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Abstract

Online networks can be construed as social networks in which people engage in interactions, build relationships, share information, and request and extend assistance to each other using electronic communication technologies. Is social capital embedded in online networks? How is such social capital mobilized (i.e., shared)? What structural properties of cyber networks are associated with mobilization of social capital? These questions have drawn the attention of researchers in the areas of social networks, social capital, and online communication. Our research is an initial effort to touch upon these three questions. Whereas most previous research on both conventional and online social networks has favored analysis of either egocentric (i.e., individuals) or bounded (i.e., groups or organizations) networks as the primary unit of analysis, this study investigates online discussion forums that span formal boundaries of organizations, examining their structural properties and patterns of information exchange. We employ a network-based approach to the study of social capital, postulating that mobilization of social capital is contingent on social network properties. Using data from professional online forums devoted to knowledge management, we find that two network properties, core–periphery structure and centralization, are related to the mobilization of informational social capital in online networks. Implications and limitations of this study are discussed and suggestions for future research are provided.

Keywords: Online social network, social capital, knowledge sharing, network structure

Introduction

In his influential work, "Bowling Alone: The Strange Disappearance of Civic America," Robert Putnam (1995) painted a gloomy picture of American society with a drastic decline in civic engagement of many sorts. Putnam's work has been widely cited both in the academe of social sciences and the mass media. Most remarkably, it has drawn great attention to the concept of social capital and the downside of its decline. While Putnam's work successfully rang the caution bell against the declining civic engagement of American society, his conclusion about the decline of social capital provoked many doubts and counterarguments. Among these, the most intriguing are related to the postulation for growing social capital via the use of new communication technologies (Lin 2001; Wasko and Faraj 2005; Wellman et al 1996). This line of research emphasizes that people can engage in interactions, build relationships, share information, and request and extend assistance to each other using electronic communication technologies. The networks of relationships built online, often referred to as online networks, can operate as social networks with various forms of resources embedded in them (Lin 2001; Wellman et al 1996)

In order to approach the issue regarding social capital embedded in and mobilized from online networks, studying the definition of social capital is a worthy exercise. Overall, most conceptualizations of social capital agree with each other on its embeddedness in social relations. However, disagreement arises in exactly what constitutes of social capital and how to measure it. Bordieu (1985) defined social capital as the aggregate of resources that are linked to membership in a group. The volume of social capital depends on the size of network and the volume of capital possessed by those who are in the network. Coleman (1990) defines

social capital by its function and argues that it consists of some aspect of a social structure, and it facilitates certain actions of individuals who are within the structure. Burt (1992) describes social structure as capital in its own right. In particular, Burt argues that social networks rich in certain structural properties provide benefits, in particular, nonredundant information resources, to participants. In an effort to clarify the concept of social capital and assess its utility for organizational studies, Adler and Kwon (2002) define social capital as the goodwill available to individuals or groups with its sources lying in the structure and content of the actor's social relations. In this study, we adopt a network-based definition, which defines social capital as "resources embedded in one's social networks, resources that can be accessed or mobilized through ties in networks" (Lin 2005, p. 2). While many researchers treat social capital as equivalent to social network structure and interactions (e.g., McFadyen and Cannella 2004; Oh et al. 2004), we think doing so might be a source of confusion. We stay with Lin's (2001, 2005) network-based definition of social capital as resources embedded in social networks. In this way we are able to differentiate social network structural properties from social capital itself. Lin (2005, p. 4) puts it this way: "While social capital is contingent on social networks, they are not equivalent or interchangeable terms.…Rather, variations in networks or network features may increase or decrease the likelihood of having a certain quantity or quality of resources." Following this logic, we treat social networks as conduits through which resources/social capital can flow.

The increasingly important roles played by online communication call for studies on the impact of social relations built online with various outcomes. Much of online network communication involves exchange of information (Wellman et al. 1996), and it is widely agreed by researchers in the field of social networks and social capital that information is a form of resource (Burt 1992; Coleman 1990; Lin 2005). While information benefits include creating new ideas and exchanging existing knowledge, the information benefits of online social networks are grounded primarily in the latter (Matzat 2004). Therefore, many studies of online networks are centered on the issue of information sharing and transmission (e.g., Matzat 2004; Wasko and Faraj 2005). To study how information flows in the networks enabled by electronic communication technologies, network structural concepts are often utilized. It has been shown that online networks sustain strong, intermediate, and weak ties. Increasing bandwidth and the low cost of communication allow frequent, reciprocal, and often supportive contacts, thus building ties that meet the criterion of strong ties. On the other hand, limited social cues online encourage contact between weak ties (Wellman et al. 1996). By tracking the evolution of a single, large online network, Homle et al. (2004) concluded that interactions online are exposed to fewer forces related to social status than is typically the case in other social settings. Empirical study of academic communication in Internet discussion groups has found that scholars build up weak contacts that make their research more visible and that make them more aware of other researchers' work (Matzat 2004). Group behaviors in online networks have been compared with those in conventional settings, and it has been found that electronic groups become information buffers or devices for pooling current information in a readily accessible form (Finholt and Sproull 1990).

The purpose of this study is to explore the link between structures of social relations built through online communication and resources mobilized from these relations, specifically, information resources. It aims to address the question: Can people engage in learning by typing messages back and forth to each other? We treat the online social network as a unit of analysis, thus expanding the research to the level of whole networks with distinct structures. Moreover, we expand the investigation of network structural properties beyond consideration of tie strength, which has been the focus of many studies on social networks to date. We analyze two social network structural properties, centralization and core–periphery, and examine how these two structural properties relate to processes and types of knowledge exchange that occur in online professional forums.

Theory and Hypothesis

There are many forms of communication supported by information technologies. Our focus is on Internet-based discussion forums devoted to topics of professional management interest, such as knowledge management, supply chain management, or customer relationship management. These are forums created online where individuals discuss topics that are of interest to them, and social ties are built through the discussions. Individuals may choose to act as silent viewers or active contributors to the discussion. Online forums offer the potential to build interorganizational social networks among professionals since communication can easily span the formal boundaries of organizations and geographic locations (DeSanctis et al. 2003). The social networks built in professional online forums are akin to the advice network in the conventional sense. In an advice network, individuals share resources such as information, assistance and guidance (Klein et al. 2004). Therefore, the social capital embedded in these online forums is mostly in the form of information resources.

Electronic communication technologies make it possible to share information quickly, globally, and with large numbers of people. Using social capital concepts, we can say that informational social capital embedded in online social networks occurs as knowledge possessed by individuals is contributed to the forum discussion. The collective pool of knowledge represents "a

potential pool of resources capable of generating returns available to the actor, indicating the capacity of social capital" (Lin 2005, p. 5). As in traditional social networks, information embedded in online social ties can be obtained in two major ways. First, information can be actively sought. The information holder, being contacted, can disseminate the requested information. Second, information may be passively received (Lai and Wong 2004). Information seeking and distributing by the participants are processes of mobilizing the embedded social capital.

In online forums, it is technically easy to ask for and provide information. A question is sent to a group and answers are available to the entire group. Feedback is shared by making both initiating messages and all responses available to all participants in the forum (Finholt and Sproull 1990). Most online forums provide data storage facilities to store previous communication in an organized form that can be sorted and searched. Thus, information repositories are created for online social networks. In this way, individual expertise and experience are turned into shared knowledge. Online communication is subject to fewer constraints in terms of information storage space than conventional communication methods. Additionally, the asynchronous nature of communications in online forums frees participants from time constraints. Therefore, the amount and range of information spread online is potentially enormous and may result in information overload. Information overload, the state where an individual cannot process or utilize all communication inputs, can lead to cognitive breakdown (Jones et al. 2004). When information is provided in excess of what has been requested, individuals may be unable to process the information adequately. In the extreme form of providing excessive information, communication becomes pure announcement, instead of exploration, rich discourse, and exchange. However, the more prominent potential problem with an advice network is inadequate response to the requests for information and assistance. If a member of a social network sends out requests for information but receives no responses, this means that the member failed to mobilize the informational social capital embedded in the social network. A wide gap between information seeking and information providing indicates the failure of the social network to generate information resources. Thus if an online forum has more requests for information than responses, the forum has relatively low value in terms of sharing knowledge. Put another way, as the ratio of information seeking to information providing becomes smaller, the more successful the processes of mobilizing online information resources.

Some types of knowledge are more readily exchanged in online social networks than others. Generally speaking, the content of knowledge may be fairly explicit (communicated without much difficulty) or more tacit (Choo 1998). Tacitness of knowledge is sometimes considered a continuous construct as the degree to which knowledge is difficult to codify or articulate (Reagans and McEvily 2003). In this study, we separate the content of knowledge exchanged in online forums into tacit and explicit, both of which can occur on a continuum from low to high. Previous research suggests that tacit knowledge is more time consuming and difficult to transfer (Hansen 1999). Learning the tacit aspects of a task most often requires some increased level of interaction. Also, tacit knowledge is more susceptible to being lost or incorrectly translated from member to member.

The central issue that our research is trying to tap into is how the structures of online social networks are related to mobilizing processes of the informational social capital embedded in the networks. These mobilizing processes include information seeking and providing, and explicit and tacit knowledge sharing. We postulate that the mobilization of social capital, specifically, in this case, information benefits, is contingent on social network properties.

An important network structural construct is the core–periphery structure. Typically in this type of structure, a dense, cohesive core exists with a sparse or unconnected periphery (Cummings and Cross 2003). An intuitive notion of core–periphery structure consists of a two-class partition of nodes in which one class is the core and the other is the periphery. In the cohesive subgroup (the core), actors are connected to each other in some maximal sense and, in another subgroup (the periphery), actors are more loosely connected to the cohesive subgroup and each other, lacking any maximal cohesion (Borgatti and Everett, 1999). An example is shown in Figure 1.

In team social networks, core–periphery structure has been shown to be negatively related to group communication and performance because of the uneven distribution of cohesiveness (Cummings and Cross 2003). However, in electronic networks, members of core subgroups can readily communicate with and broadcast to peripheral members (Koku and Wellman 2002; Smith 1999) and so greater core–periphery structure may facilitate group communication rather than disturb it. The logic for this is as follows. A core subgroup is a network structure with high closure, that is, everyone in the subgroup is connected to each other; in operational terms, this means there is a dense network inside the core. According to advocates of network closure, network closure improves communication, results in more reliable and coordinated exchange of information, and even facilitates trust and norms (Coleman 1990). For well-connected individuals, they may become more aware of the information requests sent by others. Also, members of the dense and cohesive subgroup may be more willing to share their expertise as well as to respond to the information seeking requests of others, because relationships, trust, and norms may have grown from the dense connection. Moreover, from the perspective of the overall network, the core subgroup may be playing the role of discussion leader, initiating

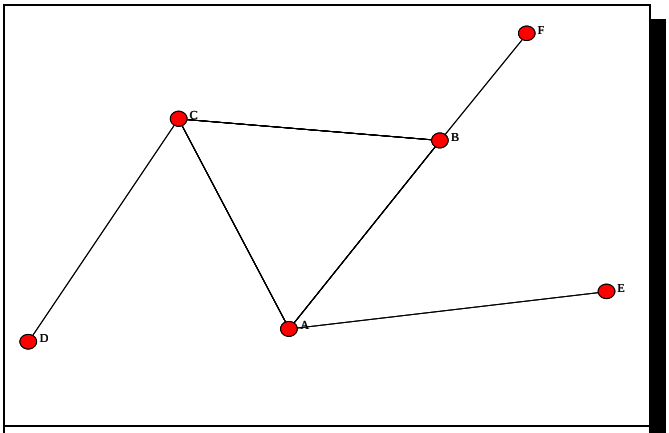

Figure 1. Core–Periphery Structure

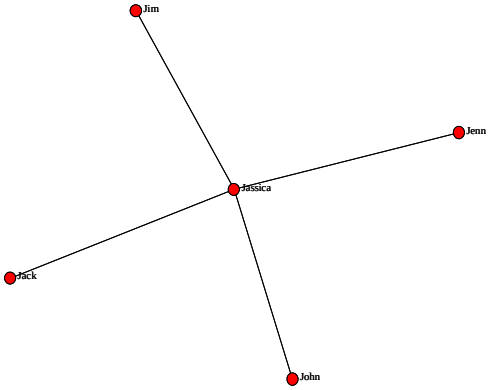

Figure 2. Star Network Structure

interesting topics, broadcasting responses to questions, and expressing opinions. The members of the peripheral subgroup benefit from the discussion as well by observing and reading what has been posted. When the responses exceed the amount of requests, it implies that a question may receive multiple answers., thus participants seeking information are provided with the opportunity to scrutinize and choose from a range of options. Overall, we expect the core–periphery structure to be associated with more effective mobilization of informational social capital in the online setting, such that members of the online forum will readily provide information to those who seek it.

H1: The greater the core–periphery structure exhibited by an online forum, the lower the ratio of information seeking to information providing behavior.

Another widely discussed network property is centralization. Network centralization indicates the extent to which certain network members are prominent in a given network in terms of connectivity among network members (Koku and Wellman 2002). The most centralized network is a "star" network where there is a central node that is connected to every other node, and all other nodes are only connected to the star (see Figure 2). From an egocentric perspective, possessing a central position in a social network may be positively associated with innovativeness, power, and access to a wider range of information (Ahuja and Carley 1999; Becker 1970; Klein et al. 2004). However, when considering a whole network as a unit of analysis, research has found that decentralized networks provide opportunities for task-related communication and information exchange (Rulke and Galaskiewicz 2002).

According to Burt (1992), two people (nodes) in a network are structurally equivalent to the extent that they have the same contacts. Redundancy is associated with structural equivalence, because the information acquired from the same contact is likely to be redundant. In a centralized network, many nodes, except for those occupying the central positions, are subject to structural equivalence because they are all connected to the central nodes. Thus the information exchanged in such a network is likely to be redundant and of less value as a resource. Meanwhile the node at the central location is exchanging information at the cost of maintaining contact with many people. The high cost may lower the efficiency of communication as well (Burt 1992). The central nodes may be overwhelmed as they work to maintain the large number of connections to engage in high quality information exchange. Overall, then, we expect high centralization in the network structure of an online forum to negatively affect the exchange of knowledge in the forum. This negative effect should hold whether the type of knowledge being exchanged is explicit or tacit.

H2: The more centralized the network structure of an online forum, the lower the amount of explicit knowledge sharing.

H3: The more centralized the network structure of an online forum, the lower the amount of tacit knowledge sharing.

Tacit knowledge is characterized by causal ambiguity and difficulty of codification (Choo 1998; Polyani 1966). Because it is not readily articulated as a set of facts or rules, tacit knowledge is difficult to transfer (Sorenson et al. 2004). This is in contrast to

explicit knowledge, which can be expressed formally as a system of symbols and facts, and therefore readily communicated (Nonaka and Takeuchi 1995). Although centralization is likely to hinder both tacit and explicit knowledge sharing, the effect is likely more harmful in the case of tacit knowledge transfer. Consider the extreme case of centralization of a social network in which all communication is directed to and from one central actor, the star. The star node is likely to become overburdened with the volume of communication required for both tacit and explicit knowledge distribution. But because tacit knowledge is particularly time consuming and difficult to transmit (Espinosa and Clark 2004), the star node will find it easier to pass on explicit rather than tacit knowledge when queried for information. The non-star nodes are limited in their opportunity to communicate tacit information since their interactions restricted to the star. Therefore, we expect the negative effect on information sharing associated with centralization in the online network to be greater for tacit knowledge than explicit knowledge.

H4: The negative effect of centralization is greater for tacit knowledge sharing than explicit knowledge sharing.

It is important to note that centralization and core–periphery structures are distinct network constructs, although they both reflect the closure and cohesion of a network to some degree. Extreme centralization is a star structure, where all communication is centered on a single individual. (As an example, imagine a guru or expert who runs an online forum where people post questions that only the guru answers.) In contrast, in a core–periphery structure, there is a core subgroup, where everyone is closely connected with each other, and a periphery group, where members are loosely connected with each other and with the core members. The core subgroup is unlikely to be centralized because if all the nodes are connected, there should be no one node that can be the star. Likewise, a centralized network may not have a core subgroup. As pointed out by Borgatti and Everett (1999, p. 393), "it is possible to collect a set of *n* most central actors in a network, according to some measures of centrality, and yet find the subgraph induced by the set contains no ties whatsoever—an empty core." This is because each actor may have high centrality by being strongly connected to different cohesive regions of the graph and need not have any tie to each other.

Method

Data were retrieved from a database created to study online professional forums (DeSanctis et al. 2003). These online forums were located by searching websites known to host a large number of online forums, such as YahooGroups, eGroups, Daja.com, AOL, and MSN.com, and by using publicly accessible search engines, such as Google and Profusion. All forums were devoted to the same topical theme, knowledge management. This theme was chosen because of its appeal to managers and technical professionals interested in sharing information about an issue of current business importance. By choosing forums on the same discussion theme, we were able to create a dataset in which we could meaningfully compare network structures and relate network structure measures to information sharing behaviors. A review of the contributor lists and content of the forums in the database indicated that, with few exceptions, contributors were drawn from many organizations and geographic locations and did not know one another prior to participating in the forums (see DeSanctis et al. 2003).

Sample Data

For each forum, we retrieved the following data: a unique identifier for each contributor, date of each message, subject of each message, and contents of each message. We retrieved data starting with the date the forum was created (i.e., the first message posted) through one year after that date. Only forums for which these data were complete were included in our dataset, yielding a total of 29 forums for analysis. Adjacency matrices, as described below, were built for these 29 online forums. To avoid problems of unreliability in the network measures, 6 of the forums were excluded from the sample because there were fewer than 10 participants in the discussion. In all, 23 forums consisting of 1,312 contributors were included in our dataset.

Network Measures

Ties in social networks can be measured by closeness and frequency of interactions between any two parties (Levin and Cross 2004). Unlike conventional social networks where parties to an interaction can be identified by multiple social cues and are subject to previous relationships, in electronic discussion forums, identity maintenance is primarily through text communication (Finholt and Sproull 1990). Closeness based on prior relationships, kinship, and emotional attachment barely exists and has minimal effect prior to the creation of the online forum. Although face-to-face or e-mail interactions are possible, we presume that the major form of interaction among the contributors occurs in the forum itself. Therefore, for each of the online forums in our database, we built social network matrices based on the interaction; among the contributors to that forum. As an indicator

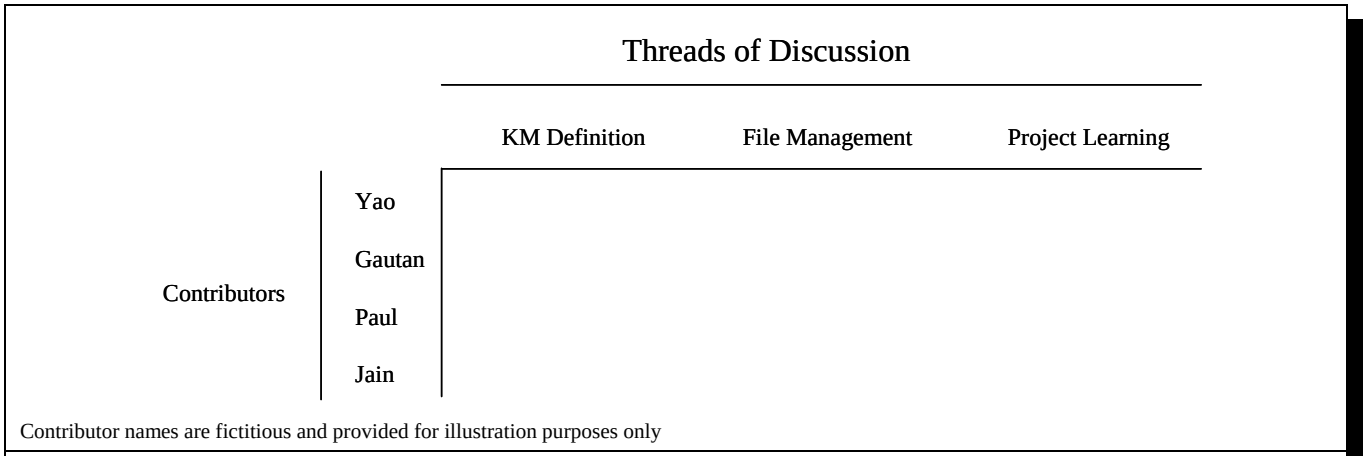

Figure 3. Affiliation Matrix

of interaction between two parties, we used a posted reply message to a topical message (also referred to as a thread of discussion) initiated by another member. The reply message was then titled "Re:" followed by the subject of the original thread. In this way, the participation of forum contributors to each thread could be represented in an affiliation matrix (per Scott 1991) with rows indicating the contributors, columns indicating the threads, and the numbers in the cells indicating the frequency of message posting from each contributor to each thread of discussion (see Figure 3).

Using Ucinet V (Borgatti et al. 2002), we were able to transform the affiliation matrix into an adjacency matrix (Figure 4), with both columns and rows representing contributors and the cells representing the interactions between them indicated by participation in the same thread of discussion. In this way, we were able to apply standard techniques of network analysis which involve the direct manipulation of adjacency matrices (Scott 1991).

Core–Periphery

For the measure of core–periphery, we input the adjacency matrix for each forum into Ucinet V, and produced a measure of core–periphery structure for each matrix (Borgatti et al. 2002). The continuous measure of fit was employed (Borgatti and Everett 1999). The measure can vary from 0 to 1.

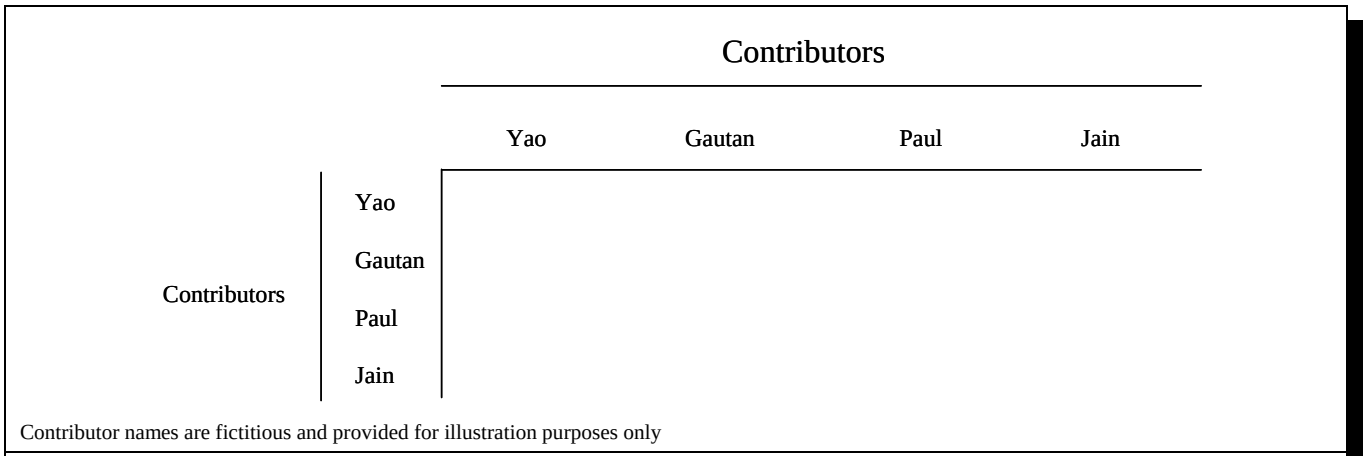

Figure 4. Adjacency Matrix

Centralization

Centralization was measured using Freeman's (1979) graph centralization approach. The measure expresses the centralization structure of a network as the percentage of variability in the members' degree of centrality in an observed network relative to that in a star network of the same size (Borgatti et al. 2002). The adjacency matrices were used as input data and Ucinet V calculated the centralization measure for each matrix (Borgatti et al. 2002). The measure can vary from 0 to 1.

Information Exchange

The contents of the messages in the forums were sampled and coded for tacit and explicit knowledge sharing as follows. Starting with the first message in each forum, the complete contents of up to 10 sequential messages were sampled. We then went on to the fourth month of the forum's life and again the complete contents of up to 10 sequential messages (starting with the first message in that quarter) were sampled. This process was repeated for each quarter (3-month time period) so that we had 40 messages from each of the 4 quarters of time periods for the first year of the forum's life. In total, 963 messages were coded.

Sampled messages were coded using a coding scheme for online knowledge exchange developed by DeSanctis and Jiang (2005). The coding scheme was developed based on definitions and examples of knowledge exchange in groups provided by Edmondson et al. (2001) and Choo (1998). We selected measures from the scheme that reflected the efforts of a speaker (contributor) to mobilize information resources embedded in the online social network. These included information seeking, information providing, explicit knowledge sharing, and tacit knowledge sharing. Components of a message could be categorized into several of these categories or none of the categories, depending on the content. Two independent coders met with one of the authors to review the scheme and an explanation of its application. The coders included an undergraduate (senior-level) student whose specialty area was social sciences and a graduate student whose specialty area was business administration. The coders first coded sample messages in a series of three waves to establish reliability. They met with one of the authors to reconcile differences and refine their understanding of the coding categories. Once adequate reliability was reached, they coded separately. (Details of the coding scheme and procedures are available from the authors.)

Information Seeking and Information Providing

Information providing and seeking can be thought of as the *push* and *pull* of knowledge sharing in the team. Information seeking was defined as asking questions, seeking resources or feedback, or verifying information. Examples include "Where can I find this software?"; "Does anybody have the document or know where?"; "What is your opinion about the definition of knowledge management?" Information providing was defined as statements of explanation, opinion, feedback, resource locations, or other information—whether or not it was solicited. Examples include "My thoughts about knowledge management and organizational learning…"; "Someone at Microsoft would know"; "Please look at the following link for more information"; "KM World 2000 -- conference announcement"; "career opportunity at IBM." The information seeking to information providing ratio was obtained by dividing the total number of information seeking statements by the total number of information providing statements in the forum.

Explicit Knowledge and Tacit Knowledge

Explicit knowledge sharing was defined as seeking or providing transactive (who and where) information and procedural (how and when) information. Transactive information included references to products or other resources—people, experts, consultants, and documents. Examples include "Where can I find…"; "You can find answers to you questions in the following book…"; "What product will do…"; "Do you know of anyone who…"; "Online courses on knowledge management available at…" Procedural information included statements about how to do a task, steps, methods, or ways of doing something. The procedure could be actionable (steps) or cognitive (stages of thinking), and could include information about when (timing). Examples include "Successful implementation first requires top management commitment"; "What post-implementation steps are necessary for success with SAP?"; "A community once formed is slow to migrate to an alternative medium." Tacit information sharing was defined as statements about understandings, opinions, and interpretations (i.e., insight, why, and explanation). Messages involving tacit information exchange could include seeking or providing opinions, clarifications, evaluations, interpretations, and elaborations. Tacit information statements try to "make sense" or otherwise gain perspective on an issue. Examples include "What do you think of …"; "My understanding on this issue is…"; "How would you define…"; "I think the difference between the two concepts is …"

Control Variable: Network Density

The density of a social network is the extent to which its members are in direct contact with each other. Some researchers have postulated that the information flow rate and quality at least partly depend on network density (Koku and Wellman 2002). However, Friedkin (1981) has shown, using simulations, that density is a problematic index of structural cohesion if a network has subgroups (such as a dense core), and that comparisons of density measures across networks that differ in size can likewise be misleading. In this study, the issue that is of most interest to us is not whether the actors are connected or not, but rather, how they are connected. As such, we tested for the significance of the network density in all of our analyses. This allowed us to check whether connectedness among members of a network can explain away the importance of structure. Network density was measured as the proportion of the existing number of ties in a network to the maximum possible number of ties, as follows:

$$\textit{Density of a matrix} = L / [N * (N-1)/2]$$

In the above formula, L represents the number of ties present, and N represents the number of members (nodes) in a network (Scott 1991). The measure can vary from 0 to 1.

Results

Table 1 provides means and standard deviations for the variables, and Table 2 provides the correlations. Tables 3 through 5 report regression results for tests of H1 through H3 respectively.

Table 1. Means and Standard Deviations for Variables

	N	Mean	Std. Deviation
Information Seeking	23	15.00	7.10
Information Providing	23	22.91	13.37
IS / IP	23	.89	.95
Explicit	23	29.61	14.09
Tacit	23	16.87	7.52
Density	23	.16	.12
Centralization	23	.15	.09
Core–Periphery	23	.75	.14

Table 2. Correlations Between Variables

Variables	1	2	3	4	5	6	7	8
1. Information Seeking	1							
2. Information Providing	.049	1						
3. IS/IP	.763**	-.452*	1					
4. Explicit	.561**	.800**	.080	1				
5. Tacit	.313	.590**	.030	.458*	1			
6. Density	-.471*	-.031	-.380	-.292	-.106	1		
7. Centralization	-.433*	-.382	-.138	-.468*	-.517*	.202	1	
8. Core–Periphery	-.597**	.202	-.532**	-.123	-.154	.434*	.367	1

**Correlation is significant at the 0.01 level (2-tailed).

*Correlation is significant at the 0.05 level (2-tailed).

Table 3. Regression Analysis Predicting Information Seeking to Information Providing Ratio

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	3.463	.997		3.475	.002
	Density	-1.442	1.624	-.183	-.888	.385
	Core–periphery	-3.103*	1.415	-.452*	-2.194	.040
R^2	0.310					
2	(Constant)	3.643	.971		3.751	.001
	Core–periphery	-3.649**	1.268	-.532**	-2.878	.009
R^2	0.283					

Dependent Variable: IS IP Ratio
**Coefficient is significant at the 0.01 level (2-tailed).
*Coefficient is significant at the 0.05 level (2-tailed).

Table 4. Regression Analysis Predicting Explicit Knowledge Sharing

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	42.654	5.679		7.511	.000
	Density	-62.141*	28.619	-.426*	-2.171	.042
	Core–periphery	-24.146	23.036	-.206	-1.048	.307
R^2	0.260					
2	(Constant)	39.660	4.920		8.061	.000
	Core–periphery	-68.193*	28.097	-.468*	-2.427	.024
R^2	0.219					

Dependent Variable: Explicit
**Coefficient is significant at the 0.01 level (2-tailed).
*Coefficient is significant at the 0.05 level (2-tailed).

Ordinary least squares regression analyses were used to test the hypotheses, and in all cases we included two regression models, with Model 1 controlling for density and Model 2 excluding density. In this way, we could compare the effects of network connection and network structure on knowledge sharing. There was support for H1 regarding a positive relationship between core–periphery structure and the ratio of information seeking to information providing (Table 3). The effect of core–periphery structure on the information seeking to information providing ratio was greater when density was excluded from the model. This confirms our speculation that it was not connectedness but rather the structure of connection among members that influenced their information seeking and information providing behaviors.

H2 and H3 regarding the negative effects of centralization on explicit and tacit knowledge sharing were supported as well (Tables 4 and 5). The negative effects were greater when density was not included in the models, again suggesting that structural properties of social networks were more powerful in explaining knowledge sharing than the connectedness of the networks.

With respect to H4, we can see in Tables 4 and 5 that the value of the standardized beta coefficient is more negative for tacit knowledge sharing than for explicit knowledge sharing. This pattern is consistent with our hypothesis. In order to test for the significance of the difference in the coefficients, we conducted a test for differences across the regression models predicting explicit and tacit information sharing from centralization respectively. We ran a test for across-equation equality to see whether the coefficients of centralization were equal in the two regression equations. The result of the test indicated that the difference between the effects of centralization on explicit knowledge sharing and tacit knowledge sharing was not significantly different from zero. Therefore, H4 was not confirmed by the data (see Table 6).

Table 5. Regression Analysis Predicting Tacit Knowledge Sharing

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	22.811	3.017		7.560	.000
	Density	-40.173*	15.205	-.516*	-2.642	.016
	Core–periphery	-.127	12.238	-.002	-.010	.992
R^2	0.267					
2	(Constant)	22.795	2.545		8.957	.000
	Core–periphery	-40.205*	14.534	-.517*	-2.766	.012
R^2	0.267					

Dependent Variable: Tacit
**Coefficient is significant at the 0.01 level (2-tailed).
*Coefficient is significant at the 0.05 level (2-tailed).

Table 6. Test for Across-Equation Equality

.test[tacit]centralization = [explicit]centralization
(1) [tacit]centralization – [explicit]centralization = 0
F (1, 21) = 1.02, Prob > F = 0.3238

Figure 5 displays the two regression lines for the effects of network centralization on explicit and tacit knowledge sharing. The steeper slope of regression line for explicit knowledge sharing on the left end of the graph suggests that explicit knowledge sharing was not as harmed by centralization as tacit knowledge sharing so long as centralization was relatively low. The negative effects of centralization on tacit knowledge sharing were more consistent across the values of centralization. Put another way, tacit information sharing was harmed at even low levels of centralization, whereas explicit information sharing held up until centralization became relatively high. This pattern is consistent with our hypothesis (H4), although the difference in the slopes is not statistically significant. Given the small sample size of this study and the variance in explicit knowledge sharing at low levels of centralization, we may not have adequate power to detect a significant difference in the slopes of these regression equations.

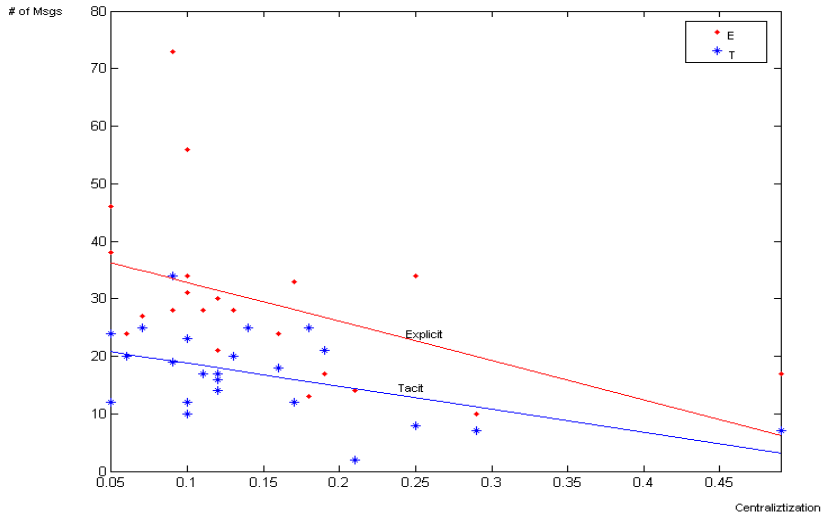

Figure 5. Regression Lines for Explicit Knowledge Sharing and Tacit Knowledge Sharing

Discussion

Our study explored one of the most open arenas of Internet-enabled communication among managers and technical professionals: publicly accessible discussion forums. As in the case of conventional social networks, social capital embedded in and mobilized from the online settings is contingent upon the networks' structural properties. We focused on two important social network structural properties, core–periphery structure and centralization. We found that the core–periphery structure of online networks was associated with responsiveness to requests for information, which can be viewed as processes of mobilizing information resources embedded in the online networks. The greater the core–periphery structure that an online social network exhibited, the lower the ratio of information seeking to information providing, suggesting the more effective the process of mobilizing social capital. Further, we found that the more the communication of an online social network was centered on certain participants (rather than shared across participants), the lower the explicit and tacit knowledge sharing in the network. Centralization in the network tended to be more harmful to tacit knowledge sharing, but it also harmed explicit knowledge sharing, especially when centralization was high. These differential effects of centralization on tacit and explicit knowledge sharing, however, were not statistically significant.

The findings of our study have significant implications to the literature of online communication, social networks, and social capital. First, the study contributes to the efforts of understanding the dynamics of social relations and information sharing on the virtual space. In particular, our findings suggest that online forums, at least those devoted to discussion of knowledge management, do provide opportunities for access to social capital in the form of information resources and, further, that the amount of such resources embedded in these online social networks is not homogenous across discussion forums. Second, the research results may provide guidelines for those interested in building sustainable professional interest groups online to support knowledge sharing. Our study demonstrates the importance of having groups of core members act to bridge and trigger communication in order to keep discussions in the groups active and rich in knowledge. Furthermore, cautions are raised against centralized social network structures which, according to our study, are likely to be associated with lower amounts and levels of knowledge exchange.

Our study is limited in several important ways. First, only a small number of online forums were included, because many of them failed to attract enough participation and thus did not survive. Second, we explored only two structural network properties. Others are potentially important to knowledge exchange, such as tie strength, average distance, and distance-based cohesion in the network. Third, our analysis was cross-sectional and so cannot account for evolution of the social network and the corresponding impact on knowledge exchange. Fourth, we were unable to take into consideration the forum members who viewed the messages without posting anything. These members may benefit from the knowledge shared in the forums as well, although they did not explicitly contribute. The last limitation has to do with the fact that our study relied on interactions in the form of text messages to detect the network structures and patterns of knowledge sharing. These interactions may not adequately reflect the cognition of participants. To gain insight into how participants benefit from the information resources, self-reported data from participants would be a helpful complement to the online behavioral data.

The limitations of this study point to directions for future research. Future studies should consider a longitudinal approach and analyze the network structures in a more dynamic way, examining how relationships are built, sustained, and, in some cases, fail over time. Whereas we treated network structures as exogenous variables, more fine-tuned dynamic analyses can reveal the causes of network structural properties which, in turn, can be treated as outcome variables. We also recommend that network analyses be complemented with interviews or surveys of the participants. In this way, researchers might examine the nuances of how informational social capital is mobilized and applied in the professional work of those who participate in online discussion forums.

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