

BRIDGING TIES: A SOURCE OF FIRM HETEROGENEITY IN COMPETITIVE CAPABILITIES

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What explains differences in firms' abilities to acquire competitive capabilities? In this paper we propose that a firm's embeddedness in a network of ties is an important source of variation in the acquisition of competitive capabilities. We argue that firms in geographical clusters that maintain networks rich in bridging ties and sustain ties to regional institutions are well-positioned to access new information, ideas, and opportunities. Hypotheses based on these ideas were tested on a stratified random sample of 227 job shop manufacturers located in the Midwest United States. Data were gathered using a mailed questionnaire. Results from structural equation modeling broadly support the embeddedness hypotheses and suggest a number of insights about the link between firms' networks and the acquisition of competitive capabilities.
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Since capabilities are critical to the pursuit of competitive advantage (Nelson, 1991; Teece, Pisano, and Shuen, 1997), understanding differences in firms' competitive capabilities is a central question in the field of strategy. Among the more prominent explanations for differences in competitive capabilities are imperfections in factor markets or luck (Barney, 1986); path dependence (David, 1985); causal ambiguity and uncertain imitability (Lippman and Rumelt, 1982); and relatively immobile internal resources (Barney, 1991). In contrast to these, and other economically derived approaches that take an atomistic view by assuming that firms act alone, this research takes an *embeddedness* perspective. Specifically, the embeddedness perspective highlights the role of firms' social, economic, and professional networks (Granovetter, 1985) to explain economic actions such as alliance forma-

tion (Gulati, 1995), interfirm exchange (Uzzi, 1997), and organizational survival (Baum and Oliver, 1992). We extend this literature by exploring how firms' embeddedness in geographical clusters relates to their competitive capabilities.

A recently renewed interest in the phenomenon of geographical clusters, also known as industrial districts (Piore and Sabel, 1984) or 'hot spots' (Pouder and St. John, 1996), has spurred research in economic geography (Krugman, 1991; Scott, 1992), sociology (Lazerson, 1988), political science (Sabel, 1993), and international and strategic management (Porter, 1990). This research documents the impressive economic growth and vitality of regions such as the 'Third Italy' (Pyke and Sengenberger, 1990) and Silicon Valley (Saxenian, 1994). A prominent feature of these and similar geographical clusters is extensive interfirm networks supporting frequent and repeated knowledge sharing and collaborative innovation.

The literature on geographical clusters argues that firms within a region tend to exhibit

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'similar resources, cost structures, mental models, and competitive behavior' (Pouder and St. John, 1996: 1195). In effect, this stream of research assumes that firms in these regions are homogeneous and achieve similar levels of performance. However, other research suggests that whereas some firms manage to acquire and maintain the capabilities to successfully compete, others languish with obsolete skills and routines (Saxenian, 1994). The natural question, then, is what accounts for the variation in competitive capabilities of firms within a geographical cluster?

We explain difference in firms' competitive capabilities by viewing economic action as embedded in firms' networks of ties, including nonmarket ties (Oliver, 1996). From this standpoint, firm actions and outcomes are substantially influenced by the ongoing pattern of relationships maintained with other firms and nonmarket organizations. Specifically, the embeddedness perspective stresses that '*networks of social relations penetrate irregularly and in differing degrees in different sectors of economic life...*' (Granovetter, 1985: 491. Emphasis added). Applied to geographical clusters, the embeddedness perspective suggests that firms are embedded in highly differentiated ways that link them to different sets of players and thereby present them with sharply distinct opportunities and constraints. Put differently, firms vary in terms of their potential to discover and exploit competitive capabilities through their networks. Consequently, it is important to understand how a firm's distinctive pattern of network ties relates to its competitive capabilities.

Extant research on firm capabilities has focused primarily on the link between capabilities and performance-related outcomes (Lieberman, Lau, and Williams, 1990; Clark and Fujimoto, 1991; Henderson and Cockburn, 1994). However, far less research attention has been paid to the *sources* of firm capabilities. What research has been conducted in this area has focused on sources internal to the firm. In contrast, we maintain that there are important *external* sources of capabilities that firms draw upon to varying degrees (Galaskiewicz and Zaheer, 1999). We propose that these 'network resources' (Gulati, 1999) enable and constrain firms' abilities to acquire competitive capabilities

through differential exposure to information and opportunities.

We highlight two key differentiating facets of firms' network resources: *bridging ties* and *linkages to regional institutions*. The network on which we focus in this study is the firm's set of linkages to external sources of advice. Focusing on the diversity of a firm's advice network, we develop the concept of bridging ties. By linking the firm's internal capabilities with its external network of bridging ties, we propose to understand and explain differences in competitive capabilities among firms in a geographical cluster.

Firms' network resources in geographical clusters are distinguished further by linkages to regional institutions. We argue that regional institutions facilitate the development of competitive capabilities among local firms by acting as network intermediaries for interaction and information exchange among firms. Although the services provided by regional institutions are available to all the firms in a geographical cluster, not all firms participate to the same degree or benefit to the same extent. Participating in regional institutions raises issues of cooperation with competitors and the potential exposure of proprietary information. Therefore, a question arises as to which firms actually do use the available services and to what extent regional institutions contribute to the development of firms' competitive capabilities.

We propose that heterogeneity in firms' networks of bridging ties and variations in their linkages to regional institutions are important sources of differences in firms' competitive capabilities in a geographical cluster. For strategy research, this proposition suggests a need to revisit a basic premise of the resource-based view of the firm—that atomistic firms generate capabilities internally. Our research also addresses a central debate in the network literature over alternative mechanisms underlying information access: Is the causal mechanism structural holes, as Burt (1992) proposes, or tie strength, as Granovetter (1973) argues? By examining questions that lie at the intersection of strategy and network research—such as the influence of inter-firm network structure on intra-firm competitive capabilities—we advance both streams of research and show how they can be usefully integrated.

KNOWLEDGE SHARING IN GEOGRAPHICAL CLUSTERS

Following Porter (1990), we define a geographical cluster as a spatially concentrated group of firms competing in the same or related industries that are linked through vertical (buyer–supplier) or horizontal (technology, information, or other resource-sharing) relationships. Illustrative of such clusters are the semiconductor and other electronics firms located in Silicon Valley and the Route 128 area of Boston. Through professional, social, and exchange relationships, firms in these clusters share advice, engineering solutions, and information about new technologies and practices (Nohria, 1992; Saxenian, 1994).

The transfer of situation-specific knowledge and the creation and exchange of new ideas is an important attribute distinguishing geographical clusters from market coordination. Marshall recognized this point nearly a century ago, noting that

inventions and improvements in machinery, in processes and the general organization of the business have their merits promptly discussed; if one man starts a new idea, it is taken up by others and combined with suggestions of their own; and thus it becomes the source of new ideas (1920: 271).

More recently, Best notes that geographical clusters have

the institutional capacity to continuously learn, adjust, and improve in economic performance. ... [I]nitiatives from one firm intersect with others and modify the production capabilities and opportunities for each firm (1990: 235).

Network-based explanations emphasize that tight-knit industrial communities are characterized by high levels of trust that enable such knowledge sharing among firms (Saxenian, 1994). In these communities, the network of relationships among firms is typically characterized as a web of dense and overlapping ties. Via this web, knowledge is rapidly diffused throughout the geographical cluster.

Yet, taken to the logical extreme, it is unclear how new ideas and information enter an entirely closed social system. Firms interacting exclusively with each other presumably would maintain a similar pattern of ties and thereby be relatively

insulated from developments and advances in external communities. It seems unlikely, however, that all firms in a geographical cluster would in fact maintain an identical pattern of linkages. Interfirm relationships are frequently formed as a result of family ties, membership in civic groups and social clubs, and spin-offs from the same parent corporations or universities. Firm networks that share such common heritage overlap more extensively. Stinchcombe's (1965) notion that firms created under similar environmental circumstances are likely to share certain attributes, including common sets of relationships (Kogut, 1993) is apropos. Correspondingly, firms' networks are likely to be quite distinct from those of other firms with whom they do not share a common history. Viewed this way, geographical clusters contain 'cliques' or subclusters of thick and multiplex networks, with fewer linkages between subclusters. This perspective of geographical clusters suggests that firms maintain unique and idiosyncratic patterns of network linkages and are consequently differentially exposed to new knowledge, ideas, and opportunities.

Knowledge sharing in geographical clusters is also influenced by the common infrastructure supporting economic activity within a region. A central theme of the geographical clusters literature is the notion that firms co-located in close geographical proximity can benefit from agglomeration effects by drawing on a common infrastructure (Maarten de Vet and Scott, 1992; Porter, 1990). The common infrastructure of geographical clusters typically includes pools of skilled labor, available capital, qualified suppliers, professional service firms, and R&D labs (Best, 1990; Saxenian, 1994; Romo and Schwartz, 1995).

Our focus is one specific element of this infrastructure—regional institutions. For purposes of this research, we define regional institutions as locally-oriented organizations that provide a host of collective support services to firms in the region. Examples of regional institutions include technical assistance centers, university outreach programs, vocational training centers, and local research institutes. While some trade associations may fulfill the criteria of regional institutions as we define them (e.g., SEMATECH), others are geared primarily toward lobbying activities (e.g., the Semiconductor Industry Association) and are outside the scope of our definition. Also excluded

from our concept of regional institutions are social and civic organizations such as the Kiwanis Club or the United Way.

THEORY AND HYPOTHESES

Network Resources

We view network resources as representing the informational advantages associated with a firm's network of ties (Gulati, 1999). To sustain a competitive advantage firms must constantly seek out new opportunities for upgrading and renewing their capabilities. However, acquiring capabilities entails uncertainty regarding the value of the capability and the extent to which it can benefit the firm. Consequently, firms may benefit from having a network of knowledgeable contacts that provide a reliable source of information about options for enhancing competitive capabilities.

Not all firms possess comparable levels of network resources, and the variation in network resources across firms influences their individual ability to discover and exploit useful information. Specifically, firms' networks vary in terms of structure, or the pattern of ties, and nodal heterogeneity, or the variation in the mix of contacts in firms' networks (Galaskiewicz and Zaheer, 1999). We argue that network structures rich in *bridging ties* offer superior informational advantages about competitive capabilities. Further, nodal heterogeneity in the form of linkages to public *regional institutions* also enables the acquisition of competitive capabilities.¹

Bridging ties

We define bridging ties as those that link a focal firm to contacts in economic, professional, and social circles not otherwise accessible to the firm. Specifically, 'a bridging tie between two persons is the sole path by means of which the two persons (and their direct contacts) are joined in a network' (Friedkin, 1980: 411). We theorize that bridging ties connect a focal firm to sources of information and opportunities that are not

available from other network contacts. In geographical clusters, firms that act as connectors between subclusters maintain bridging ties.

The concept of bridging ties has its basis in theories of social networks, which argue that new information is obtained through 'weak ties' (Granovetter, 1973) and 'structural holes' (Burt, 1992). Granovetter posits that new information is obtained through casual acquaintances (weak ties) rather than through close personal friends (strong ties). The 'strength of weak ties' thesis is based on the premise that strong ties characterize a dense cluster of actors who are all mutually connected to each other. Since this subcluster of strongly connected actors is likely to interact frequently, much of the information circulating in this social system is redundant.

Conversely, weak ties are often links with actors who move in social circles other than those of the focal actor. Weak ties enable the discovery of opportunities because they serve as bridges to new and different information. In support of this theory, Granovetter (1973) finds that a person's casual acquaintances, with whom only sporadic contact is maintained, are critical to discovering new employment opportunities.

Granovetter conceptualizes weak ties as the relative *infrequency of interaction* between the focal actor and contacts. However, infrequency of interaction alone may not be a sufficient condition for discovering opportunities if an actor's weak tie contacts are either connected to each other or connected to the actor's strong tie contacts. Burt (1992) extends the strength of weak ties argument by asserting that it is not so much the strength or weakness of a tie that determines its information potential, but rather whether a *structural hole* exists between a focal actor's contacts. In other words, the causal agent determining whether a tie will provide access to new information and opportunities is the extent to which it is *nonredundant* or, in Burt's terminology, whether a tie spans a structural hole. As Figure 1 illustrates, the weak tie between Actors 1 and 2 serves as a bridge by connecting the focal actor (Actor 1) to a contact (Actor 2) disconnected from the focal actor's other direct contacts. However, as shown from the linkage between Actors 1 and 3, strong ties may serve equally as a bridge, since the connection is nonredundant.

While both arguments offer compelling theo-

¹ 'Acquisition of competitive capabilities' refers to the process through which firms discover, internalize, and exploit industry-specific practices, methods, and techniques for achieving competitive advantage. By 'acquisition' we do not mean either the outsourcing or the wholesale purchase of capabilities.

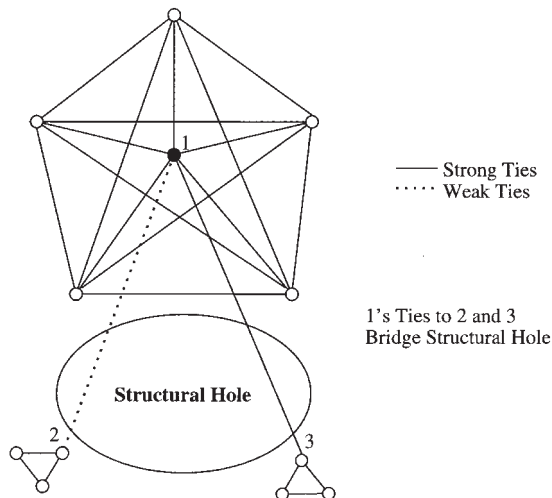


Figure 1. Illustration of weak ties and structural holes

retical explanations for the discovery of new opportunities, a question remains as to whether infrequency of interaction (weak ties) or nonredundancy (structural holes) offers a more empirically accurate explanation. A key objective of this paper is to compare the relative explanatory power of these two theories of bridging ties.

Our conception of bridging ties is consistent with both Granovetter (1973) and Burt (1992) but differs in important ways. Whereas Granovetter (1973) assumes that 'all bridges are weak ties,' we argue that bridges are not always weak ties. We also recognize Burt's position that a bridging tie spans a structural hole. However in contrast to Burt, who argues that a bridge is 'a chasm spanned, and the span itself' (Burt, 1992: 28), we maintain that there is in fact a distinction between a bridging tie and the structural hole it spans. In our view, the structural hole (chasm) presents information opportunities, but the bridging tie (span) is how an actor exploits those opportunities to realize certain benefits (e.g., information).

Bridging ties in firms' advice networks

In their original formulations, the concepts of weak ties and structural holes were used to explain individual career mobility on the one hand and industry profitability on the other. However, little research exists that has considered these theories in explaining firm-level outcomes. We propose that the causal mechanisms underly-

ing these theories are equally applicable to understanding firm-level actions resulting from information search. We see firms' acquisition of competitive capabilities as significantly influenced by the search for novel information through networks. From this perspective, firms use their networks entrepreneurially by searching for ideas and opportunities to achieve competitive advantage. Firms' advice networks are likely to be one important channel through which a firm (particularly a small one) learns about new practices and techniques and other opportunities for enhancing its competitiveness.²

We conceptualize bridging ties as embodied in three elements, two of which (nonredundancy and infrequency of interaction) are drawn from the literature reviewed earlier. We define *nonredundancy* as the extent to which the contacts in a focal firm's advice network are not linked to one another. *Infrequency of interaction* refers to the rarity with which a focal firm converses with the contacts in its advice network. To these two concepts we add a third, *geographic dispersion*, which is particularly relevant to geographical clusters.

Geographic dispersion in the advice network is a proxy for face-to-face interaction among advisors. In our view, a dispersed advice network is comprised of contacts located far enough apart spatially to impede routine face-to-face interaction. With a geographically scattered advice network, contacts interact less readily with the focal firm, as well as with each other, and therefore provide nonredundant information.

We argue that bridging ties exist when high nonredundancy, infrequency of interaction, and geographic dispersion characterize a firm's advice network. We view these three concepts as complementary formulations, because each captures in a different way the potential (or the lack thereof) for bridging ties. Nonredundancy is based on the *structural configuration* of a firm's contacts relative to each other (i.e., the presence or

² A question may be raised about the applicability of individual-level network theories to explain organizational actions. In our theoretical and empirical framing we have focused on small organizations that are typically owner-managed (91% of the firms in this study are owner-managed). The owner-CEO is invariably the only person who has the authority for all major decisions taken by the organization. In this regard, the advice network of the owner-manager is tantamount to that of the small organization.

absence of links among contacts in the network), infrequency of interaction emphasizes the *tie strength* between a focal firm and its contacts, and geographic dispersion focuses on the *spatial location* of contacts.

Bridging ties as a source of competitive capabilities

Networks have the potential of conferring both information and control benefits (Burt, 1992). Our focus in this paper is on information benefits, especially those occurring from access, which is defined as 'receiving a valuable piece of information and knowing how to use it' (Burt, 1992: 13). We maintain that firms differ in their capacity to access useful information through their networks, and that these differences are a key source of variation in firms' competitive capabilities.

Specifically, we propose that firms with advice networks rich in nonredundant ties will acquire competitive capabilities to a greater extent than firms with advice networks lacking in nonredundant ties. Actors with such optimized networks gain access to useful information to a greater extent because 'they know about ... more rewarding opportunities' (Burt, 1992: 13). However, the information benefits stemming from networks are not automatic. Rather, establishing and sustaining nonredundant contacts 'in the place where useful bits of information are likely to air, and ... providing a reliable flow of information to and from those places' (Burt, 1992: 15) is the overriding determinant of information access. When actors seek out contacts that are tapping fundamentally different informational domains, they are likely to discover unique opportunities and information not available from a network with redundant ties. On the other hand, redundant ties are likely to produce information that is largely superfluous and unoriginal. Thus, the range, novelty, and diversity of information obtained from a nonredundant tie are predicted to be much greater than from a redundant tie.

When advisors in a firm's advice network are all tied to each other, they will have access to similar information about competitive capabilities. In other words, little fresh news circulates in a highly redundant social system. In contrast, if all of a firm's advisors are complete strangers to one another, the advice network will be high in

nonredundancy. In such a case, all of the firm's advisors will operate in different economic, professional, and social circles and know of different opportunities to innovate and develop competitive capabilities.

Accordingly, firms' contacts 'are ports of access to clusters of people' (Burt, 1992: 23) that serve as independent sources of information. Firms that maintain linkages to diverse information sources gain access to novel information and learn about competitive capabilities to a greater degree than firms without such ties. By maintaining such a network of diverse and non-overlapping ties, a firm increases its chances of gaining access to new ideas and information about competitive capabilities.

We define competitive capabilities, following Amit and Schoemaker, as 'a firm's capacity to deploy resources ... using organizational processes' (1993: 35) to achieve a strategic objective. We view acquisition of capabilities as a continuous process that begins with knowledge and awareness of some opportunity, continues with a decision to internalize the capability, and ends eventually in firm actions to implement the capability. We propose that a firm's exposure via its network to more diverse sources of information is commensurate with a richer set of opportunities. Thus, by raising awareness about a capability and the potential benefit to the firm, network diversity initiates the process of capability acquisition. Following the initial learning about a capability, firms engage in a process of evaluation and eventual adoption. Since nonredundant advisors are likely to possess different information about a given capability, the focal firm cumulates superior information about the potential advantages and disadvantages associated with the capability. Put differently, when a particular capability is beneficial to the focal firm, a nonredundant network aids the firm in realizing the capability's true potential. This is akin to the argument made by Uzzi that through embeddedness, network ties improve decision making because they 'appear to reduce bounded rationality by expanding the range of data attended to and the speed of processing' (1997: footnote, p. 46). This brings us to our first hypothesis:

Hypothesis 1: Nonredundancy in the firm's advice network will positively influence its acquisition of competitive capabilities.

Similarly, an advice network composed of contacts with which the focal firm interacts frequently is less likely to contain bridging ties. Granovetter (1973) posits that the contacts with which an actor interacts frequently (i.e., strong ties) tend to interact with each other frequently as well. In these cases, we should observe a tightly knit clique, relatively isolated from external sources of information. The underlying reasoning for this prediction is that a disproportionate amount of time spent interacting with those in the clique leaves less time to interact with actors from other parts of a social system.

Granovetter's theory of weak ties also suggests that the *less* a firm interacts with the contacts in its advice network, the less a firm's advisors interact with each other. On this point Granovetter explicitly argues that 'two factors—time and similarity—indicate why weaker A-B and A-C ties make a C-B tie less likely ...: C and B are less likely to interact and less likely to be compatible if they do' (1973: 1362). Further, where a firm's advisors interact with each other infrequently they are more likely to operate in different economic, professional, and social circles. Hence, the advisors are more likely to be privy to diverse information and ideas. By maintaining weak ties with advisors, who are each likely to be tied into sources of information different from the focal firm's other advisors, the firm accesses a greater diversity of advice about acquiring competitive capabilities. These ideas are summarized in the following hypothesis:

Hypothesis 2: Infrequency of interaction with the firm's advice network will positively influence its acquisition of competitive capabilities.

We also expect to find an advice network rich in bridging ties when advisors are geographically dispersed. Building on the preceding discussion, we argue that in a scattered network, interaction among a focal firm and its contacts is likely to be limited. As the geographic distance between the focal firm and its advisors increases, the opportunity for face-to-face interaction is lower and it is more difficult to maintain strong ties. In contrast, an advice network densely clustered around the firm provides greater opportunity for a firm to interact with its contacts and for the contacts to interact with each other. As a result, the potential for the focal firm to access different

information, including learning about new capabilities, is more limited in a densely clustered advice network because each of the contacts is likely to know the same things that the other contacts know. Hence, the diversity of information obtained by a firm is likely to increase with the geographic dispersion of the firm's advice network. Diverse information about competitive capabilities will enhance the likelihood that the focal firm will learn about and acquire competitive capabilities. Accordingly, we hypothesize that:

Hypothesis 3: Geographic dispersion in the firm's advice network will positively influence its acquisition of competitive capabilities.

Participation in regional institutions and competitive capabilities

Beyond being embedded in a network of interfirm relationships, firms are also embedded in a broader set of regional linkages. In geographical clusters specifically, an important feature of the local infrastructure is regional institutions that provide collective support services to firms in the region. The connection between firms' forming linkages with regional institutions (through participation) and the acquisition of competitive capabilities is based on regional institutions' specialized network role of intermediary. As intermediaries, regional institutions facilitate the acquisition of competitive capabilities by compiling and disseminating knowledge and by reducing search costs.

Beyond providing specific support services (e.g., vocational training, market research, applied R&D) and other resource benefits (Baum and Oliver, 1992) to local firms, regional institutions act as repositories for knowledge and opportunities about competitive capabilities. Because regional institutions interact with a relatively large number of firms in the geographical cluster, they are exposed to a wide variety of solutions to organizational challenges typically faced by the firms in a region. Based on broad experience observing others who have dealt with similar problems, regional institutions compile and disseminate ready-to-use summaries about competitive capabilities and routines (Suchman, 1994). In effect, regional institutions facilitate managerial innovation by providing access to information

and resources for acquiring new, and extending existing, capabilities.

Regional institutions also mitigate search costs associated with locating external sources of knowledge and specialized expertise critical to the acquisition of competitive capabilities. The search economies generated by intermediaries stem from their maintaining an extensive network of ties to different parts of a social system. Individual members of a network thus can 'relieve themselves of a heavy burden and free up their own time and energy to engage in other activities' (Galaskiewicz, 1985: 113). Therefore, rather than maintaining numerous ties to different parts of the network, an actor can maintain a single connection with the intermediary that specializes in providing access to and information about competitive capabilities.

A key insight developed in the social network literature is that intermediaries serve as go-betweens for potential exchange partners who are otherwise disconnected. In effect, intermediaries bridge the social gaps in a network by 'linking persons having complementary interests, transferring information, and otherwise facilitating the interests of persons not directly connected to one another' (Aldrich and Zimmer, 1986: 16). In the context of geographical clusters, rather than all firms being tied to one another, each can maintain a single connection with the regional institution that specializes in providing access to and information about potential exchange partners.

In brief, regional institutions fulfill a network intermediary role for participating firms by serving as a repository of knowledge and by reducing search costs. Accordingly, we hypothesize that:

Hypothesis 4: Participation in regional institutions will positively influence the firm's acquisition of competitive capabilities.

Bridging ties and participation in regional institutions

In spite of the seemingly obvious advantages of participating in regional institutions, firms are not always inclined to use their services. While regional institutions do provide firms with opportunities to learn about new capabilities, participants are also exposed to the risk that proprietary information about their own competitive

advantage may be revealed to rival firms. Firms may hesitate to participate in regional institutions because they are concerned that they may lose more than they gain.

Our preliminary fieldwork confirmed the reluctance of some firms to participate in regional institutions because of concerns about leakage of proprietary information. As one executive commented,

I think I find [the regional institution] more useful to our association as a group. I'm not saying there'd never be anything we would work with them on, but the problem in working with them is whatever we do, and do develop, is now public knowledge ... anything they came in here and did would be common knowledge and wouldn't be proprietary to [our company].

Ambivalence about participating in a regional institution stems from the fact that firms often need to share a certain amount of information about their own operations with the regional institution. To receive assistance with an organizational problem, a firm must provide some information about its current operations so that the issue can be analyzed and diagnosed. In many cases, this process involves a number of visits to, and inspection of, the firm's operations. Such visits present the potential for exposing proprietary and sensitive information, some of which may be unrelated to the specific problem at hand.

The knowledge, expertise, or skills developed in the process of resolving a specific organizational challenge confronted by a firm become part of the regional institution's 'stock of knowledge.' As a quasi-public entity, the regional institution seeks to spread the knowledge it acquires through interactions with firms as widely as possible. This knowledge may be shared with the firm's direct competitors. From this perspective, using the specialized services available from a regional institution may indirectly help a firm's competitors resolve similar problems. Consequently, participation in a regional institution may be viewed as a threat to a firm's strategic advantage.

We suggest that firms that have created networks rich in bridging ties to access diverse sources of information are more likely to be conscious of the value of information and the competitive risk of leakage of such information through participating in regional institutions.

Moreover, we expect that firms with advice networks rich in bridging ties would want to keep proprietary whatever knowledge and skills they have acquired through their contacts. As before, bridging ties are conceptualized as nonredundancy, infrequency of interaction, and geographic dispersion. Based on these arguments we predict that:

Hypothesis 5: Nonredundancy in the firm's advice network will negatively influence its participation in regional institutions.

Hypothesis 6: Infrequency of interaction in the firm's advice network will negatively influence its participation in regional institutions.

Hypothesis 7: Geographic dispersion in the firm's advice network will negatively influence its participation in regional institutions.

RESEARCH METHODS

Research setting

The recent emergence and growth of a nationwide infrastructure of regionally based industrial extension centers provided an ideal opportunity for research relating acquisition of competitive capabilities with participation in regional institutions. The field setting for our research consisted of geographical clusters located in two states of the Midwest United States. These clusters are served by industrial extension centers affiliated with a national system of such centers, which in this study represents regional institutions.

Beginning in the late 1980s, a new set of institutional arrangements began to appear in the U.S. with a specific focus on promoting the deployment of new manufacturing technology, production techniques, and business practices among small manufacturers. This new public infrastructure is embodied in a system of regional industrial extension centers managed by the National Institute of Standards and Technology (NIST). NIST assists small manufacturers with productivity enhancement through upgrading their manufacturing technology and improving their organizational practices.

The cornerstone of NIST's efforts to improve the competitiveness of small manufacturers is

its Manufacturing Extension Partnership (MEP) initiative.³ The regionally based MEP centers provide a common set of in-house services such as information 'hot lines,' training courses, workshops and conferences, equipment demonstrations, supplier certification, and manufacturing assessments.

Each MEP center also coordinates a staff of field agents that performs a range of outreach activities such as reconfiguration of existing manufacturing operations, selection and installation of new equipment, and identification and implementation of new management practices. All of the MEPs included in this study were founded at the same time, have the same charter, are similar in size (in terms of number of employees and annual budget), and offer some of the same programs.

Because of the MEP program's public charter, the services provided are widely available to the firms in the regions. The manufacturing extension program advertises the availability of its services throughout the region by routinely mailing newsletters and other promotional material to local firms, by attending local trade fairs, and through other direct and indirect channels. The voluntary nature of the MEP program means that individual firms choose to use the services available.

Research design and data collection

To test the hypotheses presented in this study, we used a stratified (by participation in a MEP) random sample of firms. A stratified random sampling strategy was used to ensure a sufficient degree of variation in the participation variable. As Singleton *et al.* note,

[S]tratififying by variables correlated with the dependent variable in a study increases precision because it systematically introduces relevant sources of variability (or heterogeneity) in the population into the sample (1988: 145)

In essence, stratifying contributes to sampling efficiency and eliminates error that would occur

³ A question may arise as to what the MEP centers' own interests and objectives are. MEP centers fit within the rubric of economic development programs that aim to preserve and create manufacturing jobs and enterprises, support innovation, enhance firms' productivity and profitability, and strengthen regional manufacturing economies more generally.

if a relevant segment of the population were not included.

The sampling frame consisted of all job shop manufacturers located in several regions of two Midwestern states and operating in the metalworking sector (i.e., electroplating, coating and painting, printed circuit board manufacturing, screw machining, stamping, sheet metal fabrication, and machining). The two geographical regions were selected because each operates an office of the state's MEP. The metalworking industries were chosen in order to obtain roughly equivalent proportions of firms participating in each region's MEP. In addition, these metalworking industries are all populated predominantly by small and mid-sized firms and tend to rely on similar production technologies.

A primary dataset was constructed using a mailed questionnaire. Officials from the MEPs in both states compiled and made available a list of participating and nonparticipating firms in each of the industries under study. From this list, all participating firms in each industry and an equal number of randomly selected nonparticipating firms in the same industry and state were extracted.

A preliminary version of the survey instrument was pretested among a group of local executives of job shop manufacturing companies from an industry other than those just listed. The questionnaire was administered to 22 job shop manufacturers, including a roughly equal number of participants and nonparticipants. Feedback from these executives was incorporated into a revised version of the survey instrument, along with comments and suggestions from industry experts, officials from the MEPs, and several colleagues knowledgeable in survey design.

The final questionnaire was mailed to 1,000 chief executive officers or presidents, who were considered best able to respond to questions about organizational and strategic issues relating to their respective firms. This approach is consistent with the selection of key informants knowledgeable about organizational matters by virtue of their position (John and Weitz, 1988). The sample included approximately 500 participants and 500 nonparticipants across both states and all metalworking industries. We also implemented Dilman's (1978) techniques for maximizing the response rate. Most important, in addition to the initial survey mailing, extensive followup com-

munications were carried out. The followup included: (1) sending a reminder/thank you postcard two weeks after the first round of mailing, (2) sending a second round of mailings to nonrespondents, and (3) placing a telephone call to any remaining nonrespondents.

A total of 309 executives responded to the request for information about their company. This number is approximately 31% of the original 1,000 firms surveyed. The followup telephone calls revealed that 178 of the original 1,000 firms were not eligible to participate in the study,⁴ and we eliminated these firms from our initial sampling frame. The actual response rate then equaled 38% (i.e., 309/822) of eligible firms. Complete responses were obtained from 227 of these firms. All of the firms from which we obtained responses had 500 or fewer employees. Further, 75% of the firms had 63 or fewer employees. Thus, the majority of firms in our sample were truly small.

Testing for nonresponse bias

Although the overall response rate of 38% was reasonable given the general reluctance of small manufacturers to respond to mailed surveys, the possibility remained that the sample of responding firms systematically differed from the remainder of the population. We addressed the potential for nonresponse bias by comparing certain key attributes of respondents (firm size in terms of the number of employees and annual sales) to those of a group of 50 randomly selected nonrespondents. We obtained size and sales data for the 50 nonrespondents from one of the MEPs. T-tests revealed no significant differences between the mean size ($t = -1.29$) and the mean sales ($t = -1.83$) of respondents and nonrespondents, although the near significance of the difference in the mean sales suggests the possibility of some bias in our sample toward firms with higher sales. To further confirm the representativeness of our sample, we conducted a Kolmogorov-Smirnov Two Sample test.⁵ For the variables of both size (as total employees) and sales we found no sig-

⁴ Firms deemed ineligible to participate in our study include those that were not job shop manufacturers, had gone out of business, or had zero employees.

⁵ We are grateful to an anonymous reviewer for suggesting this test to us.

nificant differences between our sample and the random sample of 50 nonrespondents. P-values were, respectively, 0.225 and 0.357, suggesting that the two samples were drawn from the same population. These tests provided adequate assurance that the sample of firms responding to the questionnaire was representative of the broader population surveyed (Siegel, 1956).

Operational measures

This study used a multimeasure approach to operationalize the theoretical constructs. Whenever possible, measurement instruments available from extant research were used to operationalize the theoretical constructs. Several instruments were modified to make them more suitable for the current research setting. Table 1 presents the details of the measurement instruments and scales used to operationalize our theoretical constructs. The Cronbach α reliabilities for each construct are also reported in Table 1. With the exception of the quality management construct, which is marginal at 0.61, constructs were at or above the value of 0.70 (Nunnally, 1978).

Acquisition of competitive capabilities

The acquisition of competitive capabilities construct is based on the 'Assimilation of Innovation' scale developed by Meyer and Goes (1988). These authors argue that innovation adoption in the organizational context is not simply a discrete event that is carried out instantaneously by individual decision makers. Rather, an innovation presents organizations with an adoption opportunity and triggers a set of formal and informal decision processes that may progress through the stages of awareness, evaluation, adoption, utilization, and eventually end in institutionalization. Similarly, we view competitive capabilities as being acquired through a multistage, organizational process since capability acquisition is a form of organizational innovation. A widely accepted definition of an innovation is any new product, process, practice, or idea (Rogers, 1995). This definition clearly encompasses the competitive capabilities studied and described in this paper (i.e., pollution prevention, quality management, and competitive scanning).

To develop a variable for statistical analysis, we created a 7-point scale that captures three

primary decision making stages associated with the adoption of technology: knowledge–awareness, evaluation–choice, and adoption–implementation. Since we view the acquisition of new competitive capabilities as analogous to the adoption of technological innovation, we adapted the wording of the Meyer and Goes' (1988) Assimilation of Innovation scale. Specifically, the modified scale refers to competitive capabilities, rather than technological innovations, and focuses on small, rather than large, organizations.

We evaluated three competitive capabilities using the acquisition scale: pollution prevention, competitive scanning, and quality management. Following Amit and Schoemaker (1993), we focused on industry-specific competitive capabilities that were identified during the field research.

In the initial phase of our research we conducted a series of in-depth field interviews with 13 individuals from different segments of the metalworking industries, including the owner–CEOs of job shop manufacturers and their customers and suppliers. We also interviewed industry consultants and field agents from regional institutions working with the industry. All interviews were conducted face-to-face at company locations. A semistructured interview format was used. The length of interviews varied from one to four hours, and all interviews were tape recorded (approximately 30 hours) and transcribed (roughly 300 pages). A careful analysis of the written material and subsequent confirmation by the interviewed industry experts suggested that hazardous materials management, minimization of variations in production processes, and awareness of competitor's strategy and behavior are central to competing successfully in the metalworking sector. For these reasons, we selected pollution prevention, competitive scanning, and quality management as the industry-specific competitive capabilities to study.

Pollution prevention

Pollution prevention capabilities have become salient with recent amendments to environmental regulations, such as the Clean Water Act, which govern the use and emission of hazardous materials integral to the production process of industries in the metalworking sector. Pollution prevention emphasizes the judicious use of resources through source reduction, energy

Table 1. Measurement instruments

| Measurement items | Scales | Internal consistency reliability (α) |
|--|---|---|
| Pollution Prevention Capabilities | | |
| 1. Substitute less hazardous raw materials for more hazardous ones | 1 = We know little about this practice 2 = We know about this practice, but do <i>NOT</i> do it | 0.72 |
| 2. Offer new products/services because of low waste disposal costs | 3 = We have considered doing this 4 = We decided <i>NOT</i> to do this after considering it | |
| 3. Discontinue products/services high in environmental management costs | 5 = We do this from time to time 6 = We do this most of the time 7 = We do this all of the time | |
| Competitive Scanning Capabilities | | |
| 1. Monitor your competitors' strategies and tactics | 1 = We know little about this practice 2 = We know about this practice, but do <i>NOT</i> do it | 0.81 |
| 2. Search for information about which customers your competitors supply | 3 = We have considered doing this 4 = We decided <i>NOT</i> to do this after considering it | |
| 3. Collect information about your competitors' market share | 5 = We do this from time to time 6 = We do this most of the time 7 = We do this all of the time | |
| Quality Management Capabilities | | |
| 1. Collect data on your company's production process variations | 1 = We know little about this practice 2 = We know about this practice, but do <i>NOT</i> do it | 0.61 |
| 2. Provide charts and graphs to production employees reporting defect rates | 3 = We have considered doing this 4 = We decided <i>NOT</i> to do this after considering it | |
| 3. Conduct experiments to isolate causes of defects | 5 = We do this from time to time 6 = We do this most of the time 7 = We do this all of the time | |
| Participation | | |
| 1. Obtain on-site assistance at your company from [name of center] | 1 = We know little about this service 2 = We know about this service, but do <i>NOT</i> do it | 0.75 |
| 2. Select/install new equipment or computer systems with [name of center] | 3 = We have considered doing this 4 = We decided <i>NOT</i> to do this after considering it | |
| 3. Participate in user groups or networks organized by [name of center] | 5 = We did this once 6 = We did this a couple of times 7 = We did this several times | |
| Non-Redundancy | | |
| 1a. Please write the initials of the five most important people <i>not employed by your company</i> that you rely on for advice about managing your business | (not applicable) | (not applicable) |
| 1b. Now, using the table provided indicate if these people know each other. If so, circle 'Y' for yes. | | |

Continued

efficiency, reuse of scrap materials during production, and reduced releases of hazardous or toxic materials (U.S. Environmental Protection Agency, 1990). Product and process changes are two common methods used to reduce or eliminate

the creation of pollutants or wastes at the source. Product changes include altering the composition or use of intermediate or end products. Process changes are manufacturing modifications that affect the amount of waste generated as a result

Table 1. Continued

| Measurement items | Scales | Internal consistency reliability (α) |
|---|------------------|---|
| Infrequency of Interaction | | |
| 1. Please tell us approximately how many conversations per month (on average) you have with each of your advisors about your business | (not applicable) | (not applicable) |
| Geographic Dispersion | | |
| 1. What is the travel time by car to each advisor's office? | (not applicable) | (not applicable) |
| Firm Size* | | |
| 1. Roughly how many <i>full-time equivalent</i> employees worked for you in fiscal year 1995? | (not applicable) | (not applicable) |
| 2. Roughly how many <i>temporary and seasonal</i> employees worked for you in fiscal year 1995? | | |
| *Firm size = sum of items 1 and 2 | | |
| Organization Age | | |
| 1. How long has your company been in business? | (not applicable) | (not applicable) |

of the way a product is produced. Accordingly, we operationalized pollution prevention with three items measuring various product and process changes (Table 1, Pollution Prevention instrument). These items were adapted from a national survey of pollution prevention conducted in one of the job shop industries selected for this study (Cushnie, 1994).

Competitive scanning

Given the need to monitor competitors' actions closely in an environment of low switching costs and lack of customer loyalty, competitive scanning is critical to firm competitiveness in these metalworking industries. Central to the notion of sustainable competitive advantage is the idea that firms strive to insulate themselves from the uncertainties of competitive interaction by establishing a unique position relative to rivals (Grant, 1995). Consequently, strategy formulation implicitly entails scanning the external environment for information about competitors to identify threats and opportunities (Aguilar, 1967; Andrews,

1971). The concept of competitive scanning was operationalized in this study using three items that tap into the practices a firm uses to gather information about rivals (Table 1, Competitive Scanning instrument). These items are based on the measurement instrument created and validated by Miller (1987).

Quality management

Quality management has increasingly become a prerequisite for doing business in metalworking industries that are part of supply chains supporting the automobile and other global industries. Although total quality management (TQM) means different things to different people, the elimination of production defects through continuous improvement of all processes is a common feature of most definitions (Hackman and Wageman, 1995). A core principle guiding the management of quality improvement is the analysis of variability in processes and outcomes through systematic data collection and statistical analysis (Deming, 1986; Juran, 1974).

In this study, TQM was measured with three items capturing the use of statistical process control charts to provide operators with feedback. The feedback allowed operators to base their actions on the variability of the manufacturing process (Table 1, Quality Management instrument). These items are based on the measurement instrument developed by Flynn, Sakakibara, and Schroeder (1995: 1327).

Participation in regional institutions

This construct indicated the extent to which a firm used the services available from a regional industrial extension center. Analogous to the acquisition of competitive capabilities, participation in a regional institution is not a discrete event, but rather represents an ongoing opportunity for a small manufacturer to access information and ideas.

A 7-point scale similar to the acquisition scale was developed to measure participation and capture three primary decision-making stages: knowledge-awareness, evaluation-choice, and utilization. Participation was measured with a three-item scale capturing the use of services available (Table 1).

Nonredundancy

To operationalize nonredundancy, this study used an ego-centered network measure based on an instrument designed and developed specifically for use in the small firm context (Aldrich, Rosen, and Woodward, 1986). This instrument asks respondents (ego) to identify the five most important external sources of advice (alters) relied upon and to report the extent to which these five⁶ sources know each other (Table 1). Using this matrix, a nonredundancy score was computed as follows:

$$\text{Nonredundancy} = (\text{Potential Ties} - \text{Actual Ties}) / \text{Number of Advisors}$$

where,

Potential Ties = the maximum number of ties that could exist among advisors (0 to 10),

or $n(n-1)/2$; where, n is the total number of advisors listed

Actual Ties = the number of ties that *do* exist among advisors (0 to 10)

Number of Advisors = the total number of advisors listed (0 to 5).

This equation defines nonredundancy as a ratio of nonredundant ties per advisor.⁷ The values for this variable ranged from zero to two, with low numbers indicating low nonredundancy and high numbers reflecting high nonredundancy. In the case where all advisors knew each other, nonredundancy equals zero (i.e., there was no nonredundancy, but rather complete redundancy). In contrast, when no advisors knew each other nonredundancy reached its maximum of two, reflecting a network of ties that was entirely nonoverlapping. In other words, a low percentage of advisors that know each other indicates that a firm's network is rich in bridging ties.

Infrequency of interaction

This variable measures the rarity of interaction with advisors in terms of the number of conversations per month (Table 1). Respondents were asked to report the average number of conversation held per month with each of the advisors listed. Using this information, an overall average infrequency of interaction score for each respondent is computed as⁸

$$\text{Infrequency of Interaction} = \frac{1}{\sqrt{\text{mean (conversations per month)}}}$$

Geographic dispersion

To operationalize this variable respondents were asked to indicate how far away each advisor was

⁶ The data show that there is not a bias toward listing five advisors. In fact, 50% of the firms report fewer than 5 advisors, with the mean number of advisors being 3.5.

⁷ We normalize our nonredundancy measure by the number of advisors (or the size of the network) since a larger network would permit greater opportunity for nonredundancy among contacts. We also evaluated a number of alternative computations of nonredundancy, including network size alone, and determined that the present formulation proved to be the most robust and consistent with our theoretical conceptualization.

⁸ A square root transformation is used to normalize these data.

located in terms of travel time by car (Table 1). These data were used to compute an aggregate geographic dispersion score for each respondent based on the average distance to an advisor as follows:⁹

$$\text{Geographic Dispersion} = \sqrt{\text{mean (distance)}}$$

Control variables

We included as a control firm size, in terms of the total number of employees (as standardized z-scores). Larger firms may be less inclined to participate in regional institutions and better positioned to acquire competitive capabilities. Scale economies, associated with spreading the costs of implementing capabilities over a larger base of operations, are greater in larger firms.

We also included organization age as a control because older organizations tend to be relatively more inert (Hannan and Freeman, 1977) and therefore less likely to acquire new capabilities and participate in regional institutions that promote change.

Construct validity

A measure of a construct is valid to the extent that it actually measures what it purports to measure (Carmin and Zeller, 1979). The logic of construct validity suggests that multiple indicators of the same theoretical construct should be positively and strongly related. In particular, convergent validity refers to 'the degree to which multiple attempts to measure the same concept by different methods are in agreement' (Campbell and Fiske, 1959; Phillips, 1981: 399). The degree to which two theoretical constructs differ from each other indicates discriminant validity.

The ego-centered network data described earlier relies on a surveying strategy that asks a focal actor (ego) to identify a set of alters connected to ego, and then report on the network of ties among these alters. The validity of the network constructs based on this ego-centered network data obviously hinges on ego's ability to assess accurately the ties between pairs of alters (Krackhardt, 1996; Marsden, 1993). Despite the importance of accurate assessments by ego, the

validity of ego-centered network measures has received little attention (Wasserman and Faust, 1994). For this reason, we evaluated the validity of the bridging ties constructs using data gathered from a second knowledgeable respondent who could provide an accurate report on the network data.

Validity of network constructs

To validate the constructs based on the ego-centered network data gathered, this study surveyed the contacts (alters) of 40 randomly selected firms (egos), of which 21 agreed to provide access to their contacts. All of the 85 contacts identified by the 21 respondents were telephoned. All contacts agreed to confirm their ties with the other alters listed by ego (i.e., the focal firm). We found that 72% of the time, ego's assessment of the tie between a pair of alters corresponds with *both* alters' report of the tie between themselves. Further, 86% of the time, ego's report of the tie between a pair of alters is in agreement with at least one of the alters. In other words, we can be fairly sure that, on average, these measures are no less than 72% accurate and well within the range of generally acceptable measurement accuracy. Based on this analysis, it is reasonable to conclude that the validity of the ego-centered network measures is acceptable.

Discriminant validity

The discriminant validity of two constructs can be assessed by demonstrating that the correlation between a pair of constructs is significantly different from unity. We test discriminant validity by comparing an unconstrained with a constrained structural equation model. The constrained model sets the correlation between two constructs equal to one. A significantly lower χ^2 value for the unconstrained model supports the discriminant validity criterion. As Table 2 indicates, the three bridging ties constructs, as well as the three competitive capabilities constructs, all exhibit satisfactory discriminant validity.

ANALYSIS AND RESULTS

To test the hypotheses developed earlier, we used the maximum likelihood estimation procedure in

⁹ A square root transformation is used to normalize these data.

Table 2. Discriminant analysis

| Model | d.f. | χ^2 | $\Delta\chi^2$ | p-value of $\Delta\chi^2$ |
|--|------|----------|----------------|---------------------------|
| Independent (exogenous) Latent Variables | | | | |
| All ϕ s left free | 3 | 1.98 | — | — |
| ϕ_{12} fixed to 1.0 (Non-Redundancy & Infrequency of Interaction) | 4 | 70.48 | 68.50 | 0.000 |
| ϕ_{13} fixed to 1.0 (Non-Redundancy & Infrequency of Geographic Dispersion) | 4 | 43.72 | 41.74 | 0.000 |
| ϕ_{23} fixed to 1.0 (Infrequency of Interaction & Geographic Dispersion) | 4 | 52.77 | 50.79 | 0.000 |
| Dependent (endogenous) Latent Variables | | | | |
| All ψ s left free | 48 | 64.80 | — | — |
| ψ_{23} fixed to 1.0 (Pollution Prevention & Quality Management) | 49 | 134.49 | 69.69 | 0.000 |
| ψ_{24} fixed to 1.0 (Pollution Prevention & Competitive Scanning) | 49 | 136.70 | 71.90 | 0.000 |
| ψ_{34} fixed to 1.0 (Quality Management & Competitive Scanning) | 49 | 130.40 | 65.60 | 0.000 |

LISREL 7 (Jöreskog and Sörbom, 1993) to specify a structural equation model. Rather than assuming that constructs are measured without error, LISREL explicitly models the measurement error in the indicators. This feature was relevant to this study, which relies heavily on psychometric measurement instruments. LISREL also provides the capability of simultaneously estimating a system of structural equations. This was appropriate for the present study also, since we tested a partial-mediation model (Venkatraman, 1989) that predicts direct as well as indirect (i.e., through participation in regional institutions) effects of the independent latent variables on the acquisition of competitive capabilities.

The structural equation model estimates a series of path coefficients reflecting the relationships specified among the latent variables. The Beta coefficient (β) indicates the structural path among dependent (endogenous) latent variables, which in this case is the link between participation in regional institutions and acquisition of competitive capabilities. The Gamma coefficient (γ) represents the structural paths between the independent (exogenous) latent variables and the dependent (endogenous) latent variables. The sign and statistical significance of the Beta and Gamma path coefficients serve as a test of the hypothesized relationships.

The results for the structural equation model

include the path coefficients and t-values (shown in parentheses) corresponding to each hypothesized relationship, and a series of standard fit indices¹⁰ reflecting the degree of overall fit between the actual and predicted covariances among variables of a model. The χ^2 statistic tests the correspondence between the model and the underlying data. A nonsignificant χ^2 value is desirable and indicates that the model is not significantly different from the underlying data. Descriptive statistics and zero-order correlations among the constructs are reported in Table 3.

The structural equation model specified the relationship between the three bridging ties constructs and the three acquisition of competitive capabilities constructs. The model also estimates participation in regional industrial extension cen-

¹⁰ Four fit indices are reported for the model estimated. The goodness of fit index (GFI) indicates the relative amount of variance and covariance jointly explained by the model. The adjusted goodness of fit index (AGFI) is similar to GFI, but adjusts for the number of degrees of freedom in the model. The normed fit index (NFI) (Bentler and Bonett, 1980) represents the point at which the model being evaluated falls on a scale from a null model (specifying mutual independence among indicators) to a perfect fit. The comparative fit index (CFI) (Bentler, 1990) is the same as the NFI, but corrects for small sample size by subtracting the degrees of freedom from their corresponding chi-square values. Each index ranges from zero to 1.00, with values closer to 1.00 indicating a good fit. A commonly accepted rule of thumb is that a fit index should be greater than 0.90.

Table 3. Descriptive statistics and zero-order correlations among constructs

| | Mean | S.D. | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 |
|-------------------------------------|--------|--------|---------|---------|---------|---------|--------|--------|-------|---------|
| 1 Pollution Prevention Capabilities | 3.831 | 1.778 | 1.000 | | | | | | | |
| 2 Competitive Scanning Capabilities | 3.363 | 1.551 | 0.260** | 1.000 | | | | | | |
| 3 Quality Management Capabilities | 4.510 | 1.501 | 0.295** | 0.323** | 1.000 | | | | | |
| 4 Participation | 2.131 | 1.405 | 0.132* | 0.098 | 0.215** | 1.000 | | | | |
| 5 Non-Redundancy | 0.990 | 0.629 | 0.130* | 0.135* | 0.032 | -0.121* | 1.000 | | | |
| 6 Infrequency of Interaction | 0.626 | 0.335 | -0.014 | -0.115 | 0.016 | -0.0583 | -0.071 | 1.000 | | |
| 7 Geographic Dispersion | 1.095 | 0.886 | -0.021 | 0.126* | 0.083 | 0.007 | 0.091 | 0.031 | 1.000 | |
| 8 Firm Size | 0.000 | 1.000 | 0.020 | 0.176** | 0.264** | 0.032 | -0.038 | -0.064 | 0.026 | 1.000 |
| 9 Organization Age | 29.930 | 22.120 | 0.066 | 0.083 | 0.066 | -0.43 | -0.020 | 0.004 | 0.030 | 0.170** |

** $p < 0.01$, * $p < 0.05$

ters as a mediator of the relationships between bridging ties and capabilities constructs while controlling for firm size and age (Figure 2). The structural equation model demonstrated a χ^2 (94 df) value of 101.87 ($p = 0.272$). All fit indices

are above 0.9, indicating a satisfactory fit of the model with the data. Parameter estimates for the model are provided in Table 4.

Hypothesis 1. The first hypothesis predicting a positive relationship between nonredundancy and

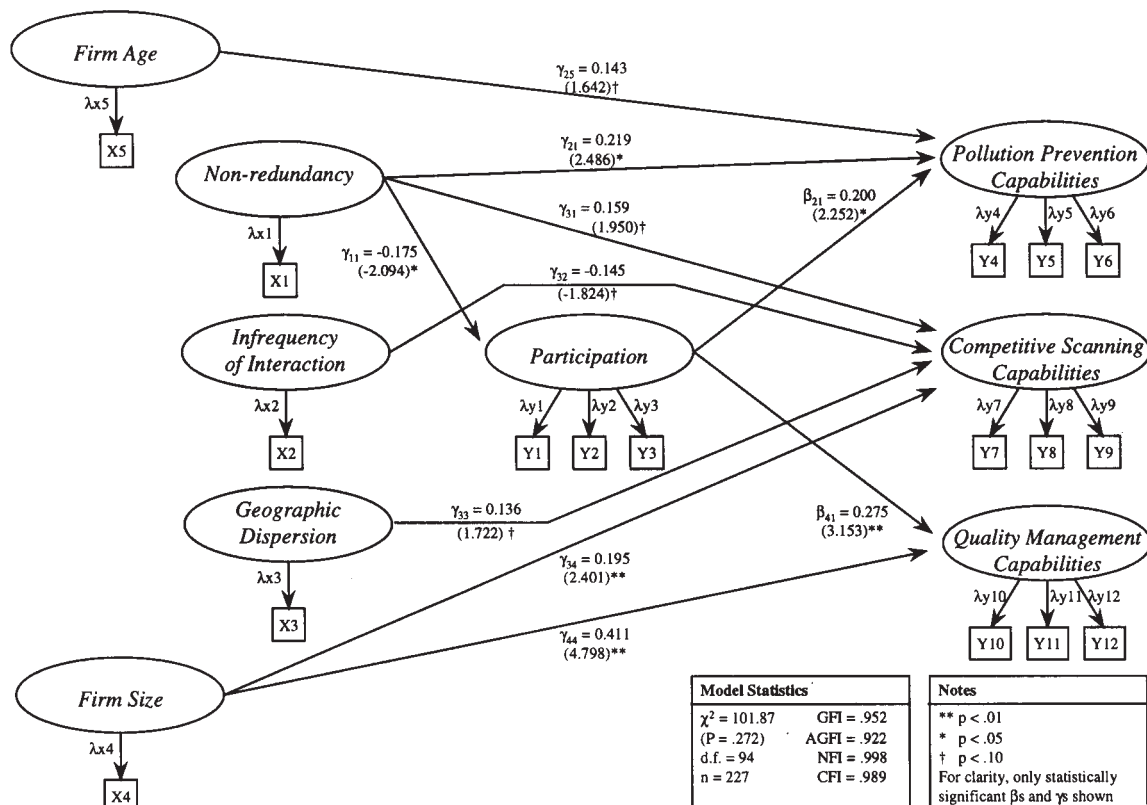


Figure 2. Bridging ties structural equation model

Table 4. Parameter estimates for structural model (Figure 2)

| Parameter | Standardized solution | t-value |
|------------------|-------------------------|----------|
| β_{21} | 0.200 | 2.252* |
| β_{31} | 0.130 | 1.593 |
| β_{41} | 0.275 | 3.153** |
| γ_{11} | -0.175 | -2.094* |
| γ_{21} | 0.219 | 2.486* |
| γ_{31} | 0.159 | 1.950† |
| γ_{41} | 0.068 | 0.803 |
| γ_{12} | -0.083 | -1.010 |
| γ_{22} | -0.006 | -0.076 |
| γ_{32} | -0.145 | -1.824† |
| γ_{42} | 0.020 | 0.240 |
| γ_{13} | 0.034 | 0.410 |
| γ_{23} | -0.065 | -0.763 |
| γ_{33} | 0.136 | 1.722† |
| γ_{43} | 0.058 | 0.704 |
| γ_{14} | 0.056 | 0.667 |
| γ_{24} | -0.057 | -0.654 |
| γ_{34} | 0.195 | 2.401** |
| γ_{44} | 0.411 | 4.798** |
| γ_{15} | -0.076 | -0.905 |
| γ_{25} | 0.143 | 1.642† |
| γ_{35} | 0.067 | 0.826 |
| γ_{45} | 0.053 | 0.625 |
| λx_1 | 0.900 (Fixed Parameter) | |
| λx_2 | 0.900 (Fixed Parameter) | |
| λx_3 | 0.900 (Fixed Parameter) | |
| λx_4 | 0.900 (Fixed Parameter) | |
| λx_5 | 0.900 (Fixed Parameter) | |
| λy_1 | 0.817 (Fixed Parameter) | |
| λy_2 | 0.763 | 8.536** |
| λy_3 | 0.593 | 7.665** |
| λy_4 | 0.776 (Fixed Parameter) | |
| λy_5 | 0.662 | 7.355** |
| λy_6 | 0.598 | 7.000** |
| λy_7 | 0.828 (Fixed Parameter) | |
| λy_8 | 0.716 | 9.961** |
| λy_9 | 0.755 | 10.320** |
| λy_{10} | 0.801 (Fixed Parameter) | |
| λy_{11} | 0.476 | 5.490** |
| λy_{12} | 0.485 | 5.565** |

**p < 0.01, *p < 0.05, †p < 0.10

competitive capabilities is *largely supported*. Two of the three competitive capabilities are significantly associated with nonredundancy in the advice network. Specifically, while the link between nonredundancy and pollution prevention capabilities is positive and statistically significant ($\gamma_{21} = 0.219$, $t = 2.486$, $p < 0.05$), and the relationship between nonredundancy and competitive scanning capabilities is positive and statistically significant at the 0.05 level ($\gamma_{31} = 0.159$,

$t = 1.950$, $p = 0.05$), the link to quality management capabilities is not significant ($\gamma_{41} = 0.068$, $t = 0.803$, n.s.).

Hypothesis 2. The hypothesized positive relationship between infrequency of interaction and competitive capabilities is *not supported*. Although infrequency of interaction exhibits an association with one of the three competitive capabilities studied (competitive scanning) that is statistically significant at the 0.07 level, the sign is negative rather than positive as predicted ($\gamma_{32} = -0.145$, $t = -1.824$, $p = 0.07$). The relationship between infrequency of interaction and pollution prevention capabilities is not statistically significant ($\gamma_{22} = -0.006$, $t = -0.076$, n.s.), nor is the link with quality management capabilities ($\gamma_{42} = 0.020$, $t = 0.240$, n.s.).

Hypothesis 3. The predicted positive relationship between geographic dispersion and competitive capabilities is *partially supported*. There is a positive relationship between geographic dispersion and competitive scanning significant at the 0.09 level ($\gamma_{33} = 0.136$, $t = 1.722$, $p = 0.09$), however the data reveal nonsignificant statistical relationships for both the geographic dispersion to pollution prevention link ($\gamma_{23} = -0.065$, $t = -0.763$, n.s.) and the geographic dispersion to quality management relationship ($\gamma_{43} = 0.058$, $t = 0.704$, n.s.).

Hypothesis 4. The fourth hypothesis positively relating participation in regional institutions to the assimilation of competitive capabilities is *largely supported* by the data. Indeed, we observed positive and statistically significant relationships for the link between participation and pollution prevention capabilities ($\beta_{21} = 0.200$, $t = 2.252$, $p < 0.05$) and for the link from participation to quality management capabilities ($\beta_{41} = 0.275$, $t = 3.153$, $p < 0.01$). However, the relationship between participation and competitive scanning capabilities is not statistically significant ($\beta_{31} = 0.130$, $t = 1.593$, n.s.).

Hypothesis 5. The model provided *support* for the fifth hypothesis predicting a negative relationship between nonredundancy and participation in regional institutions. As predicted, the nonredundancy to participation link is both negative and statistically significant ($\gamma_{11} = -0.175$, $t = -2.094$, $p < 0.05$).

Hypothesis 6. The prediction that infrequency of interaction and participation in regional institutions would be negatively related is *not sup-*

ported, since the relationship is nonsignificant ($\gamma_{12} = -0.083$, $t = -1.010$, n.s.).

Hypothesis 7. The hypothesized relationship predicting a negative relationship between geographic dispersion and participation is *not supported*; the link between these two variables is nonsignificant ($\gamma_{13} = 0.034$, $t = 0.410$, n.s.).

Limitations of the research

Before discussing our findings it is important to mention some limitations. Because of the cross-sectional nature of our research design, we are cautious in inferring the direction of causality among the key constructs. Although we have presented the findings in a manner that implies a certain causal chain, it is possible that the direction of causality may be reversed in some cases. For instance, Hypotheses 5–7, predicting a relationship between firms' networks of bridging ties and participation in regional institutions, could be interpreted as causally reversed. This would suggest, for example, that participation actually lowers nonredundancy, rather than nonredundancy lowering participation, as we have hypothesized.

To explore this possibility, we compared the duration of the relationship between a firm and the regional institution with the average duration of the relationship between a firm and its advisors. We found that 96% of the time, the relationships between a firm and its advisors were in place prior to participating in the regional institution. Moreover, on average, firms knew their advisors for nine years and two months before their first participation in the regional institution. We believe these data provide some indication that firms' network structure precedes participation in regional institutions, as we hypothesize.

A question may also be raised as to the diversity of the advisor network. If the firm's advisors are predominantly from the same industry as each other, then it is possible that the information accessed by the focal firm is less diverse. To explore this possibility we analyzed additional data collected that reported each advisor's industry category (e.g., supplier, customer, consultant, banker, competitor, university contact). These data indicated that 46% of the firms' advisors were in different respective categories (i.e., no two advisors belonged to the same category). Further, 36% of the firms had exactly two of

their advisors in the same category. Only 18% of the firms reported more than two advisors from the same category. These data are consistent with the notion that the majority of firms' advisors represent diverse sources of information.

A further challenge we confronted was operationalizing the bridging tie concept. Because we limited ourselves to five advisors and the links among them, we may not have captured the full effects of nonredundancy in the extended network. We justify this approach by pointing out that our research strategy emphasized a multi-construct conceptualization of bridging ties and was theoretically derived. Further, we operationalized bridging ties with the specific aim of creating a parsimonious measure.

Generally, the reliance on egocentric network measures introduces the potential for bias in the assessment of network structure. One issue arising with the use of ego-centered network data is the accuracy of the reports from focal actors (egos) about the relationships among their contacts (alters) (Krackhardt, 1996; Marsden, 1993). As discussed earlier, we addressed this issue by conducting a follow-up study with a sample of alters and find a substantial degree of correspondence between egos' and alters' reports of relationships among alters.

A second issue associated with ego-centered network data is the inability to capture the broader network of ties beyond an actor's immediate contacts. The implication is that an apparent structural hole between two primary contacts may be bridged by an indirect connection to a common third party. While unidentified third party connections are a legitimate concern, we note that the inability to capture the broader network is a challenge for the large body of research relying on ego-centered network data.

In addition, our choice of small manufacturing firms as the focus of this study limits the generalizability of the findings to this population. At the same time, small manufacturing firms constitute a large and critical segment of the economy.

DISCUSSION

This study holds important implications for strategic management and social networks research. For strategy research, the study suggests the need to revisit the implicit assumptions prevalent in

the resource-based view that firms are atomistic and that capabilities are internally generated. Rather, as this research shows, sources of competitive capabilities can be embedded externally in firms' network resources—their network of bridging ties and linkages to regional institutions.

For network research, we provide insight into a central debate over the underlying causal agent leading to the acquisition of unique information and the discovery of productive opportunities. In particular, we shed light on the relative explanatory power of structural holes versus strength of weak ties theories.

Contributions to strategy research

Our contribution to strategy research consists of using a key set of ideas from the embeddedness literature to deepen understanding of the fundamental question of why firms differ (Nelson, 1991). Existing strategy research employing the resource-based view of the firm tends to explain firm heterogeneity and profitability differences as arising primarily from internally generated capabilities (Barney, 1991). Moreover, this, and other economics-based perspectives explaining firm heterogeneity, implicitly suggest that firms are autonomous and atomistic in their pursuit of competitive advantage.

Our research challenges both assertions by pointing to the role of network resources, and the externally embedded nature of capabilities acquisition, and highlighting the central role of firms' ties with other economic and noneconomic actors. Put differently, in contrast to firm-centric approaches to explaining firm heterogeneity, our research adopts the embeddedness notion that idiosyncratic patterns of linkages account for differences in competitive capabilities across firms. Our central premise is that a firm's network resources of interfirm ties and institutional linkages expose it to new ideas, information, and opportunities about competitive capabilities. In effect, the distinctiveness in firms' network resources, and the information access they provide, have important implications for firms' capacity to compete.

Drawing on the social network literature, we develop three complementary explanations for the discovery of new information and opportunities: network structure (nonredundancy), tie strength (infrequency of interaction), and spatial location

of contacts (geographic dispersion). The results demonstrate that the structure of firms' networks of bridging ties exerts the greatest influence on both the acquisition of competitive capabilities and participation in regional institutions.

In geographical clusters, keeping on top of developments is achieved by maintaining a network of advisors who are nonoverlapping and disconnected. This finding implies that a firm's configuration of linkages with other actors in the cluster is an important vehicle through which the firm's skills, competencies, and routines are continually upgraded, refreshed, and renewed.

The link between networks and capabilities contributes a valuable insight to the literature on competitive capabilities, which has yet to formulate a comprehensive theory for the *source* of competitive capabilities. In particular, while the strategic management literature has explained performance differences in terms of resources and capabilities, there is scant theory explaining how firms identify, obtain, and develop competitive capabilities. Some previous work in this area has suggested that capabilities derive from external linkages such as alliances (Hamel, 1991) and networks of information (Zaheer and Zaheer, 1997), or learning (Powell, Koput, and Smith-Doerr, 1996). We extend this stream of research by elaborating upon how firms' patterns of bridging ties and the nature of their linkages with regional institutions *both* influence the acquisition of competitive capabilities.

We do not mean to imply that firms' network resources entirely explain differences in competitive capabilities, which are undoubtedly also the outcome of other factors, including immobile resources, causal ambiguity, luck, and path dependence. However, we do argue that firms' embeddedness in networks of social, economic, and professional ties is an important, if somewhat neglected, perspective in strategy research.

Consistent with the notion of embeddedness, we suggest that bridging ties are not necessarily only connections between a focal firm and its competitors. Rather, bridging ties also commonly exist with symbiotic partners such as customers, suppliers, professional service providers, investors, and firms in related industries, all of which maintain a considerable interest in the competitive success of the focal firm. Moreover, such bridging ties with a firm's main advisors are most likely to exist with trusted actors that provide reliable

and valuable information. The implication for network theory is that, rather than focusing on the strength or weakness of a tie, research should recognize that new ideas, information and opportunities can be sourced through contacts that are simultaneously nonredundant and trusted. For strategy research, because high-trust relations penetrate irregularly and in differing degrees, bridging ties offers an important explanation for the differences among firms' competitive capabilities.

Contributions to network research

Our research contributes to the network literature by drawing a theoretical link between the notion of embeddedness and firm heterogeneity. Specifically, we theorize and demonstrate that one source of important firm heterogeneity is the idiosyncratic and unique manner in which firms are embedded in networks. Since firms are each embedded in highly differentiated ways, they occupy unique network positions that link them to different sets of players and thereby present them with distinct opportunities and constraints. In this way, our research highlights a significant avenue through which embeddedness influences economic actions.

Our research further contributes to the network literature through our conceptualization of the bridging ties constructs in terms of nonredundancy, infrequency of interaction, and geographic dispersion. By relating each of the bridging ties constructs to competitive capabilities and to participation, we test the explanatory power of the underlying network theories (Burt, 1992; Granovetter, 1973). The results indicate that, consistent with the structural holes thesis, nonredundancy in the firm's advice network explains the acquisition of capabilities and participation in regional institutions; while infrequency of interaction and geographic dispersion show virtually no effects. The implication of these findings is that the diversity of information sources is best reflected in the lack of overlap among contacts (nonredundancy), rather than in the intensity of interaction with advisors (infrequency of interaction).

At the same time, our results show that, contrary to structural hole theory, structural holes (as measured by nonredundancy) and weak ties (as measured by infrequency of interaction) are in

fact unrelated. Although Burt (1992) argues that weak ties and nonredundancy overlap to a certain degree, we found no systematic relationship between these concepts as reflected in the nonsignificant zero order correlation between nonredundancy and infrequency of interaction (Table 3). Given received theory about the relationship between structural holes and weak ties, this result is surprising. It implies, as Burt also acknowledges, that 'information benefits are expected to travel over all bridges, strong or weak' (1992: 30).

Before concluding that the weakness of a tie is not related to the discovery of new information and opportunities, we encourage future research to test other possibilities. For example, despite the explicit use by Granovetter (1973), infrequency of interaction may not be the best measure of weak ties. Future research may consider alternative dimensions of weak ties, such as bandwidth of communication, emotional intensity, or reciprocity.

Alternatively, a study mapping the entire network of advisors would allow for distinctions to be examined between weak ties with recluses versus weak ties with strategically-situated actors. The lack of an association between nonredundancy and infrequency of interaction raises important questions about boundary conditions of the strength of weak ties theory. For example, it would be useful to understand under what circumstances tie weakness might act as a substitute for structural holes.

This research further demonstrates that participation in regional institutions mediates the link between bridging ties and the acquisition of competitive capabilities. On the one hand, the findings indicate that firms with an advice network rich in bridging ties tend to acquire and develop competitive capabilities independent of the regional institution. Conversely, those firms with an advice network limited in bridging ties participate to a greater extent in regional institutions. We interpret this finding as suggesting that a participating firm's link with a regional institution may act as a 'surrogate tie' by serving as a functional substitute for its own cluster of bridging ties. In effect, a regional institution acts to condense networks spatially, thereby allowing a firm's link through its 'surrogate tie' to serve as a conduit for a wide range of information and opportunities.

Directions for future research

While our research has deepened understanding of the links between networks, resources, and capabilities, it has raised a number of further questions. The finer-grained process through which network structure translates into the acquisition of competitive capabilities is an interesting and important area for future research. Mediating variables, such as the diversity of information obtained, could be examined. Another fruitful area of inquiry is the longitudinal dynamics of how firms' networks evolve and change in response to emerging competitive challenges and opportunities. As a firm's competitive environment changes, to what extent does inertia constrain a firm's ability to reconfigure its pattern of bridging ties?

Further, our understanding of the processes of cooperative competition in geographical clusters could greatly benefit from a more detailed analysis of the mix of cooperation and competition in networks. The balance between interfirm cooperation and competition, while a popular idea (Hamel, 1991), warrants greater research attention, particularly in the network context.

Yet another interesting extension of this research would be to investigate the outcomes and consequences of the two-way flow of information among a focal firm and its contacts, and the exchange dynamics that may accompany it.

Concluding remarks

Despite the centrality of competitive capabilities to the field of strategic management, research has devoted far less attention to exploring the sources of capabilities than to performance-related outcomes. Consequently, we know relatively little about how firms acquire and develop capabilities and what explains differences in the level of capabilities among firms. To this end, our research contributes to a better understanding of the role of firms' network resources of bridging ties and participation in regional institutions in the development of competitive capabilities. We thus take an initial step in the direction of embedding the economic action of capabilities acquisition in the broader context of firm networks in geographical clusters.

The findings of this study demonstrate that firm differences exist, in terms of network structure

and the degree of participation in regional institutions, and that these differences do matter for understanding firms' acquisition of competitive capabilities.

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