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When Shall I Tell? Relational Promotion and Timing of Information Technology Diffusion

Deborah Gibbons
Naval Postgraduate School, degibbon@nps.edu

Brian Butler
University of Pittsburgh, bbutler@katz.pitt.edu

Scott Boss
University of Pittsburgh, scboss@katz.pitt.edu

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Deborah E. Gibbons
degibbon@nps.edu
Graduate School of Business and Public Policy
Naval Postgraduate School
Monterey, California

Brian S. Butler
bbutler@katz.pitt.edu
Katz Graduate School of Business
University of Pittsburgh
Pittsburgh, PA

Scott R. Boss
scboss@katz.pitt.edu
Katz Graduate School of Business
University of Pittsburgh
Pittsburgh, PA

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Abstract

This study adds to existing knowledge about information technology diffusion within organizations by examining the effects of social embeddedness on behavior of individual diffusers. Building on a social capital perspective of relationships, the authors theorize that individuals make intentional decisions to promote or suppress an innovation contingent on the nature of their relationship(s) with the potential adopters. Hypotheses regarding the likelihood of diffusion of an IT innovation through friendship, advice and multiplex friend and advisor relationships at early versus later stages in the diffusion process were tested using social network and panel survey data in two organizations. Results support predictions that individual diffusion behavior is contingent on the relation type and the progress of the innovation in the organization.

Keywords: IT Diffusion, Social Networks, Social Capital, Friendship, Advice

When Shall I Tell?

Relational Promotion and Timing of Information Technology Diffusion

Successful management of information technology requires attention to infusion of innovations in organizations (Fichman, 2000). Toward this goal, technology implementation professionals have been encouraged to think of themselves as "change agents" who catalyze and support ongoing adoption by organization members (Markus & Benjamin, 1996). In cases where the tools are to be used by professionals who work on non-routine activities that are not subject to process-monitoring, individual adoption decisions are central to implementation efforts (Venkatesh, Morris, Davis, & Davis, 2003). Even when working with complex organizational systems (e.g. inventory management systems), or infrastructure components (e.g. database management systems), acceptance and application of the innovation within an organization remains a significant challenge (Cooper & Zmud, 1990; Fichman & Kemerer, 1994; Zmud & Apple, 1992). With or without management intervention, firms often rely on the diffusion process—transfer of an innovation from person to person—in order to embed new tools within their work procedures (Beath, 1991; Howell & Higgins, 1990).

Studies of information technology diffusion within organizations have typically focused on either the behavior of individual adopters or the progress of overall adoption (Fichman, 2000). For example, many studies have examined how characteristics of the individual and the information technology innovation affect adoption decisions (Chwelos, Benbasat, & Dexter, 2001; Venkatesh et al., 2003). While these phenomena are important for understanding diffusion, an equally important issue has received minimal attention from researchers and practitioners. What aspects of the social environment lead people to become diffusers of

innovation? Studies that mention diffusers tend to view them as adopters who automatically impact subsequent adopters' choices (e.g., Markus, 1990). Likewise, research that models overall adoption has typically relied on a minimalist conception of the individual diffusers and their behaviors. Most commonly, aggregate diffusion models assume that: (a) all adopters are diffusers, (b) non-adopters are not diffusers, and (c) all diffusers promote the innovation equally. Although these assumptions are consistent with the spread of many diseases, reflecting the epidemiological roots of much of diffusion research (Rogers, 1995), they may not be appropriate when describing the diffusion behaviors of individuals within organizations (Butler & Gibbons, 1998).

People make deliberate strategic choices about how, where, and when they will promote (or not promote) a new technology within an organization (Beath, 1991). These decisions are likely to reflect potential diffusers' social relations and structural positions within the social system. Personal and systemwide adoption of innovation can influence people's social positions and power (Burkhardt and Brass, 1990). Because individuals are not all equally connected in a social setting (Burt, 1997; Granovetter, 1973), their expectations regarding social outcomes of innovation diffusion must also be unequal. This may lead to variance in willingness to diffuse a technology, separate from individual tendencies to adopt it. The decision to share information or assistance in using a new technology is likely to reflect the type(s) of relations that are already in place between potential diffusers and potential adopters. By identifying these social contingencies in diffuser behavior, we may advance our ability to implement technology in organizations.

This paper extends prior work by proposing and testing a theory to explain how attributes of social relations influence diffusion behavior. This theory rests on social network research that

considers the structural constraints diffusers face and on the power and innovation champion literatures, which conceptualize individuals as agents making intentional decisions about the promotion or suppression of innovation diffusion. From the theory, we derive hypotheses regarding the likelihood of diffusion of a new technology through various dyadic relations within an organization. These hypotheses are tested using social network and panel survey data collected in two organizations. Following the analysis, we consider the implications for practitioners involved in information systems implementation and for researchers interested in diffusion of information technology within organizations.

Social Context and Diffusion Behavior

Within a social environment, a relationship refers to the connection that exists between two particular entities, and a relation refers to a specific type of connection, such as friendship or mentoring. These aspects of the social context may affect innovation diffusion. For this study, we define diffusion as the process through which an innovation spreads from one entity to another. Infusion is defined as the incorporation of an innovation into the normal practice of an organization (Cooper and Zmud, 1990; Zmud and Apple, 1992). Successful diffusion leads to infusion.

For professionals introducing an information technology (IT) innovation, a key challenge is understanding how use of the new technology becomes infused into the organization (Cooper & Zmud, 1990). The basic premise of network diffusion models is that individuals' social ties serve as conduits for transfer of beliefs and practices. Through social contact, new attitudes develop, information spreads, knowledge transfers, and behaviors change.

Interpersonal relationships provide the context for ongoing interaction between individuals. Diffusion studies have long considered how relationships promote the spread of an

innovation by supporting the flows of information and interpersonal influence (Abrahamson & Rosenkopf, 1997; Rogers, 1995). A few researchers have gone further by examining the distinct roles of varying types of relations in shaping conversations and outcomes in organizations (e.g., Sias & Cahill, 1998). Two relations that occur in nearly all organizations are friendship and advice relations. Advice relations facilitate the transfer of work-related information and knowledge (Borgatti & Cross, 2003). Similarly, friendship supports interaction that can enhance cooperation and open communication (Jehn & Shah, 1996). Both friendship and advice relations can provide social contexts that support diffusion, but only if the individuals decide to share the innovation with one another.

What happens when a potential diffuser believes that diffusion may affect his or her existing relationships? Social capital, the value contained within one's social ties and the resource availability that results from those ties, may influence decision making and action. Social capital theorists (e.g., Burt, 1997; Nahapiet & Ghoshal, 1997) posit that social capital is a valuable resource grounded in the structure and content of relationships (Tsai & Ghoshal, 1998). Thus, social relationships are more than contexts for transfer of ideas or innovations. They are valuable assets that can be developed, maintained, or potentially damaged by individuals' choices and actions. Because of the role that social capital plays in organizational life, individuals can be expected to pursue strategies that both protect and enhance their relational resources while avoiding behaviors that jeopardize those relationships (Butler & Gibbons, 1998; Cross & Sproull, 2004).

From the social capital perspective, innovations that change work practices and social structures present potential diffusers with a dilemma. On one hand, their relationships create interpersonal contexts for transfer of information and innovation. Advice relations are based on

the provision of information and knowledge (Krackhardt, 1990), so unwillingness or inability to advise someone about a relevant innovation may weaken the relationship. Similarly, friendship, which includes trust and altruism (Bell, 1981), may create an obligation to share knowledge of an innovation that might affect one's friend. On the other hand, if the spread of a particular innovation is likely to alter interpersonal relationships, organizational structure, or work practices, then potential diffusers may choose not to share, or even to hinder diffusion in order to protect their existing relationships (Tillquist, King, & Woo, 2002). In such cases, individual diffusers will seek an interpersonal diffusion strategy that, at the very least, maintains their relationships and extant social capital (Butler & Gibbons, 1998).

Network based conceptualizations of power or bridging ties (Brass, 1984; Burt, 1997; Wasserman & Faust, 1994) rest on the premise that individuals have the ability to intentionally act as gatekeepers and may deliberately choose to promote (or hinder) the flow of information through their social ties. Similarly, studies of information and power in organizations argue that individuals have agency with respect to diffusion behavior (Piercy, 1989). For example, Pettigrew (1972) describes how individuals chose to share (or withhold) information about new information technologies as part of their bid to maintain or develop organizational power. Opinion leadership, which has been defined in the diffusion literature as the degree to which an individual is able to influence the attitudes or opinions of others (Rogers, 1995 p. 281), is often measured by assessing the centrality of individuals within a social network. This implies that the people who have the best structural position for diffusing an innovation also have the greatest motivation to protect their social capital by managing the process. This management activity requires decisions about how much to give to whom, on what timetable.

The nature of information systems (IS) diffusion may interact with the nature of one's relationships to change diffusion behaviors over time. Diffusion scholars have long recognized that the overall diffusion of innovation does not progress at a steady pace (Rogers, 1995). This aggregate phenomenon has been explained by growing social influence (Valente, 1995; Valente, 1996), externalities that affect the benefits of adoption (e.g., Markus, 1990), and changes in available information about the innovation (Abrahamson & Rosenkopf, 1993). Each of these factors affects adoption decisions, but they also indicate changing pressures regarding diffusion behavior. Early in the diffusion process, when an IT innovation is not yet part of the work routines and structures of the organization (i.e., it is not yet infused in the organization), individuals face a different diffusion problem than later in the process when the innovation is increasingly common and the associated organizational changes are more complete. As a result of these changing circumstances and the fundamental attributes of the relations, IT diffusion behavior is likely to differ through friendship and advice relations over time.

Friendship, Advice, and Information Technology Diffusion

Friendship and advice relations play a role in many aspects of organizational life. Through friendships, individuals receive social support and build commitment (Ibarra, 1995). Friendship plays a role in how people enter (Morrison, 2002) and how they leave (Krackhardt & Porter, 1985) organizations. Advice relations are also important sources of information and knowledge for individuals in organizations (Granovetter, 1973; Ibarra, 1995; Krackhardt, 1990). Although advice and friendship networks can be related (McGrath, Vance, & Gray, 2003), it is both conceptually and methodologically possible to distinguish them (Brass, 1984; Ibarra, 1995; Morrison, 2002). In contrast to the relationship-as-context view, which predicts that advice and

friendship relations would have similar effects on IT diffusion behaviors, the relationship-as-asset perspective predicts different diffusion behaviors in these relations at different points in time.

Friendship and Advice Relation Effects on Early IT Dissemination

Friendships are characterized by trust and positive affect (Krackhardt, 1992). They are based on equal exchange (Blau, 1964), and they are more likely to foster altruism than are any other non-kin relations (Ma, 1985). Sharing information and knowledge about an IT innovation with a friend is a form of investment in the relationship. Kindness given to a friend fits the nature of the relation, and there is an expectation that some time, somewhere, the friend will reciprocate favors given. Especially in the early stages of diffusion when information or access is scarce, willingness to share a valued information resource can contribute to the maintenance or growth of the friendship. Therefore, the relationship-as-asset model of IT diffusion behavior predicts that:

H_1: During the early stages of information technology dissemination, friendship will be positively associated with diffusion.

In contrast, advice relations are defined by the instrumental transfer of information and knowledge related to the work practices of the organization (Ibarra, 1995). They reflect knowledge dependencies built on individuals' recognized abilities to provide others with information about regular work and routines (Krackhardt, 1990). People on whom others rely for advice tend to have power in an organization (Brass, 1984), so a loss of advisory relations may cause a loss of power. One threat to advice relations, and thereby to the social positions and power of advisors, would be a reduction or a cessation of the need for advice. If an advisor maintains relations by dispensing information from a database, for example, diffusion of access

to the database would threaten the advice relations. To generalize this principle, we may say that advisors who transfer their unique information sources to advisees relinquish their information advantage and risk losing those relations. As a result, an advice network is unlikely to diffuse knowledge of IT innovations that provide valuable work-related information that is scarce within the organization. This relation-based hindrance of IT diffusion should only occur in the early stages of diffusion when the new technology is sparsely distributed within the organization and not embedded in its work practices.

H_2: During the early stages of information technology dissemination, advice relations will be negatively related to diffusion.

Given the opposing predictions for early IT diffusion through advice and friendship relations, what is the impact on diffusion behavior when a relationship includes both? Because they focus on personal similarities and affective bonds, friendships are not tied to routines and demands of the organization. Conversations between friends include a broad range of topics that are likely to be more personal than instrumental, so people are less likely to discuss general work issues with someone who is a friend than with someone who is an advisor or advisee. As a result, a friend's need for a work-related IT innovation may become more salient if the pair also engages in advice giving. This multiplex relationship can be seen as a diversified social "portfolio" in which actions that might undercut the advice component can be counterbalanced by benefits to the friendship.

The combination of advice and friendship relations creates a situation in which members recognize each other's technology needs and have some personal motivation to help each other. At this point, we propose that close friendship combined with advice relations will positively influence diffusion behavior. Casual friendship is unlikely to overwhelm advisors' concerns

about social influence and power, but close friendship encourages altruistic behavior. The union of trusting altruism and shared work knowledge makes multiplex relationships that combine strong friendship and advice particularly likely to transfer access to new and valuable information resources.

H_3: During the early stages of information technology dissemination, multiplex relationships that combine advice and strong friendship will be positively associated with diffusion.

Friendship and Advice Effects on IT Dissemination after the Initial Stages of Diffusion

We based our hypotheses regarding friendship and advice relation effects on early IT dissemination on the premises that people share information that fits and supports their existing relations with others, but they withhold information that threatens their relationships. By the same line of reasoning, information that seems irrelevant to the relation will not have high priority for transmission, but if withholding information is likely to threaten the relationship, people are motivated to disseminate it. These additional considerations influence diffusion behavior as infusion of the IT progresses.

The predicted unwillingness of advisors to transmit use of an IT innovation applies only during the early stages of dissemination when the innovation provides scarce information that is not readily available through alternate sources. If the technology does not begin to spread through the organization, advisors who have adopted may never reveal what they know, but if information becomes available through other channels, their positions as experts depend on continuing demonstration of their knowledge. Otherwise, new advice relations may begin to form with individuals who share information regarding the new technology (Burkhardt & Brass, 1990), and failure to participate may have a negative impact on existing advisory relations. As

the technology becomes part of the organization's practices, helping others with the innovation falls within the normal realm of the advisory relationship. Individuals' roles as advisors are then supported by diffusing information about the innovation.

H_4: The role of advice relations in diffusion of an IT innovation will increase as dissemination within the organization progresses.

As the new technology becomes integrated into the organization, and information availability increases through work-related channels, the role of friendship in dissemination is likely to decline. Because the technology is no longer a scarce resource, its value as a gift to one's friend diminishes. Advice relations, whether newly developed or continuing, support the day to day demands of working with this technology, and favors from friends are no longer needed. Meanwhile, friends continue their pattern of intimate discussions and sensemaking around current or interesting topics, and their attention is likely to drift away from the information technology. As dissemination progresses, then, IT diffusion moves from the realm of friendship into the context of advice relations.

H_5: The role of friendship in diffusion of an IT innovation will decline as dissemination within the organization progresses.

We conclude that diffusion behaviors will be contingent on both the type of relation and the status of the innovation in the organization as a whole. Expectations regarding friendship, advice relations, and diffusion behaviors during the course of information technology infusion into an organization are depicted in Figure 1. Prior to point 1, information about the innovation is not readily available in the organization, so friendship is likely to play a crucial role in diffusion, but advice relations are not likely to diffuse the innovation. Between points 1 and 2, information is becoming available from other sources within the organization. As this occurs,

the role of friendship lessens, and advisors realize a demand for knowledge-sharing with advisees that may negatively impact their relationships if not met. In contrast, early adopters who can and do share information about the innovation can reinforce or advance their positions in the advice network. By point 3, the innovation is spreading, such that information is readily available from multiple sources in the organization. At this point, friends and advisors alike recognize that organization members are aware of the innovation and can identify sources of information about its use. Now the information falls within the normal domain of work relations and is no longer unique. When this occurs, it no longer serves an advisor's social interests to withhold information, and it is no longer necessary to share the information as a favor to one's friends. From this point forward, advice networks become the primary means of diffusion.

Methods

Sample and Data Collection

The hypotheses were tested using social network and e-mail use data collected in two locations (SmallTown High School and BigCity Elementary) [1] shortly after internet connections had become available, and then about a year later. The first site, SmallTown H.S., was located in a western U.S. town and employed 68 professionals, the majority of whom were male (68 percent of the 64 respondents). At the time of the study, interviews with organization members and county officials indicated that the organizational climate was heavily political due to administrative changes and members' jockeying for positions and influence. The other site, BigCity Elementary, was located in an upscale neighborhood of a large Midwestern city. Although the principal had made known her intent to retire at the end of the school year, no evidence of political behavior emerged during interviews with her or the teachers. BigCity

[1] The names of the organizations and individuals were changed to protect confidentiality.

employed 31 professionals, the majority of whom were female (89 percent). In both organizations, email accounts and Internet access were available, but lack of individual work stations limited the usefulness of email for internal communication.

Data Collection. The data were collected as part of a larger two-stage survey designed to assess the role of social networks in the formation of teaching values and the diffusion of an alternative teaching method. At; Time 1, participants completed a survey regarding their use of electronic communications, various demographics, and their friendship and advice relations with colleagues. About a year later, the Time 2 survey assessed use of electronic communications, retrospective information about the time of email adoption, and which of the respondent's colleagues had provided or been given help with electronic communications. At both times, respondents sealed their completed surveys in large envelopes, and a teacher or administrator from the school returned them to the researcher.

Sample. The initial survey yielded a 94 percent response rate for both organizations in the study (Table 1). The respondents included 47 men and 46 women. Ninety respondents reported completion of some education beyond the bachelor's degree and 45 held a master's level or higher degree. Respondents ranged in age from 22 to 62 years with a mean of 41.5. Individuals' tenure within their organization ranged from 1 to 38 years with a mean of 10.5 years. The Time 2 survey generated responses from 66 percent of the original participants in each organization.

	Time 1 Survey			Time 2 Survey			T1-T2 Retention	
	# Surveyed	Respondents	Response Rate	# Surveyed	Respondents	Response Rate	T1-2 Respondents	Retention Rate
SmallTown	68	64	94%	67	48	72%	42	66%
BigCity	31	29	94%	28	19	68%	19	66%

Table 1: Survey Response Rates

Measures

Advice Relations. Advice relations were measured by presenting respondents with an organizational roster and asking them to indicate how often they went to each other person in the organization to obtain advice. The available categories represented two levels of positive relationship (occasional or frequent advice), in addition to no relationship. Each respondent was also asked to indicate "how often each person comes to you to discuss work-related issues or to obtain advice." To minimize missing data in the advice matrix, this information (aggregated from all respondents) was used to represent the advice-seeking behaviors of six people who declined to answer the advice question during the initial survey and to complete advice relationship measures for a seventh who stopped halfway. The intersection of two missing reports was marked as missing. The matrix was symmetrized by taking the average of the values reported in each pair of individuals, on the premise that overall communication could best be represented by combining both parties' advice-seeking activity. The symmetric matrix was used to predict similar e-mail use at Time 1 (Hypotheses 2 & 3) and the directed matrix was used to predict information transfer over time (Hypothesis 4).

Friendship relations. As with advice relations, friendship relations were assessed by presenting respondents with an organizational roster and asking them to "indicate the extent to which you consider each person a friend." Possible responses included no relation, casual friend, or close friend. Each respondent was also asked to report "the extent to which each person whom you know considers you a friend." To minimize missing data, information aggregated from all responses to this question was used to represent the relations of ten people who declined to answer the friendship question. The intersection of two missing reports was marked as

missing. The matrix was symmetrized by taking the average of the values reported in each pair of individuals. Thus, each cell in the symmetric matrix represented the intensity of the friendship, based on both parties' self-reports. The symmetric matrix was used to predict similar e-mail use at the time of the initial survey (Hypothesis 1 & 3), and the directed matrix was used to predict information transfer over time (Hypothesis 5).

Advice and strong friend networks. Multiplex relationships combining advice and strong friendship were measured by combining respondents' reports of advice relations and friendship. The friendship network was dichotomized such that close friendships were indicated by a 1, and all other cells contained a 0. The directed advice network was dichotomized so that a value of 1 represented the presence of any advice relation. This binary matrix was symmetrized by averaging and then multiplied, cell-by-cell, by the symmetrized "close friend" matrix to represent the multiplex close friendship and advice relationship network.

Diffusion Behavior. This measure assessed information transfer activities related to the diffusion of the electronic communications technologies. Respondents were asked, "Have any of your colleagues ever helped you to use e-mail or other electronic communications?" If yes, they were requested to "please write their name(s) below." On a separate page, they were asked, "Have you ever helped any of your colleagues to use e-mail or other electronic communications?" If yes, they were requested to "please write their name(s) below."

E-mail and Electronic Communications Use. On the initial survey, respondents were asked if they used electronic mail, read electronic bulletin boards, or participated in electronic mailing lists, and their no/yes answers were coded as a 0/1 variable to indicate any electronic communications usage. A matrix was created to represent dissimilarity of usage behavior, calculated as the absolute difference between adoption by the sender and receiver of each

relation. This matrix was used to determine whether and which social relationships were associated with similar adoption behaviors at the time of the initial survey. Actual difference in initial adoption was also calculated as a control variable to predict subsequent transfer of directed help with electronic communications over time.

Department Membership. Organizational structure was included as a control variable. The organizations had limited formal hierarchy, but people with similar specialties tended to be grouped together, both in recognized departments and through shared facilities and resources. Therefore, respondents were asked what subjects they teach in order to identify people who work in the same department(s). People who taught similar subjects or served similar functions (e.g., counselors) were grouped together. The department membership matrix indicated shared group membership by indicating whether each pair of individuals was not in the same group (0), co-members in one group (1), or in two groups (2).

Analysis

At the time of the initial survey, 13 of the 64 respondents (20%) at SmallTown reported using electronic communications. In BigCity, 6 of the 29 respondents (21%) reported similar use. This proportion is slightly higher than Rogers' (1995) definition of innovators and early adopters as the first 16% to adopt, and it is large enough that prior theories of social contagion predict positive correlation between social relations and adoption.

All data were analyzed at the dyadic level using Quadratic Assignment Procedure (QAP) Correlation and the Multiple Regression Quadratic Assignment Procedure (MRQAP). QAP is a nonparametric (bootstrap) method that does not depend on the assumptions intrinsic to OLS, and it is robust against interdependence among observations within each matrix. The QAP Correlation procedure calculates correlation between two matrices, randomly permutes rows and

columns of one matrix, then re-computes the correlation and stores it. This procedure was repeated 1000 times, and the resulting distribution was used to determine the probability (p) that correlation as strong as that observed could occur by chance. MRQAP uses a similar procedure to determine the probability that coefficients and an overall model fit as extreme as those observed could occur by chance. Although correlations and R-squared values are generated during these procedures, the nature of social networks data limits their potential range, making them unreliable indicators of relation strength (Krackhardt, 1988). The statistic of interest is the p-value. A p-value less than .01 indicates that less than one percent of correlations produced by random permutations were as extreme as the correlation observed in the data.

Hypotheses were tested by using friendship, advice, and multiplex close friendship and advice network structures to predict initial adoption patterns and subsequently reported help with the technology. Department membership, gender makeup of each dyad, and differences in education and graduation year were included as control variables predicting adoption and subsequent help with electronic communications. Because inclusion of these control variables did not significantly affect the results, they were excluded from the regressions reported here.

Results

Hypothesis 1, that friendship will be positively associated with diffusion during the early stages of information technology dissemination, was supported at SmallTown HS. Regression results appear in Model 1 of Table 2 for both sites. At SmallTown HS, friendship predicted similar usage ($p = .001$), but the relationship was not significant at BigCity ($p = .116$).

	Small Town		Big City	
	Model 1	Model 2	Model 1	Model 2
Advice Network	-1.84***	-.211***	-.196*	-.226**
Friendship Network	.197***	.168***	.119	.045
Friend & Advice Network		.173†		.264†
Model R-squared	.044***	.047***	.032	.041

Beta coefficients are unstandardized. Significance of individual models was determined by MRQAP.
***p ≤ .001; **p ≤ .01; *p ≤ .05; †p ≤ .1

Table 2: Analysis of Relationships and External Email Use Similarity at Time 1

Hypothesis 2, that advice relations will be negatively related to diffusion during the early stages of information technology dissemination, received strong support in both organizations. Results in Table 2 show that advice relations were negatively related to adoption ($p < .001$ at SmallTown, $p = .015$ at BigCity), such that persons who maintained an advisory relation were likely to differ in use of the IT innovation. This is consistent with the premise that advisors would not immediately diffuse a new information technology.

Hypothesis 3 predicted that multiplex relationships that combine advice and strong friendship will be positively associated with diffusion during the early stages of information technology dissemination. This hypothesis was tested by adding the interaction term to the QAP regression for each site, controlling for friendship and advice relations (Table 2, Model 2). The multiplex relationship had a marginally significant positive influence on diffusion, both at SmallTown ($p = .081$) and at BigCity ($p = .075$). Given the consistency in direction at both sites, this outcome supports Hypothesis 3.

Individuals' reports of e-mail help received were regressed on their advice-seeking relations, reports of others claiming them as friends, and multiplex relationships in which they seek advice from others who see them as close friends. Simultaneous consideration of all three relation types allows discernment of which relations supported information sharing during this

year, and thus provides a test of Hypotheses 4 and 5. In Table 3, Model 1 uses Time 1 advice and friendship networks to predict subsequent e-mail help. Model 2 adds a term for multiplex relationships, and Model 3 controls for difference in prior e-mail adoption.

Hypothesis 4 predicted that information about the IT innovation would begin to spread through advice relations after the early stages of diffusion. This is apparent at SmallTown, where people named their general advisors as sources of e-mail help at the time of the follow up survey ($p < .001$). At BigCity, advice relations were not significant predictors of help with electronic communications ($p = .105$), but the coefficients were no longer negative.

	Small Town			**Big City**		
	Model 1	**Model 2**	**Model 3**	**Model 1**	**Model 2**	**Model 3**
Advice Network/10	.101***	.126***	.153***	.089	.031	.041
Friendship Network/10	-0.005	.020	.032	.132*	.029	-.003
Friend & Advice Network/10		-.174***	-.225***		.379*	.450*
E-mail Use Difference/100 (T1)			-.083**			.008
Model R-squared	.011***	.014***	.023***	.022*	.031**	.045**

Beta coefficients are unstandardized. Significance of individual models was determined by MRQAP. Variables have been scaled to improve readability of coefficients.
*** $p \leq .001$; ** $p \leq .01$; * $p \leq .05$; † $p \leq .1$

Table 3: Analysis of Relationships and External E-Mail Help across Time

Hypothesis 5 predicted that the role of friendship would decline as diffusion progressed. At SmallTown, this shift was apparent, as the friendship network had no significant effect on provision of information about the new technology at the time of the follow up survey ($p = .409$). In contrast, the BigCity friendship network exhibited a positive effect on help with electronic communications at Time 2 ($p = .031$), but this effect disappears when the multiplex relation is entered into the model (Table 3, Model 2). This indicates that it is the combination of advice and close friendship that supports information transfer ($p = .03$).

Discussion

Information technology innovations can change work practices, employment arrangements, information flows, and organizational structure (Barley, 1990). By providing new information sources, innovative technologies can alter existing relationship structures (Gray, 2001). The introduction of a new information system can change the overall structure of an organizations' social network and the centrality of people within that structure (Burkhardt and Brass, 1990). The current study adds to existing IT diffusion research by addressing the likely scenario in which potential diffusers consider effects on their relationships when deciding whether and to whom to diffuse an innovation.

The results of this study imply that the variability of IT diffusion within organizations may depend on both adoption and diffusion behaviors. The timeline depicted in Figure 1 was largely supported, demonstrating that individuals' diffusion behaviors vary with relation type and stage in the diffusion process. At Time 1, advice relations apparently inhibited diffusion, while friendship and multiplex relationships supported it. This effect was more pronounced in the more political environment of SmallTown than at egalitarian BigCity. By Time 2, advice relations at SmallTown and multiplex friend and advice relationships at BigCity had replaced friendship-only relations as sources for technology help. The shift from friendship to multiplex friend and advisor relationships as diffusion channels may be capturing the transitional stage at point 2 in Figure 1. The model suggests that friends would eventually stop discussing the technology, and advisors would continue to provide necessary information and support. We observed this completed transition at SmallTown, where Time 2 respondents reported receiving e-mail help from their advisors, but not from friends. During the intervening year, SmallTown

advisors shifted from hindrance to diffusion, and the friendship network diminished in importance for dissemination.

These changing patterns of social influence are consistent with the natures of the relations, including the development of advice relations as components of social capital and the establishment of friendship on trust and norms of reciprocity. Assessment of these relations' roles in fostering or inhibiting diffusion behavior provides insights about the nature of information technology diffusion that goes beyond the usual focus on adoption. Although the exact pattern differed somewhat in the two organizations, we have clearly demonstrated that information technology diffusion behavior is contingent on the nature of preexisting relationships. Friendship can promote early diffusion of information technology because friends like to share valuable discoveries with each other. At the same time, concerns about maintaining their unique information sources may lead advisors to withhold valuable discoveries from their advisees. As the innovation becomes incorporated into the organization, it loses its uniqueness as a source of otherwise unavailable information or resources. Since it is no longer scarce, friends become less likely to pass it on, and advisors become more likely to pass it on.

Study Limitations

The setting of this study in public schools raises an immediate question about generalizability to other organizations. Because school teachers, administrators, and counselors enjoy considerable autonomy, the study occurred in an environment that allows workers to select or reject technological innovations with minimal pressure from their boss. In fact, there was no pressure whatsoever placed on these professionals to begin using electronic communications. This scenario contrasts with circumstances in which someone mandates adoption of an information technology. How would the friendship and advice networks influence diffusion

behaviors there? Assuming that the mandating entity is also providing information about adoption, we would expect friends to provide early assistance or attempt to figure things out together if no established advice relation is available to support adoption. Because the technology is not scarce, unique, or valuable, advisors would be likely to provide ongoing information that further establishes recognition of their expertise in the organization. Failure to provide useful information could weaken their advisory positions because forced adopters would seek information elsewhere, with the possibility of establishing newer, more relevant advice relations.

Managerial Implications

It has been noted that rearranging information flows can affect departmental power structures, creating impetus for certain people to hinder the introduction of the new system (Markus, 1983). Arguments presented here, along with the results of this study, suggest that managers must also attend to informal network structures when trying to introduce new information technologies. Further, organizations that hope to maintain a culture of change need to pay attention to friendship networks. Any innovation that provides a unique advantage to influential advisors is unlikely to be promoted internally by them, but people who scan the environment for innovations may be quite willing to tell their friends what they have discovered. Rather than expecting information about new technologies from gatekeepers who hold central positions in the advice network, managers could support innovation efforts that occur at the periphery of the network where it is more likely to be shared.

Conclusions

Studies of IT diffusion within organizations have typically focused on either the behavior of individual adopters or the progress of the overall diffusion process (Fichman, 2000). While

modeling individual adoption is important for understanding diffusion, the behavior of individual diffusers is also significant. One of the main challenges in investigating IT adoption is that the diffusion is not just the mechanical behavior of the individuals within the context of the adoption, but is the result of intentional choices to maintain social relationships.

The pattern of diffusion observed through friendship and advice suggest that diffusion behaviors of individuals are affected by the desire to maintain these valuable relationships. We conclude with two principles that may be applicable to any information technology. First, friends will support their altruistic, reciprocal relationships by sharing information technology resources that are new, scarce, and valuable, but when the innovation loses its uniqueness, they are less likely to help friends adopt it. Second, advisors will support their dependence relationships by withholding information technology resources that are new, scarce, and valuable, but when the innovation loses its uniqueness, they are more likely to help advisees adopt it. Additional tests of these ideas with other technologies are needed to determine their applicability in various settings, and resulting models of diffusion behavior may significantly improve our understanding of the micro-macro links in the infusion of new technologies into organizations.

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Figure 1. Diffusion Efforts and Adoption over Time