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Individual connectedness in innovation networks: On the role of individual motivation☆

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ABSTRACT

Explanations of knowledge sharing in organizations emphasize either personality variables such as motivation or network-related structural variables such as centrality. Little empirical research examines how these two types of variables are in fact related: how do extrinsic and intrinsic motivation explain the position that an employee entertains in a knowledge sharing network within an organization? Much is to be gained from a better understanding of how, empirically, psychological variables and an organization's network interrelate (Burt et al., 1998; Kalish and Robins, 2006; Moch, 1980; Teigland and Wasko, 2009). Still, this line of enquiry is not pursued much (Foss et al., 2009). This paper integrates the structural characteristics known to be implicated in knowledge transfer typically focused on in the social network literature on the one hand, with the motivational perspective commonly identified in the organization literature. This study examines how motivation – extrinsic (expected organizational rewards, reciprocal benefits) and intrinsic (knowledge self-efficacy, enjoyment in helping others) – might explain how employees may be better connected in the full knowledge transfer network or might be engaged more in inter-unit knowledge transfer. Connectedness (closeness centrality) and inter-unit ties are well-known to contribute to knowledge transfer. Analyzing data from a survey at two large European organizations, this study, counterintuitively, shows that neither intrinsic nor extrinsic motivation explain an individual's favorable position in a knowledge transfer network.

1. Introduction

As firms find themselves in increasingly competitive markets and realize that they must be more innovative (Grant, 1996), the importance of knowledge transfer within their company is increasingly recognized. Knowledge may be spread throughout the organization and not be available where it might best be put to use. Transfer of knowledge within the organization to gain competitive advantage has thus received considerable attention in the literature (Grant, 1996; Teece et al., 1997; Moorman and Miner, 1998; Hansen, 1999). Scholars have emphasized that effective transfer of knowledge between employees within an organization indeed increases the creativity and innovativeness of that same organization (Tushman, 1977; Ghoshal and Bartlett, 1988; Amabile et al., 1996; Moorman and Miner, 1998; Kanter, 1985; Hargadon, 1998; Perry-Smith and Shalley, 2003). Effectively orchestrating knowledge transfer to stimulate innovative outcomes certainly requires further attention, however (Jackson et al., 2006).

As pointed out by Foss (2007), organizations can seek to influence individual actions to help accomplish favorable outcomes for the organization as a whole. Such orchestration may start with an understanding of both what motivates the individual to transfer knowledge, as well as, structurally, with whom individuals exchange knowledge. The former is relevant to develop proper HRM policy to stimulate knowledge transfer (Wasko and Faraj, 2000; Kankanhalli et al., 2005; Quigley et al., 2007). The latter is indicated by an individual's position in the knowledge transfer network of an organization (Wellman and Berkowitz, 1988; Diehl and Stroebe, 1987; DeChurch and Marks, 2006). How each of these contributes to knowledge transfer in a firm has been studied in the past. Someone favorably positioned in the network in which innovative knowledge is transferred will perhaps unintentionally contribute more to firm-level outcomes than that of someone not well-positioned (Obstfeld, 2005; Tsai, 2001). The relationship *between* network structure and individual motivation, however, has not received much attention (exceptions are Kadsuhin, 2002;

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Kalish and Robins, 2006; Teigland and Wasko, 2009). Researchers commonly ignore how differences between individual might affect organizational network usage and benefits (Anderson, 2008[1]). Nevertheless the structural patterns of relationships that emerge in organizations and form the social infrastructure for the transfer of innovative knowledge unavoidably implicate human psychology (Moreno, 1961; Simmel, 1950). In this paper we study how individual motivation may explain an individual's position in the structure of the network in which innovative knowledge is transferred. As such we aim to generate further insights into the psychology of the intra-organizational networks that facilitate the transfer of innovative knowledge.

Although studies on the influence of intrinsic and extrinsic motivation on individuals' knowledge sharing behavior are not new (e.g. Amabile, 1993; Hung et al., 2011; Kankanhalli et al., 2005), scholars have only begun to explore the effect of individual psychological differences on network structures (Klein et al., 2004; Anderson, 2008). The number of different issues addressed remains rather limited which may in part be due to the difficulty of collecting relevant data. The question as to how individual differences predispose actors to position themselves in a network of relations thus has not received a persuasive answer as a result. Social network researchers seldom discuss the effects of individual psychological differences on network structure and particularly not in the context of knowledge transfer, while scholars in the field of HRM seldom consider social networks (Mehra et al., 2001; Minbaeva et al., 2003; Kaše et al., 2009). Although personality characteristics have occasionally been linked to network position (a.o. Burt et al., 1998; Kalish and Robins, 2006; Klein et al., 2004; Oh and Kilduff, 2008; Burt et al., 2000), motivation has not been investigated in more detail recently (with Foss et al., 2009 as a notable exception). This is somewhat surprising as the seminal work of a.o. Moreno (1961) and Simmel (1950) already emphasized the relevance of linking social structures and psychological processes. And even although more recent work has begun to link motivation to knowledge sharing (a.o. Wasko and Faraj, 2000; Kankanhalli et al., 2005; Quigley et al., 2007), these studies continue to ignore the organizational network perspective. This study explicitly investigates the way in which motivation explains an individual's connectedness in the organizational knowledge transfer network, linking the structural patterns of relationships that emerge in organizations with human psychology.

We use the broadly accepted psychological construct of intrinsic and extrinsic motivation (Vallerand, 1997; Osterloh and Frey, 2000; Kankanhalli et al., 2005) to examine whether individuals with certain predispositions are indeed (1) better connected than others in a knowledge transfer network, in terms of closeness centrality, or (2) more engaged in inter-unit knowledge transfer. Individuals that are well-connected within the full knowledge transfer network of an organization, for instance, contribute significantly more to beneficial outcomes including to innovative knowledge transfer in particular (Nerkar and Paruchuri, 2005). We use the concept of closeness centrality to indicate the individual's position in the full knowledge transfer network, rather than merely observing her immediate connections. The connections an individual has may be within the own unit, while also knowledge transferred from other units, crossing unit boundaries, is believed to contribute to innovation in an important way (Burt, 2004; Aalbers et al., forthcoming). We thus also determine how individual motivation might positively influence her tendency to be involved in inter-unit knowledge transfer. By relating network structure elements to motivational variables, this paper thus contributes significantly to the understanding of knowledge transfer within organizations and potentially benefits corporate innovation policies aimed at increasing employee participation in knowledge transfer and innovation.

2. Knowledge transfer within an organization: connectedness and motivation

Finding the person within a multi-unit organization who possesses the knowledge that one is looking for may be difficult (Szulanski, 2003; Hansen, 1999; Hansen and Haas, 2001). The relative autonomy of units within a multi-unit organization structure can create a lack of awareness of each other's activities on an individual and a unit level, limiting knowledge-transfer. Within a unit that specializes in one knowledge field, knowledge may also be of the tacit kind. The advantage of the tacit nature of knowledge is that imitation by competitors is relatively difficult (Nonaka and Takeuchi, 1995), but at the same time the tacitness of the knowledge requires a high degree of personal contact to disperse it throughout a company (Teece, 1998; Hansen, 1999). An individual's capacity to contribute to the innovation processes in a firm then depends not just on his own (absorptive) capacity originating from earlier experiences (Cohen and Levinthal, 1990), but also depends on the social, professional and hierarchical relations within the organization.

If one is not well-connected one's contribution to knowledge transfer and thus the innovation process can be limited. There have been a number of recent calls to focus on the specific role of individuals in leveraging knowledge transfer (Felin and Hesterly, 2007). While the literature on networks has been very helpful in suggesting the beneficial role of informal interpersonal ties for knowledge transfer (e.g. Granovetter, 1973; Hansen, 1999), the *actual* process through which organizational knowledge is transferred remains relatively under-explored in the literature (Schulz, 2003; Reagans and McEvily, 2003).

In this paper we focus on the social network characteristics known to particularly stimulate knowledge transfer within an organization (Ibarra, 1993; Tsai, 2002; Nerkar and Paruchuri, 2005; Teigland and Wasko, 2009; Mäkelä and Brewster, 2009), and study how an individuals' motivation helps explain how individuals will be well-positioned. More specifically we look at how an individual's motivation – extrinsic or intrinsic – explains their connectedness in the organization-wide knowledge transfer network at large, and also affects the maintenance in particular of inter-unit ties. Overall connectedness and inter-unit ties in a knowledge transfer network are each argued to be beneficial, as we explain below.

Individual *motivation* is indicated as the primary trigger for knowledge transfer (Osterloh and Frey, 2000; Lin, 2007) and as key determinant of successful or appropriate behavior by individuals within organizations in general (Deci and Ryan, 1987). When an employee is motivated it means he/she is moved to do something, which turns motivation in a main concern of any manager (Hung et al., 2011; Wasko and Faraj, 2005). Several prior studies explored conceptual (Bartol and Srivastava, 2002; Damodaran and Olpher, 2000) or qualitative approaches (Weir and Hutchings, 2005; Yang, 2004) to study the motivatives fundamental to knowledge sharing behavior. Motivation is believed to positively influence the amount of knowledge transferred (Gupta and Govindarajan, 2000; Tsang, 2002), and conversely lack of motivation in accepting knowledge from others leads to 'stickiness' or difficulties in the transfer process (Szulanski, 1996). Motivation is central to learning and lack of motivation can hinder knowledge transfer (Pérez-Nordtvedt et al., 2008).

In line with Osterloh and Frey (2000; Vallerand, 2000; Lin, 2007) we identify two broad classes of motivation – extrinsic and intrinsic motivation. Extrinsic motivation focuses on the goal-driven

[1] See Ibarra (1992, 1995) for one of the few exceptions related to gender and race.

reasons, e.g. rewards or benefits earned when performing an activity (Osterloh and Frey, 2000). Intrinsic motivation indicates the pleasure and inherent satisfaction derived from a specific activity (Deci, 1975). Both forms have been found to influence individual intentions regarding an activity as well as their actual behaviors (Davis et al., 1992; Lin, 2007). As a result of their predispositions, individuals may shape their immediate network environment by (failing to) establish relations (Mäkelä and Brewster, 2009; Argote and Ingram, 2000).

Sharing[2] knowledge may be extrinsically motivated as the consequence of such behavior is expected to lead to benefits for the employee initiating in this activity (Osterloh and Frey, 2000; Kankanhalli et al., 2005). In case of extrinsic motivation the sharing of knowledge will continue as long as the expected benefits equal or exceed the cost of participating in the exchange. Consequently when the benefits no longer exceed the costs involved, the exchange will stop (Kelly and Thibaut, 1978). Benefits of being involved in knowledge transfer comprise of receiving organizational recognition and rewards or the obligation of other colleagues to reciprocate with knowledge transfer at some moment in the future (Ko et al., 2005). Costs typically relate to effort, such as time spent, mental effort, preparation and so on (Lin, 2007).

Sundgren et al. (2005) observed that information sharing requires self-initiated activities to fully benefit from the available pool of knowledge. Self-initiated activities are influential as they are primarily driven by intrinsic motivation (e.g. Dhawan et al., 2002). Engaging in the exchange of knowledge for its own sake, or for the pleasure and satisfaction derived from the experience, is a common indication that one is intrinsically motivated (Deci, 1975; Lin, 2007). The sharing of knowledge can in itself be fulfilling for employees as it increases their own knowledge level or degree of confidence in their ability to provide knowledge that is useful to the organization (Constant et al., 1996). Previous research has demonstrated that people actually enjoy helping others by sharing knowledge and experience without an immediate or material benefit for themselves (Baumeister, 1982). Such intrinsic motivations have been found to explain human behavior in various contexts (Vallerand, 2000; Vallerand and Ratelle, 2002).

Research on creativity has found that people will be most creative when they are primarily intrinsically motivated, rather than extrinsically motivated by expected evaluation, surveillance, dictates from superiors, or the promise of rewards (Amabile, 1997; Teigland and Wasko, 2009). Knowledge workers have been found to tend to be highly intrinsically motivated and often value knowledge generation for its own sake (Mudambi et al., 2007). Furthermore intrinsic motivation is positively associated with creativity (e.g. Amabile et al., 1996; Woodman et al., 1993). It is reasonable to expect that intrinsic motivation will have the same positive effects on knowledge sharing as it has on other learning activities (Bock et al., 2005; Burgess, 2005; Foss et al., 2009; Quigley et al., 2007; Vallerand and Bissonnette, 1992; Vansteenkiste et al., 2004). This is supported by scholars who have argued that intrinsic motivation promotes knowledge sharing (Cabrera et al., 2006; Lin, 2007; Osterloh and Frey, 2000). Hence, building on the insights from this literature, we suggest that employees who are intrinsically motivated are more likely to share knowledge (Lin, 2007).

Existing research has taken an individual's *connectedness* as one of the most eminent indicators of an individual's position in a network. Being well-connected indicates the ease with which someone can connect with any other alter in a network. Being well-connected either directly or indirectly, allows one to access information and muster support (Bala and Goyal, 2000). Well-connected individuals in a network are more likely to contribute to the development of relevant knowledge (Sparrowe et al., 2001; Wasserman and Faust, 1994). Well-connected individuals receive information and insights from many others, of higher accuracy, and are more innovative than individuals that are positioned less strategically (Aalbers et al., forthcoming; Brass, 1984; Dekker et al., 2003; Ibarra, 1993). Well-connected individuals can collect and spread existing information more rapidly, but can also recombine existing ideas and knowledge in a novel way thus being more creative (Burt, 2004; Sparrowe et al., 2001). The more individuals are in regular contact with one another, the more likely they are to develop a "habit of cooperation" and act collectively (Marwell and Oliver, 1988; Wasko and Faraj, 2005, p. 41).

Diversity of input from one's connections is particularly relevant when considering the innovative knowledge transfer network. Such diversity can come from two different sources. First of all, an individual may be receiving diverse information since she is well-connected in the full network. Closeness centrality indicates the ease with which an individual is likely to receive information originating from the different subgroups in a full network, through the indirect connections she has. In a direct sense, an individual may connect with others who are in a different department or unit, and thus offer diversity of input(Teigland and Wasko, 2009).

An individual's *motivation* and *connectedness* in the full network may be argued to be conceptually connected. A better empirical understanding of the link may increase our understanding of intra-organizational knowledge transfer. Connectedness need not per definition imply that an individual is directly connected to all other colleagues, however. She may be able to reach others indirectly. Katz (1964) observed that those who are well-connected into networks of relationships in a professional environment will be more likely to participate in decision making, and see clearly how they contribute to group performance. Teigland and Wasko (2009) extended this notion to cooperation patterns in a multinational corporation setting and found that individuals who maintain more social relationships with their peers will be more vital in the overall knowledge flows across the organization (see also Nerkar and Paruchuri, 2005).

Moch (1980), then, observes that intrinsically motivated individuals are more socially integrated. The degree to which an individual is favorably positioned in the knowledge transfer network, in particular, is expected to be driven by intrinsic motivation for a number of reasons. Someone who is intrinsically motivated to share knowledge is more likely to volunteer knowledge that might be relevant for a co-worker. In response to a request for knowledge from her social environment, an intrinsically motivated individual will be more likely to provide knowledge above and beyond what is asked for as the sharing of knowledge in itself is perceived as fulfilling (Constant et al., 1996). Intrinsically motivated individuals will also be approached more often to provide knowledge because alters expect that no immediate quid pro quo is expected or negotiated for; they are trusted more (Burt, 2005; Hansen, 1999). In such a context, no immediate return to time and effort invested in knowledge transfer is to be expected and economic payoffs are highly uncertain (Dolfsma et al., 2009). For the individual to be well-connected in the full network, she depends on others to maintain their connections so the focal individual can reach others indirectly.

In the context of studying the full innovative knowledge transfer network in an organization, these thus are reasons to expect intrinsically motivated individuals to be well-connected. Hence we hypothesize that intrinsic motivation is a useful predictor of an individual's connectedness in the full innovative knowledge transfer network:

[2] We use the terms knowledge sharing, knowledge exchange and knowledge transfer interchangeably throughout this paper.

Proposition 1. *The degree to which an individual is well-connected within the full innovative knowledge transfer network, is positively influenced by their intrinsic motivation.*

3. Knowledge transfer within an organization: inter-unit relations and motivation

Aside from the benefits to the individual employee of being connected well in the full innovative knowledge transfer network, indirectly, innovative knowledge sharing will benefit from diversity of direct relations an individual maintains (Whelan et al., 2011). Individuals maintaining a larger number of such diverse contacts outside one's own unit allows her to contribute better to the innovative capacity of the organization (Tsai, 2002; Perry-Smith and Shalley, 2003). Spanning unit boundaries provides access to diverse sources of knowledge to an individual and its organizational unit and is critical for an individual's innovativeness within an organization (Aalbers et al., forthcoming; Burt, 2004). Differentiating between inter- and intra-unit knowledge transfer is common to social network studies and has provided some interesting insights regarding social capital, value creation and innovation (Tsai and Ghoshal, 1998; Tsai, 2002; Paruchuri, 2010; Mäkelä and Brewster, 2009). Participation in cross-functional activity by individuals, for instance, increases their access to alternative views on a firm's existing strategy, goals, interests, time horizon, core values and emotional tone (Floyd and Lane, 2000), but also extends their complementary functional expertise. Exposure to conflict and discussion as a result of different needs, objectives and interests between differentiated organizational units and hierarchical levels is believed to increase ambidexterity at the individual level (Mom et al., 2007). Maintaining diverse relations, directly, holds various benefits to the individual, including in relation to her contribution to innovative knowledge transfer.

Employees are most likely to interact with others in their immediate surroundings, however. Interacting with others, beyond the immediate contacts or beyond whom one would as a matter of course meet regularly is more costly. Establishing and maintaining ties is costly (Buechel and Buskens, 2012). Investment in (the expansion of) one's network might become uneconomic especially when already supporting many ties.[3] Indeed, studies of network connectedness find that the value of each connection maintained decreases with its distance, while the costs of establishing and maintaining them increases, ensuring that actors in general strive to connect with others at a short distance (Jackson and Wolinsky, 1996; Hummon, 2000; Doreian, 2006). These costs might surge in particular when ties span unit boundaries (Tsai, 2000; Haas and Hansen, 2005). An effort must be made to arrange meetings to establish or maintain a contact. In addition, an employee that acts outside his immediate surrounding is likely to have a different social or professional thought world that can be difficult (costly) to relate to. Unit membership tends to come with a shared knowledge base and operational routines that have been there from inception and is likely to have developed since (Gulati and Puranam, 2009). The diversity of or cognitive distance between specialized knowledge developed in separate units is very likely to be (much) larger than within a unit (Nooteboom, 2000). In addition, knowledge transfer across unit boundaries tends to involve others with whom one interacts relatively less frequently as a matter of course and with whom one is less familiar. Multiplex ties, known to be beneficial to innovative knowledge transfer (Aalbers et al., forthcoming), in which the same two individuals connect through different networks, are less likely to develop between individuals from different units. Reciprocity in exchange may be less likely (cf. Ensign, 2009). Levels of trust may then be lower between individuals from different units who interact. The result may be that more uncertainty is involved in inter-unit knowledge transfer when compared to intra-unit knowledge transfer. Interactions between individuals from the same unit tend to have a higher expectation of results, albeit that these results are more incremental; interactions between individuals from different departments may yield a more radical result, but the chances of the result materializing can be (much) lower (Constant et al., 1996; Whelan et al., 2011). A high risk, uncertain yield environment that characterizes an innovation setting where inter-unit knowledge transfer with relatively less well known others from across unit boundaries is involved, is likely in particular to attract individuals motivated by immediate personal returns to knowledge exchange, such as career progression, status or financial rewards, to engage in knowledge transfer (Osterloh and Frey, 2000; Kankanhalli et al., 2005; Lin, 2007).

When employees are to be actively encouraged to establish and maintain diverse, inter-unit ties, they may then need to be stimulated by relating to their immediate personal and professional interests, which entails that they must be sensitive to that (Amabile, 1997). Based on the previous arguments, we propose that the increased perceived uncertainty and costs involved in inter-unit knowledge transfer indicate why inter-unit knowledge transfer may in particular appeal to an individuals' extrinsic motivation.

Proposition 2. *The number of inter-unit ties an individual holds in the full innovative knowledge transfer network is positively influenced by their extrinsic motivation.*

4. Method and data

4.1. Organizational settings

Recognizing the need of more empirical support for the theoretical findings to underscore the importance of inter-unit communication structures (Hansen and Haas, 2001), this paper draws upon empirical research collected at a two separate companies. We have collected data for the full network of individuals involved in transfer of innovative knowledge in two companies in very different industries to provide indication of the representativeness and robustness of our findings. As innovative activity is a discretionary or extra-role activity, the network of individuals involved with transfer of innovative knowledge in a company is likely to be much smaller than the total number of individuals employed. A minority of individuals in any firm tends to be transferring innovative knowledge (Albrecht and Hall, 1991; Albrecht and Ropp, 1984). We have aimed to collected information from and about all these individuals to have an understanding of the *full* innovative knowledge transfer network. In social network analysis, it is common to work with data for relatively small networks (e.g. Dholakia et al., 2004; Albrecht and Hall, 1991; Tichy et al., 1979), and centrality measures based on such small scale or even sampled network data have proven to be robust in network studies (Costenbader and Valente, 2003).

One company studied is a subsidiary of a European electronics and engineering conglomerate (Alpha Company), the other is a leading European financial service provider (Beta Company).

Alpha Company is a multinational electronics and engineering company headquartered in Europe. We study the Dutch subsidiary, which has been in operation since the late 19th century and employs some 4000 employees. Alpha Company is organized according to a unit structure with a high level of autonomy and

[3] The benefit of being well-connected by being on the shortest path to others in the network (having a low closeness score) and of having diverse inter-unit ties should therefore be analyzed while controlling for number of an individual's immediate ties, as we explain in the methods section.

responsibility for the separate units and the units are organized according to product-market segmentation. Recently, the company shifted its strategic insights from offering specific products toward offering 'total solutions' to its customers. As the company now aims at offering integrated and innovative solutions based on its technical competencies that cross unit boundaries, this heightens the relevance of internal knowledge exchange and the network that facilitates it. The unit structure constitutes a natural membership boundary (see Hansen, 1999), however, and it is therefore that employees, sorted by unit membership, form the object of analysis in this study of inter-unit transfer of knowledge. The selection of these units is carried-out based on the input gathered during several interviews with the new business development director and the business managers in the separate units. Through the new business development director the commitment of the unit directors was sought and secured.

Beta Company is one of Europe's largest and most innovative payment processors, leading the market for secure payments and card processing solutions. We study its headquarters. With an annual processing volume of almost 7 billion payments and the switching of 1.9 billion POS and ATM transactions, the company's market share within the Eurozone is well over 10%, employing 1500 employees; with the large majority based in its European headquarters. Beta Company is characterized by a strong unit structure. Again access was negotiated through the director of the new business development unit, operating directly under the supervision of the board of directors.

4.2. Data collection process

To test the formulated propositions, data on the social relations within both companies are gathered on individuals involved in the innovative knowledge transfer network. We follow Farace et al. (1977) to define social networks as repetitive patterns of interaction among members of an organization. Data on the individual level of the innovative knowledge transfer network, hereafter referred to as the innovation network, are collected using semi-structured interviews with managers and other employees as well as by means of an ego centric network survey. The interviews served a two-fold purpose: first, to become familiar with the organizational setting and thus gain input for the proper design of the network survey and second, to determine the appropriate response group within the company. In social network studies the most pragmatic approach in an organizational setting is believed to be the survey methodology (Borgatti and Cross, 2003; Wasserman and Faust, 1994). This study uses snowball methodology as the basis for this survey. Snowball sampling is especially useful when the population is not clear from the beginning (Marsden, 1990, 2002; Wasserman and Faust, 1994), which is the case for both organizations studied here. Innovative concepts may arise from employees who are not part of a cross-unit team set up to stimulate innovation, for instance, or it may arise from interactions not mandated by management. Snowball sampling is based upon several rounds of surveying or interviewing where the first round helps to determine who will be approached as a respondent in the second round, and so on. The first round of snowball sampling can be totally at random but it can be also based on specific criteria (Rogers and Kincaid, 1981). To reduce the risk of 'isolates', i.e. isolated persons within the organization who do possess relevant knowledge to a particular subject, but who are being left out by the study due to the lack of accuracy of random sampling (Rogers and Kincaid, 1981), this study opted in a first round to target respondents selected in conjunction with new business development management.

The networks analyzed are egocentric networks, an approach commonly adopted for the purposes of this kind of research. The survey was first tested on a small sample of respondents whom had been personally informed of the purpose of the study to increase their level of cooperation. The final version of the survey was sent in three rounds in each of the companies. The names mentioned at Alpha Company by this first round of respondents (9) formed the input of respondents for the second round (42), who named another round of respondents. Closure was reached after this third round of surveying. The full network studied consists of 83 employees partaking in the knowledge transfer network, with a joint number of 122 individual innovative knowledge transfer ties. The final overall response rate at Alpha Company was 96%. Only 4% did not respond to the first mailing and the later three reminder mailings. Following an identical procedure a comparable response was achieved at Beta Company, with an overall response of 93%. With 30 employees at Beta Company partaking in round one, which named another 54 employees that together formed the second survey round, the total innovative knowledge transfer network at Beta Company showed to comprise off 144 employees. This innovation community together maintained 381 individual innovative knowledge transfer ties.

The invitation to participate in the survey was distributed by e-mail at each of the companies, accompanied by a personalized cover letter introducing the project and the hyperlink to the online survey to the respondent, signed by the senior new business development manager to improve response rates. An online survey was chosen to reduce the time needed to complete the questionnaire, thus improving response rates. We did not opt to fix the number of contacts throughout the survey by using a list of names provided by management or to indicate a limit to the number of possible contacts a respondent could list (Friedman and Podolny, 1993). However, we did issue a guideline of naming six employees to make sure that only the most important contacts per employee were mentioned. To reduce ambiguity regarding the interpretation of the questions by the respondents, the network questions were formulated in the native language.

5. Variables

For each of the employees partaking in the innovation network we collected input for each of the variables. The innovative knowledge transfer network was measured by asking individual respondents with whom they initiate a discussion of new ideas, innovations and improvements regarding products and services their unit offered (Borgatti and Cross, 2003; Cross and Prusak, 2002; Rogers and Kincaid, 1981; Stephenson and Krebs, 1993; Rodan, 2010). Based on the network data gained via the ego centric survey, the dependent variables of closeness centrality and interunit ties were calculated, using Ucinet 6.0 (Borgatti et al., 2002; Freeman, 1979).

5.1. Dependent variables

5.1.1. Individual connectedness

Individual connectedness in the full network was measured by means of individual closeness centrality (Teigland and Wasko, 2009; Costenbader and Valente, 2003; Freeman, 1979). Closeness centrality takes the structural position of actors in the whole network into account, and has been identified as one of the most important centrality measures in network analysis (Borgatti, 2005). Not only because it is the most appropriate centrality measure to determine the structural position of actors in terms of one's effectiveness of contacting all others in the network (Borgatti, 2005; Freeman, 1979), but also because closeness centrality has proven to be a robust measure (Costenbader and Valente, 2003). Closeness centrality measures how many steps on average it takes for an individual to reach everyone else in the network. Individuals who

have high closeness centrality measures can most efficiently make contact with others in the network (Freeman, 1979; Costenbader and Valente, 2003, p. 298). The higher one's closeness centrality, the better positioned the individual is in dispersing information to other employees (Wasserman and Faust, 1994). In this study closeness centrality is preferred to degree centrality, as it does not only take into account direct connections among units but also indirect connections (Teigland and Wasko, 2009). An individual's closeness centrality is the inverse of an individual's closeness score, which is calculated[4] as the sum of graph-theoretic distances from all other individuals in the network, where the distance from one individual to another is defined as the length (in links) of the shortest path from one to the other (Freeman, 1979). Closeness is an inverse measure of centrality, a larger value indicates a less central actor while a smaller value indicates a more central actor. For this reason we normalize the centrality score, following Borgatti and Halgin (2011) by dividing raw closeness by its maximum score in the database and extract this score from 1, which simultaneously reverses the measure so that high scores indicate greater connectedness. This allows for easier interpretability of the results as well. Assuming that what knowledge flows in a network originates from all other nodes with equal probability and travels along the shortest path, highly central individuals have short distances from others, and so will tend to receive innovative information flows sooner (Borgatti, 2005, p. 59).

5.1.2. Number of inter-unit ties

The number of inter-unit ties was calculated based on data from the ego-centric network survey. This variable was constructed from the number of ties outside the unit, but inside the boundaries of the organization, that the individual employee maintained in the previous three months (Tsai, 2000). We normalized this measure by dividing each individual score by the maximum in the dataset.

5.2. Independent variables

The independent variables *intrinsic and extrinsic motivation* were derived from the Work Preference inventory of Amabile (1994). The Work Preference Inventory (WPI) is specifically designed to assess individual differences in intrinsic and extrinsic motivational orientations (1994). The questions of the inventory are specifically aimed to assess the major elements of intrinsic motivation (self-determination, competence, task involvement, curiosity, enjoyment, and interest) and extrinsic motivation (concerns with competition, evaluation, recognition, money or other tangible incentives, and constraint by others). Drawing from a total repository of 30 propositions, Amabile points out that to fit the context of the study we should match our findings accordingly. In this study we draw from 6 propositions on intrinsic motivation and 6 propositions on extrinsic motivation. These propositions were converted in 12 questions for the questionnaire, framed on 7 point Likert scales. The Cronbach alpha for the intrinsic motivation questions was .62, the Cronbach alpha for the extrinsic motivation questions was .58. For 33 percent of our respondents we were able to collect motivational data on both intrinsic as well as extrinsic motivational antecedents.

5.3. Control variables

Four variables were included as controls: *tenure* (in months), *gender*, *unit membership*, and *number of ties* per individual employee. We included tenure to control for the effect of time, as relations tend to develop throughout the years. Gender and unit membership were added to control for group affiliation effects. Number of ties per individual employee was included to control for the effect of individual network size and the corresponding costs involved in maintaining or possibly increasing the number of connections (Buechel and Buskens, 2012; Tsai, 2000; Haas and Hansen, 2005). For our analysis of the connectedness in the full network (closeness centrality), we controlled for number of cross-unit ties, and vice versa.

6. Results

Since aggregating the data for the two firms in our study into a single dataset is both methodologically as well as substantially meaningless, we provide analyses for each of the firms separately. Descriptives are presented in Tables 1a and 1b show the means, standard deviations, and zero-order correlations of each of the variables for each company. Moving beyond these zero-order results, the multiple regression analyses in Tables 2 and 3 present the findings with regard to our first and second proposition, for each company. To make sure that the sample size did not lead to a violation of the normality assumption central to the ordinary least square (OLS) procedure we used, we checked for non-normal distributions and examined the skewness and kurtosis of all the variables. The skewness and kurtosis showed no values greater than an absolute value of one (1) for each variable, suggesting reasonably normal distributions. Histograms for each variable were also examined, however, and these showed that most scales were moderately positively skewed, with floor effects evident for number of inter unit ties which appeared to violate the assumption of normality. Thus a square root transformation was computed. The regression analyses were conducted using both the non-transformed and transformed scores and this was not found to make a statistically significant difference to the variance explained or to the regression coefficients. For simplicity and interpretability of the findings reported upon, only the non-transformed scores are presented. Homoscedasticity was examined via several scatterplots and these indicated reasonable consistency of spread through the distributions. Multiple linear regression analysis was deployed to determine which of the motivational attributes predicts connectedness (closeness centrality) and number of inter-unit ties per employee in the knowledge transfer network.

The results of the multiple regression analyses, presented in Table 2, are remarkable. After running the model with the control variables in isolation and after controlling for the specific effect of number of ties as a proxy of an individual's economic investments into his social infrastructure, models A3 and B3 introduce intrinsic motivation. The inclusion of intrinsic motivation in explaining individual connectedness results in a significant improvement to the regression model at Beta Company (Model B3; F-test for $\Delta R^2 = 4.645$, $p < .05$), identifying the relationship as significant (Model B3; beta = $-.278$, $p < .05$). The sign for the effect found in the case of Alpha Company is actually opposite to the one found for Beta Company; the effects found for Beta Company are not statistically significant, however. In models A4 and B4 we introduce extrinsic motivation as well. An individual's motivation is not a dichotomous matter, as we argued above, but might very well be based on a combination of both intrinsic and extrinsic motives. The introduction of extrinsic motivation does not provide a statistically significant beta and, in line with that, does not significantly improve our model B4 results for Beta Company as a whole compared with model B3 (Table 2). A significant positive relationship between extrinsic motivation and connectedness, however,

[4] Closeness of a node is equal to the total distance (in the graph) of this node from all other nodes. As a mathematical formula closeness, $c(i)$, of node i can be written as: $c(i) = \sum_i d_{ij}$ where d_{ij} is the number of links in a shortest path from node i to node j.

Table 1a
Descriptive statistics Alpha Company.

	Variable	Means, standard deviations and correlations								
		Mean	Std. dev.	1	2	3	4	5	6	7
1	Gender	.925	.267							
2	Tenure	10.666	6.325	.099						
3	Unit	2.222	1.251	−.064	.078					
4	Ties (#)	4.810	3.680	.26	−.087	−.083				
5	Closeness centrality	.127	.175	−.692**	−.27	−.045	−.182			
6	Intrinsic motivation	3.735	.481	−.059	−.233	.07	.087	.235		
7	Extrinsic motivation	2.957	.516	.302	.288	.214	.181	−.564**	.124	
8	Inter-Unit ties	1.370	2.151	.117	−.05	.083	.636**	−.05	.08	.246

$N = 28$.
* A significance level of 5%.
** A significance level of 1%.
*** A significance level of .1%.

Table 1b
Descriptive statistics Beta Company.

	Variable	Means, standard deviations and correlations								
		Mean	Std. dev.	1	2	3	4	5	6	7
1	Gender	.793	.409							
2	Tenure	7.450	4.654	−.20						
3	Unit	2.31	1.547	.20	.01					
4	Ties (#)	10.43	6.754	.06	−.44	−.11				
5	Closeness centrality	.145	.229	−.03	.22*	.14	−.31***			
6	Intrinsic motivation	5.155	1.105	.24*	−.11	−.02	.04	−.29***		
7	Extrinsic motivation	4.270	1.246	.05	−.02	.09	−.18	−.11	.19	
8	Inter-unit ties	3.590	3.656	−.28*	.15	−.14	.61***	−.16	−.03	−.23*

$N = 58$.
* A significance level of 5%.
** A significance level of 1%.
*** A significance level of .1%.

does show for Alpha Company (Model A4; beta = −.419, $p < .01$). We nonetheless, conservatively, interpret these findings as indicating that Proposition 1 cannot be supported.

The role of motivation for determining connectedness of individuals in a knowledge transfer network seems to be somewhat different for the two companies involved, suggesting that contingent elements, to be researched in future papers, may be at play beyond the scope of current research on motivation and involvement in knowledge transfer. From among the control variables we include, it is striking to see how women at Alpha Company are more likely to be located in the network close to potential sources of knowledge. As this effect appears to be limited to Alpha Company only, we refrain from further speculation on the causes of this apparent relationship. What is more striking is the lack of significance for the control variable Tenure: one would expect that individuals are more likely to have developed more relations as they have been employed at a firm for a longer period of time, including relations with 'distant' colleagues. This is not the case. In addition, being well-embedded locally, by having a large number of direct ties in the knowledge transfer network, does not make an employee well connected indirectly, at the network level, by having a higher closeness centrality.

Table 2
Motivation and closeness centrality (connectedness[a]) – Proposition 1 tested.

D.V.	Closeness centrality[a] Alpha Company				Closeness centrality[a] Beta Company			
	Model A1	Model A2	Model A3	Model A4	Model B1	Model B2	Model B3	Model B4
Controls								
Tenure	.197	.201	.163	.036	−.139	−.115	−.097	−.106
Unit	.073	.075	.090	.003	−.215	−.104	−.087	−.074
Gender	.678***	.669***	.660***	.551***	.012	.015	−.053	−.051
# ties		.032	.47	.012		.250	.251	.278
IVs								
Extrinsic motivation				.419**				.123
Intrinsic motivation			−.168	−.245*			.278*	.254
N	28	28	28	28	58	58	58	58
F-value	8.495***	6.117**	5.192**	7.195**	1.286	1.742	2.418*	2.157
R^2	.526	.527	.553	.683	.067	.116	.189	.202
Adjusted R^2	.464	.440	.446	.588	.015	.049	.111	.109
F-test for ΔR^2		.044	1.233	8.249**		2.968	4.645*	.881

Standardized coefficients. Durbin Watson model A: 1.837, VIF < 1.34, tolerance > 74; Durbin Watson model B: 1.877, VIF < 1.31, tolerance > 75.
[a] Connectedness is operationalized as normalized closeness centrality at the employee level (see Section 4).
* $p < .05$.
** $p < .01$.
*** $p < .001$.

Table 3
Motivation and inter-unit ties – Proposition 2 tested.

D.V.	Inter-unit ties Alpha Company				Inter-unit ties Beta Company			
	Model A1	Model A2	Model A3	Model A4	Model B1	Model B2	Model B3	Model B4
Controls								
Tenure	−.070	.002	−.036	−.040	−.092	−.009	−.006	−.001
Unit	.096	.134	.102	.103	.106	.478**	.471***	.473***
Gender	.130	−.046	−.082	−.084	−.242	−.232**	−.230*	−.244**
# ties		.659****	.636***	.637**		.838***	.825***	.823***
IVs								
Extrinsic motivation			.144	.147			−.057	−.068
Intrinsic motivation				−.015				.059
N	28	28	28	28	58	58	58	58
F-value	.210	4.59**	3.308*	2.628*	1.934***	25.101***	19.969***	16.551***
R^2	.027	.425	.441	.441	.097	.655	.658	.661
Adjusted R^2	−.100	.320	.307	.273	.047	.628	.625	.621
F-test for ΔR^2		15.219***	.601	.007		85.522***	.462	.473

Standardized coefficients. Durbin Watson model A: 2.665, VIF < 1.35, tolerance > 88; Durbin Watson model B: 1.874, VIF < 1.30, tolerance > 76.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

Our second proposition looks at what explains the number of inter-unit ties an individual has in the knowledge transfer network. Inter-unit ties have been found in the past to contribute to innovation in particular. Table 3 reports results of the multiple regression analyses for the datasets. Contrary to expectation, neither intrinsic nor extrinsic motivation of individuals predicts their involvement in knowledge transfer across unit boundaries.[5] The third and fourth model that add the motivation variables in comparison to the base models 1 and 2 offer no significant improvement as judged by the *F*-test for ΔR^2. Betas are non-significant for both types of motives and so Proposition 2 must certainly be rejected.

Entered as a control in models A2 and B2 (Table 3), the sheer number of ties seems to be the best predictor of the inter-unit ties an individual maintains in the innovation networks at both companies. Statistically, the relation remains significant in each of the models where this variable is included. Gender negatively impacts the number of inter-unit ties an individual has in a statistically significant way only for Beta Company. Also departmental affiliation appears to matter in explaining the maintenance of inter-unit ties at Beta Company only. Again, and again surprisingly, having enjoyed a long tenure at a company does not lead an employee to have more inter-unit ties.

7. Discussion and conclusion

Connectedness and inter-unit ties in the knowledge transfer network are both, separately, known to allow individuals to contribute to innovation (Burt, 1992; Tsai, 2001). The literature on people's willingness to exchange knowledge suggests that individuals' motivation should also be expected to be an important explanatory for one's favorable *position* in an innovative knowledge transfer *network*, but fails to investigate this important claim (Anderson, 2008). We empirically investigate the role of intrinsic and extrinsic motivation on one's overall connectedness and one's diversity of ties in the intra-organizational innovation network. Analyzing data for the full network where innovative knowledge is transferred between individuals in two separate innovative companies we present unexpected results. Intrinsic nor extrinsic motivation plays a role in determining an individual's cross-unit knowledge transfer. The effect of individuals' intrinsic or extrinsic motives on connectedness in the overall network (closeness centrality) are rather mixed. We thus find no indication that individual motivation – extrinsic or intrinsic – favorably influences an individual's position in a network where innovative knowledge is transferred.

Motivation to be involved in knowledge transfer is thus different from motivation to position oneself favorably in the network in which innovative knowledge is transferred. The number of ties already maintained seems to prevent an individual from having cross-unit ties, as one would expect drawing on costs of communication considerations (cf. Reagans and McEvily, 2003). The same does not hold for being well-connected in the whole network, however, as evidenced by the findings for closeness centrality. Given that an individual is dependent on possibly distant others to maintain a path for knowledge transfer to him to persist, the costs of communication is not (fully) born by her, even when the diversity of input thus received can be larger than from immediate cross-unit ties one maintains oneself. How exactly communication costs are implicated in an explanation of positioning in a knowledge transfer network is left for further research. In addition, the mutually interdependent nature of motivations, actions and positions in a social environment may need to be more explicitly incorporated in an analysis in future research (cf. Teigland and Wasko, 2009). Including reciprocal benefits as an extrinsic motivator (Lin, 2007; Kowal and Fortier, 1999) might not adequately recognize the interdependencies and socially embedded exchange or transfer of knowledge over time (Bouty, 2000; Ensign, 2009). It might be more important for partners in knowledge transfer to have valuable knowledge to exchange (so as to call in a return favor later) than what motivates them to exchange in the first place (Bouty, 2000; Ensign, 2009, e.g. at p. 103).

As evidenced from the differing findings for the control variables included, organizationally contingent factors may play an important role (cf. Lin, 2007). The effect of the variables Gender (Tables 2 and 3) and of Unit membership (Table 3) differs substantially by company. The extent to which organizational fault lines (Bezrukova et al., 2009) differ between organizations can thus be significant, something that a cross-sectional study without a focus on social networks would not necessarily notice. Exactly how this additional psychological factor relates to social networks needs to be studied in future research.

Our study thus contributes to the understanding of intra-organizational transfer of innovative knowledge and may steer away management attention from too much attention to

[5] Analysis of contribution from motivation – extrinsic and intrinsic – explicitly limited to intra-unit knowledge transfer provides similar findings.

individuals' motives to others avenues for intervention. Management interventions have been found to hurt firm innovativeness (e.g. Mellahi and Wilkinson, 2008; Shah, 2000). Although managerial interventions are daily routine especially in large companies, and involve substantial allocation of resources, studies on the effectiveness of managerial interventions are few and far between (Okhuysen and Bechky, 2009, p. 482). If and when management is keen to sustain the structural features of a knowledge transfer network, it may not want to focus too much exclusively on individuals' motivations our study suggests. Innovation policy may thus fruitfully focus in particular on other individual characteristics such as skills (cf. Kaše et al., 2009) or on routines to be established in a firm (Zollo and Winter, 2002; van Driel and Dolfsma, 2009).

While a main strength of this paper is the analysis of data of actual knowledge transfer in multiple firms, so firmer conclusions may be drawn than those conducted previously under controlled setting of an experiment in which, e.g. students participate (Quigley et al., 2007), nevertheless the study also holds limitations. First, we are not in a position to offer firm evidence for the causality of the findings presented. We need to rely on theory for that to some degree. Second, the conceptual framework is not inclusive of all the possible variables that could be related to innovative knowledge transfer, such as corporate reward system or corporate culture. In our study, we have rather focused on factors that have conceptual meaning beyond the idiosyncrasies of the firms included.

We do stress that the knowledge sharing conditions in this study are strongly focused on the transfer of innovative knowledge. Few previous studies have this focus, limiting the comparability of our findings, in part because of the difficulties in collecting this type of data. It might be that the role of motivation is different in actual business settings compared to experimental conditions.

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