nonprofit associations whose communication links, grant making, and donative activities were persistently tracked and observed periodically across two decades (Galaskiewicz, 1985, 1997; Galaskiewicz & Bielefeld, 1998). These successful investigations of interorganizational relations were conducted by one or two principal investigators and a few research assistants, with relatively modest research funds.

Researchers should attempt to observe the entire membership of an organization field for a prolonged period as its organizations communicate and engage in collaborative activities. Conceivably, data collection might span several years, undeniably requiring a substantial time investment by the investigator before he or she obtains a payoff. Archival records from news reports and organizational publications might extend the time frame into the recent past—for example, by reconstructing interlocking directorates and joint memberships in a field's interest groups. Archival methods are better for identifying such key collaborative events as joint ventures and strategic alliances (Knoke, 2001) than for mapping details of a historical information exchange network comprising the crucial independent variable in the propositions. For this reason, we suggest that longitudinal for-

ward tracking is preferable to a retrospective data collection research design.

Studying a field-net during its early developmental stages offers a more suitable test of the propositions than observing a mature field whose stable relationships have become thoroughly institutionalized. Consequently, researchers should begin investigating recently emergent organizational fields of the twenty-first century. Such sites would be equivalent to the organization fields launched in the 1900s for automobiles, in the 1920s for airlines, in the 1970s for biotechnology, and in the 1980s for information technologies. Of course, anticipating which fields-in-information might emerge as fruitful arenas to study is a critical task. Small fields rapidly constructed around highly specialized technologies might provide the most tractable research opportunities. Within nonprofit and public sectors, initiation of a new social service program, such as welfare reform, could provide opportunities for tracking emergent interorganizational structures.

Another important question for empirical researchers is whether to identify field-nets primarily in objective or in subjective terms. That is, the criteria for determining membership in a field and selecting specific organizations could involve quantified indicators, such as industry and size, or more cognitive approaches, such as informant judgments. In previous empirical analyses of national policy domains, researchers combined several behavioral and reputational indicators to identify the core organizations in energy, health, and labor policy fields (Knoke et al., 1996; Laumann & Knoke, 1987). As Scott notes, "In stable and more highly institutionalized fields, there is high consensus on the definitions as to who the critical players are, what activities and interactions are appropriate, and which organizations are included, marginal to, or outside field boundaries" (1998: 129). By inference, the newly emergent fields most appropriate for testing the propositions would lack consensus about which governmental, private, and nonprofit organizations were members. Hence, researchers might develop and deploy multiple, overlapping measurements for bounding a field prior to data collection.

Empirical examination of the propositions might eventually falsify some of our propositional statements. For example, Provan and Milward (1995) found counterintuitive evidence that

centralized social welfare networks were more effective than decentralized systems in delivering services. If analyses spanning diverse organizational fields disproved the validity of specific propositions, such outcomes would yield a revised set more consistent with the observed relations between network structures and interorganizational relations.

Another issue with important implications for research on social change in general, and network analysis in particular, is the question of ontological validity. Briefly, collecting data on existing social relations at one particular time runs some risk of incompletely capturing the phenomenon. Because most interorganizational communication exchanges occur intermittently rather than continuously, using a very narrow time frame may result in underreporting of latent ties because of their low salience to informants. Measures spanning a longer time interval may produce a more comprehensive tally of relations but, in turn, might inaccurately represent the actual network structures existing at a specific moment. That is, measuring an organizational field over time and verifying its changing network structures depend crucially on how researchers operationalize interorganizational ties within and across particular intervals.

This entity-measurement conundrum, with its echoes of the quantum physics uncertainty principle, requires empirical researchers to ponder how best to measure changing social structures. Although we do not offer a definitive solution, we recognize that this difficult issue deserves greater attention than network analysts have yet paid it. For now, we reiterate our contention that communication-event or "episode" measures, which would identify specific information exchanges occurring within a dated interval, are preferable to asking informants about their generalized communication links during a vague period. However, the ontological validity of our assertion awaits empirical confirmation through a comparative investigation of alternative measurement instruments.

### Implications for Practitioners

On first consideration, our macrolevel propositions would seem to offer little practical guidance for harried administrators trying to cope with the daily contingencies of organizational management. Some network properties may

have contradictory implications across different levels of analysis. For example, although increasingly centralized field-nets reduce the rate of interorganizational collaborations (Propositions 5a through 5c), individual organizations typically benefit by occupying the more central positions in their field. Despite such cross-level conundrums, leaders who ignore interorganizational relations potentially imperil their organizations' performance and even survival.

Although large field-net structures are probably highly resistant to overt manipulations by individual organizations, top executives should continually monitor their field for signs of significant change. Creating and maintaining effective communication links to diverse field members are vital in gathering useful organizational intelligence about potential opportunities and threats. By proactively forming and breaking information linkages, top executives should try to move their firms and agencies into more advantageous positions. For example, they could reap organizational benefits by facilitating exchanges of reliable information or by brokering virgin collaborations of otherwise unconnected organizations. As practitioners learn more about how an organization field's communication network shapes the rates of interorganizational collaborations, they may acquire a proactive interest in developing and sustaining this valuable collective asset.

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