Assessing How Advice And Friendship Ties Form Cohesive And Non-Redundant Networks

Jarle Aarstad, Bergen University College, Norway

ABSTRACT:

Research has suggested that the combined effects of network-cohesion or -closures and the spanning of structural holes and non-redundant ties can leverage innovation and creative ideas. However, we do not know what kinds of social relations have the strongest propensity to form such beneficial network properties. By analyzing and comparing triad census distribution of advice- and friendship-relations in two different firms, I find that friendship ties have a stronger propensity than advice ties to form both network closures and structural holes. Friendship ties may accordingly play a crucial role in leveraging innovative and creative ideas, and I discuss the findings' implications for knowledge management practice.

Keywords: *Advice networks, Cohesion, Friendship networks, Non-redundancy, Triad census distributions.*

---

1. Introduction

A well debated topic in organizational research is the network structure of teams and how it affects innovation, creative ideas, and performance. Some will argue that a cohesive structure is beneficial, referring to Coleman's (1988) concept of network closures creating normative sanctioning mechanisms, finely grained information sharing, trust, and decreased fear of opportunism. Research gives some support to this theory (Ahuja, 2000; Ingram & Roberts, 2000; Tortoriello & Krackhardt, 2010). Others would instead favor Burt's (1992) theory of structural holes, in which people are in a position to brokerage and gain non-redundant information from otherwise disconnected actors. Empirical studies also support this theory (Aarstad et al., 2010; Burt, 2004; Rodan, 2010; Vissa & Chacar, 2009; Zaheer & Soda, 2009). Finally, some would argue that the effects of network closures and structural holes are related to contextual issues (Rowley et al., 2000), or the concepts complement each other and act in tandem (Burt, 2005; Hite & Hesterly, 2001).

The theory of small worlds taps into the latter reasoning. Small worlds are characterized by local clustering, which foster rich communication and shortcut ties between clusters that at the same time provide diversity and non-redundant resources (Watts & Strogatz, 1998). Research shows that such structures can foster innovation, creative ideas, and increase overall performance (Lazer & Friedman, 2007; Schilling & Phelps, 2007; Uzzi & Spiro, 2005). But what kinds of network ties are most likely to foster the seemingly combined benefits of local cohesion and non-redundancy? Is there any difference between advice- and friendship structures in terms of fostering either network closures or the spanning of structural holes? Do advice- and friendship structures complement each other in the formation of these network properties, or are they substitutes?

In this paper I will study these research questions by revisiting the data of two small- and medium sized firms, where I analyze triad census distributions (TCDs) for advice- and friendship structures. TCDs count the frequencies of 16 types of triads that can occur in networks (Davis & Leinhardt, 1972), and they are reported in Figure 1. Scholars claim that "the overall structure of a directed network… can be inferred from the types of triads that occur" (De Nooy et al., 2005: 207), and "a remarkable amount of network information can be gathered by examining configurations defined on [triads]" (Wasserman & Faust, 1994:

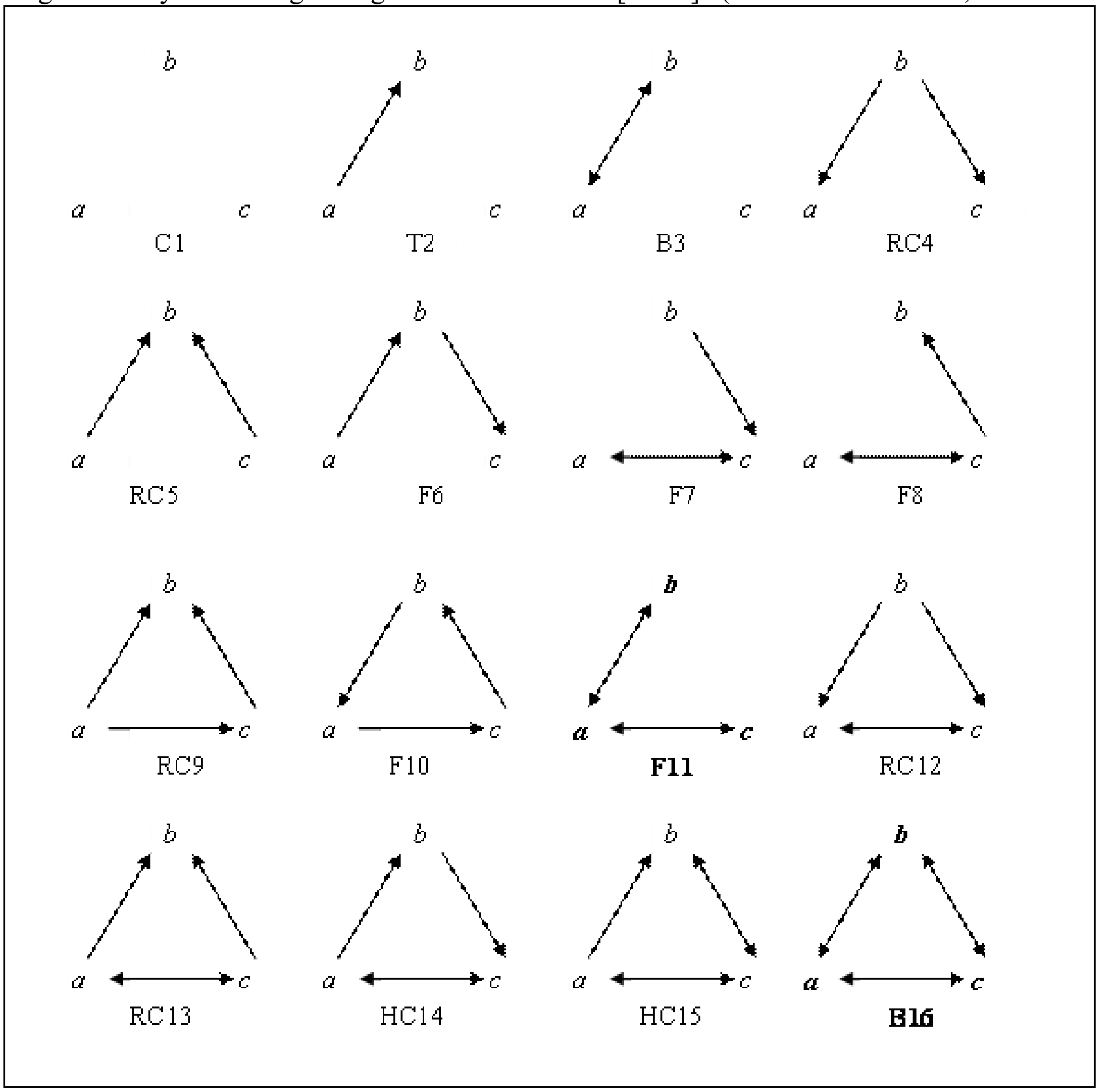

Figure 1: The 16 Triad Types

Note. Formally a so called M-A-N number of three digits identifies each triad type (for details, see Davis & Leinhardt, 1972; Holland & Leinhardt, 1970). However, for the purpose of this paper, I find the current denominations of the triad types reported to be more easily interpretable.

In particular, I will argue that TCDs can enable us to understand what kinds of network ties may induce or exhibit the formation of cohesive or non-redundant network structures. Mainly, I will focus on the triad types B16 and F11, reported in Figure 1 (in the Appendix I will present empirical analyses on the other triad types). B16 is a so-called balanced triad in that all relations are symmetrical and the three network members are connected to each other. Intuitively, we observe that B16 represents a network closure, and the higher the relative prevalence of this triad type, the more cohesive and closed a network is. F11 is a so-called "forbidden" triad, due to the absence of a tie between *b* and *c* (Davis & Leinhardt, 1972; Holland & Leinhardt, 1970), allegedly causing cognitive dissonance (Festinger, 1957). Said differently, *a* spans a structural hole in that the actor brokerages and connects two otherwise disconnected actors. A relatively high prevalence of triad type F11 is accordingly indicative of a network rich in structural holes.

To my knowledge, this is the first study which examines and compares how advice- and friendship ties are formative on cohesive networks and networks rich in structural holes. The paper takes an explorative approach, i.e. I have no clear presupposition that advice structures will dominate over friendship structures (or the other way round), in either the formation of network closures (B16) or structural holes (F11).

In the next section, I will present the empirical contexts and the network data for this study. Then, I will describe how I analyzed and interpreted the results of the TCDs. After that, I will discuss my findings' implications for knowledge management, address the study's limitations, and suggest avenues for future research.

2. Methods And Results

2.1. Research Contexts

The datasets I analyze were gathered by David Krackhardt from two different firms. The first set was gathered from the managerial group (21 managers) in a 10 year old firm producing high-tech machinery (Krackhardt, 1987). The data has later been applied in other studies (e.g., Kilduff et al., 2008; Krackhardt & Kilduff, 1999). I denominate the data 21M.

The second dataset was gathered from a small entrepreneurial firm, given the pseudonym Silicon Systems. At the time of the collection of data, the firm had 36 employees (Krackhardt, 1990). This dataset has also been applied in numerous studies (Aarstad et al., 2011; Bondonio, 1998; Kilduff et al., 2008; Kilduff & Krackhardt, 1994; Krackhardt & Kilduff, 1999). "Silicon Systems' business involved the sales, installation, and maintenance of the state-of-the-art information systems…" (Krackhardt, 1990: 347). I denominate the data SiSys.

2.2. Data Instruments And The Modeling Of Network Ties

Questionnaires were used to gather data on advice- and friendship ties, and similar procedures were followed in the two populations. Each respondent was asked to indicate who he/she would go to for help or advice at work, and who would come to him/her. In a similar vein, the respondents were asked to indicate who they considered to be a personal friend, and who they believed considered them as a personal friend. To validate a network relation, both actors had to agree on both its existence and its direction. For a symmetric relation, both actors had to report that they were giving advice to each other and seeking advice from each other. Likewise, to identify a symmetric friendship relation, both actors had to indicate mutual friendships. The procedure of modeling network relations is analogue with the term "locally aggregated [network] structure", LAS, described by Krackhardt (1987).

All the managers in the 21M population participated in the study, so modeling ties for this group of managers was straightforward. For the SiSys population, however, 3 employees, out of a total of 36, did not participate. I therefore modeled advice- and friendship ties between participating and missing candidates whenever a participating respondent reported on a tie. To model possible relations between the non-respondent employees, I applied consensus data from the participating respondents in a similar vein as reported by Krackhardt (1990).

2.3. Modeling TCDs

All TCDs were modeled in the network program Pajek 1.02 (De Nooy et al., 2005). In previous research, analyzing TCDs has proven complicated (Wasserman & Faust, 1994: 567), but methodological developments have simplified the algorithms (Batagelj & Mrvar, 2001; Moody, 1998). The algorithm, developed by Batagelj and Mrvar (2001), is implemented in Pajek. The program lists the number of observed triads for each the 16 classes (see Figure 1). Correspondingly, it also "lists the numbers of triads that are expected by chance in a network of this size [number of actors] containing this number of arcs [relations]" (De Nooy et al., 2005: 210). Thus, TCDs embody the number of observed triads (*ot*) relative to the number expected triads (*et*) by chance for each class. However, in cases where the number of expected triads is close to zero this can generate extreme and unstable values. I therefore calculated the number of observed triads (*ot*) relative to the number of expected triads (*et*) for each class as follow: $(ot–et+1)/(et+1)$. In other words, I added the constant 1 to both the numerator and denominator to level out extreme and unstable values. Values higher (lower) than 0 indicate that the relative prevalence of a triad type is larger (smaller) than expected by chance.

2.4. Results

Figure 2 reports that the prevalence of both B16 (network closures) and F11 (structural holes) are higher than expected by chance for both advice- and friendship ties in both populations (note that I apply a logarithmic scale). However, the relative prevalence of both triad types tends to be stronger for friendship- than for advice relations, and in particular this is the case for the formation of structural holes (F11). This indicates that friendship ties play a more crucial role in both the formation of network closures and structural holes than advice relations do.

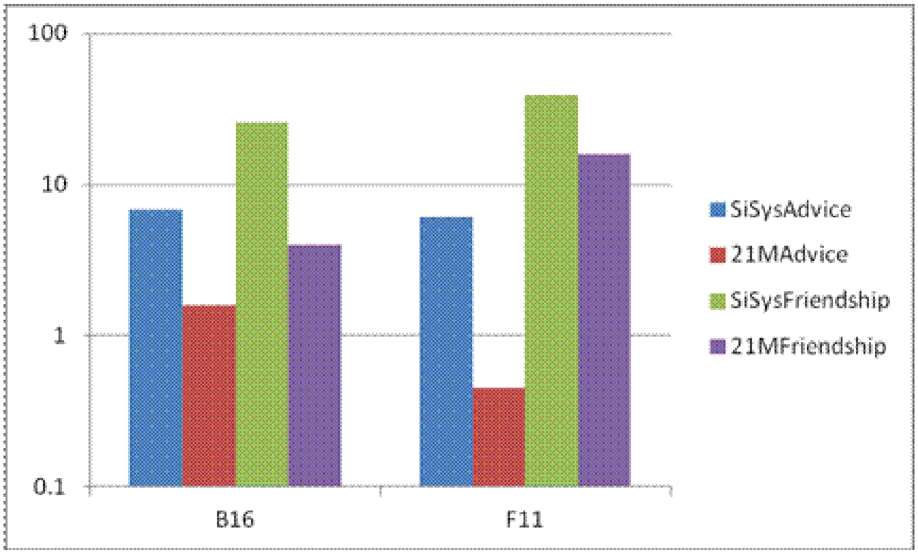

Figure 2: TCDs For Advice- And Friendship-Ties (B16 And F11)

3. Discussion

The aim in this paper has been to study the roles of friendship- and advice relations in the formation of network cohesion or network closures (Coleman, 1988), and structural holes (Burt, 1992). I have argued that these seemingly contradictive network properties can act in tandem and play complementary roles in leveraging innovation and creative ideas. Triad census distributions (TCDs) showed that friendship relations tended to play a more crucial role in the formation of both network closures and structural holes than advice relations did. As a consequence, cultivating friendship relations at the work place may leverage efficient network structures beyond the "feel good" experience of social acquaintances and work satisfaction in general. In the following I will further address how managers aiming at leveraging learning and organizational knowledge, in particular should be aware of the extended benefits that friendship relations within and across organizational boundaries may have on innovativeness, creativity, and performance as such.

In today's modern working life, employees often collaborate across formal organizational charts, or even across organizations. This paper has shown that advice relations can leverage the combined benefits of network closures and structural holes, but the most important finding is that friendship relations seem to play an even more crucial part in leveraging such network properties. Advice relations are inherently task related, thus in many instances predefined challenges or unresolved problems may spur the formation of such relations. This is a reactive approach to organizational undertakings. On the other hand, since friendship ties are not task related, they can to larger extent foster connections that are not motivated by predefined working tasks. Such encounters can bring about novel ideas or innovative solutions on issues that were not predefined as a problem, challenge, or opportunity for that matter (cf., the garbage can model by Cohen et al., 1972). Studying networks of ship owners and ship builders, Greve (2009: 1) claims that "valuable innovations remain rare because they are not adopted by distant firms in geographical and network space." Thus, his finding indicates that connections between otherwise distant actors can spur innovation.

Implicitly, the discussion has so far assumed that the structural benefits of friendship ties will have positive implications for working tasks in organizations, and regarding the effects of network closures or cohesion, I find this assumption rather intuitive. Perhaps even stronger than advice relations, friendship relations will act as a sanction mechanism, increase the level of trust, and consequently decrease the fear of opportunism. Yet regarding the provision of information redundancy, the implication may be less straight forward and less intuitive. However, I find it reasonable to assume that relations primarily established on a basis of friendship, subsequently can foster the exchange of work related issues or ideas. In other words, friendship ties can connect otherwise distant people in an organization (or across organizations for that matter) and act as a catalyst for the formation of advice relations. Yet having said this, I do not deny that advice relations can also foster friendships, but due to similarities in the problem space at the outset, such friendship relations may tend to be more redundant than those described above.

This study has several limitations that should also inspire future research. The data analyzed is cross-sectional, and to gain further information about the dynamics and development of triad types, longitudinal data on network dynamics can provide richer knowledge about these issues. However, data reported in Figure 2 (and also in Figure A1) illustrate how triad types deviate from comparable randomized networks. Thus, despite the data's cross-sectional nature, we can infer the dynamic development of the network structures. Yet when it comes to the possible interaction of advice- and friendship relations (e.g., in what ways friendship relations may foster advice relations or the other way round), only longitudinal data can provide validated information, which is a topic for future research.

This study has aimed to identify in what ways advice- and friendship relations tend to form network closures and structural holes. Future studies should also aim to compare and assess in what ways friendship- and advice relations de facto leverage innovation and creative ideas in organizations.

4. Appendix

In the following, I will give a brief overview of the all the 16 triad types illustrated in Figure 1. After the brief overview, I will relate the triad types to the 21M and the SiSys data.

4.1. Introduction to the 16 Triad Types

Figure 1 illustrates the 16 types of isomorphism classes of triads that can occur in directed networks (Davis & Leinhardt, 1972; Holland & Leinhardt, 1970). The 16 types of triads are classified within the five following models: Balance (B3 and B16), clustering (C1), hierarchies between clusters or ranked clusters (RC4, RC5, RC9, RC12 and RC13), transitivity (T2), hierarchies within clusters (HC14 and HC15), and so called forbidden triads (F6, F7, F8, F10 and F11). For instance, if triad types B3 or B16 predominate (i.e., they are more frequently present than expected by chance), we can say that a network tends to be balanced, whereas the predominance of RC4, RC5, etc. indicates a high degree of ranking or hierarchies between clusters in the network (the triad models are well described in the literature, e.g., Davis, 1979; De Nooy et al., 2005; Wasserman & Faust, 1994).

4.2. Empirical Findings On The 16 Triad Types

Figure A1 reports the TCDs for the 16 triad types for advice- and friendship networks in both populations. Values above (below) 1 represent a higher (lower) number of observed triads than expected by chance.

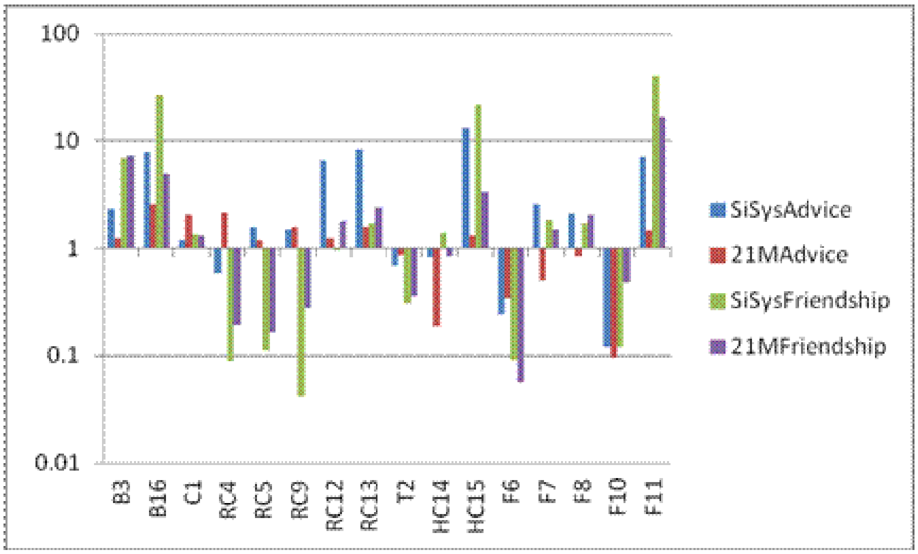

Figure A1: TCDs For Advice- And Friendship-Ties (Including B16 And F11)

We observe that there are fewer rankings between clusters for the friendship ties than for the advice ties for triad types RC4, RC5, and RC9. This is an expected finding, I argue, since advice related issues are often entailed with asymmetries in skills, experience, and tenure, etc., whereas friendship ties by their very nature are not task related. The findings are furthermore consistent with a relatively higher tendency of symmetric friendship ties than advice ties as observed for triad types B3, B16, and F11. Both RC12 and RC13 entail one symmetric relation, which may explain a less clear-cut distinction between advice- and friendship ties here.

Contrary to ranked triads, at the outset the tendency to form hierarchies within clusters seems to be smaller for advice ties than for friendship ties (HC14 and HC15), and HC15 is more prevalent than expected by chance in all the networks. I have argued that it makes sense to accept a relative tolerance for rankings between clusters for advice relationships, due to possible asymmetries in skills and knowledge. I argue that the same argument is also valid for a relatively high acceptance of hierarchies within clusters. But how can we then explain that our empirical data show the opposite? (It is matter of fact that the strong prevalence of triad type HC15 in previous research has represented a challenge in the literature (Davis, 1970, 1979; Holland & Leinhardt, 1972; Johnsen, 1985)). Granovetter (1985) distinguishes between the concepts of relational and structural embeddedness. If we now go beyond balance theoretical arguments and take another look at HC15, we observe that *c* is mutually connected with both *a* and *b* (Figure 1). In other words, the *a*-*c* and *b*-*c* dyads are relationally embedded. I therefore argue that HC15 is relatively relationally embedded (where the *a*-*b* dyad represents the only asymmetric relation). In other words, triad HC15 may not tell us so much about the formation of hierarchies within clusters, but it rather expresses the presence of relational embeddedness in social structures. HC15 may also indicate that, due to symmetric friendship ties between *a*-*c* and *c*-*b*, another friendship tie is being formed between *a* and *b*, which is not (yet) symmetric.

F6 and F10 are truly "forbidden", both theoretically and empirically, but we observe that F7 and F8 may tend to be slightly more prevalent than expected by chance, at least for the friendship relations. A possible explanation of these findings is that *a*-*c* is symmetric for both F7 and F8 (cf., previous arguing regarding the relatively high prevalence of symmetric friendship ties).

5. References

Aarstad, J., Haugland, S. A., & Greve, A. (2010). Performance spillover effects in entrepreneurial networks: Assessing a dyadic theory of social capital. *Entrepreneurship Theory and Practice, 34*(5), 1003-1020.

Aarstad, J., Selart, M., & Troye, S. V. (2011). Advice seeking networks and the learning oragnization. *Problems and Perspectives in Management, 9*(2), 63-70.

Ahuja, G. (2000). Collaboration networks, structural holes and innovation: A longitudinal study. *Administrative Science Quarterly, 45*(3), 425-455.

Batagelj, V., & Mrvar, A. (2001). A subquadratic triad census algorithm for large sparse networks with small maximum degree. *Social Networks, 23*, 237-243.

Bondonio, D. (1998). Predictors of accuracy in perceiving informal social networks. *Social Networks, 20*, 301-330.

Burt, R. S. (1992). *Structural Holes: The Social Structure of Competition*. Cambridge, MA: Harvard University Press.

Burt, R. S. (2004). Structural holes and good ideas. *American Journal of Sociology, 110*(2), 349-399.

Burt, R. S. (2005). *Brokerage and Closure : An Introduction to Social Capital*. New York: Oxford University Press.

Cohen, M. D., March, J. G., & Olsen, J. P. (1972). A garbage can model of organizational choice. *Administrative Science Quarterly, 17*(1), 1-25.

Coleman, J. S. (1988). Social capital in the creation of human capital. *American Journal of Sociology, 94*(Supplement: Organizations and Institutions: Sociological and Economic Approaches to the Analysis of Social Structure), S95-S120.

Davis, J. A. (1970). Clustering and hierarchy in interpersonal relations: Testing two theoretical models in 742 sociograms. *American Sociological Review, 35*, 843-852.

Davis, J. A. (1979). The Davis/Holland/Leinhardt studies: An overview. In P. W. Holland & S. Leinhardt (Eds.), *Perspectives on Social Network Research* (pp. 51-62). New York: Academic Press.

Davis, J. A., & Leinhardt, S. (1972). The structure of positive interpersonal relations in small groups. In J. Berger (Ed.), *Sociological Theories in Progress.* (Vol. 2, pp. 218-251). Boston: Houghton Mifflin.

De Nooy, W., Mrvar, A., & Batagelj, V. (2005). *Exploratory Social Network analysis with Pajek* (Vol. 27). New York, NY: Cambridge University Press.

Festinger, L. A. (1957). *Theory of Cognitive Dissonance*. Evanston, IL: Row, Peterson.

Granovetter, M. (1985). Economic action and social structure: The problem of embeddedness. *American Journal of Sociology, 91*(3), 481-510.

Greve, H. R. (2009). Bigger and safer: The diffusion of competitive advantage. *Strategic Management Journal, 30*(1), 1-23.

Hite, J. M., & Hesterly, W. S. (2001). The evolution of firm networks: From emergence to early growth of the firm. *Strategic Management Journal, 22*, 275-286.

Holland, P. W., & Leinhardt, S. (1970). A method for detecting structure in sociometric data. *American Journal of Sociology, 70*, 492-513.

Holland, P. W., & Leinhardt, S. (1972). Some evidence on the transitivity of positive interpersonal sentiment. *American Journal of Sociology, 72*, 1205-1209.

Ingram, P., & Roberts, P. W. (2000). Friendships among competitors in the Sydney hotel industry. *American Journal of Sociology, 106*(2), 387-423.

Johnsen, E. C. (1985). Network macrostructure models for the Davis-Leinhardt set of empirical sociomatrices. *Social Networks, 7*(3), 203-224.

Kilduff, M., Crossland, C., Tsai, W., & Krackhardt, D. (2008). Organizational network perceptions versus reality: A small world after all? *Organizational Behavior and Human Decision Processes, 107*(1), 15-28.

Kilduff, M., & Krackhardt, D. (1994). Bringing the individual back in: A structural-analysis of the internal market for reputation in organizations. *Academy of Management Journal, 37*(1), 87-108.

Krackhardt, D. (1987). Cognitive social structures. *Social Networks, 9*, 109-134.

Krackhardt, D. (1990). Assessing the political landscape: Structure, cognition, and power in organizations. *Administrative Science Quarterly, 35*, 342-369.

Krackhardt, D., & Kilduff, M. (1999). Whether close or far: Social distance effects on perceived balance in friendship networks. *Journal of Personality and Social Psychology, 76*(5), 770-782.

Lazer, D., & Friedman, A. (2007). The network strucrure of exploration and exploitation. *Administrative Science Quarterly, 52*, 667-694.

Moody, J. (1998). Matrix methods for calculating the triad census. *Social Networks, 20*, 291-299.

Rodan, S. (2010). Structural holes and managerial performance: Identifying the underlying mechanisms. *Social Networks, 32*(3), 168-179.

Rowley, T., Behrens, D., & Krackhardt, D. (2000). Redundant governance structures: An analysis of structural and relational embeddedness in the steel and semiconductor industries. *Strategic Management Journal, 21*(3), 369-386.

Schilling, M. A., & Phelps, C. C. (2007). Interfirm collaboration networks: The impact of large-scale network structure on firm innovation. *Management Science, 53*(7), 1113-1126.

Tortoriello, M., & Krackhardt, D. (2010). Activating cross-boundary knowledge: The role of Simmelian ties in the generation of innovations. *Academy of Management Journal, 53*(1), 167-181.

Uzzi, B., & Spiro, J. (2005). Collaboration and creativity: The small world problem. *American Journal of Sociology, 111*, 447-504.

Vissa, B., & Chacar, A. S. (2009). Leveraging ties: The congtingent value of entrepreneurial teams' external advice networks on Indian software venture performance. *Strategic Management Journal, 30*(11), 1179-1191.

Wasserman, S., & Faust, K. (1994). *Social Network Analysis: Methods and Applications* (Vol. 8). Cambridge, NY: Cambridge University Press.

Watts, D. J., & Strogatz, S. H. (1998). Collective dynamics of 'small-world' networks. *Nature, 394*(6684), 440-442.

Zaheer, A., & Soda, G. (2009). Network evolution: The origins of structural holes. *Administrative Science Quarterly, 54*(1), 1-31.

About the Author:

Jarle Aarstad (Dr. oecon.) is Associate Professor in organization studies at Bergen University College, Faculty of Engineering. His major research interests are social network theory, organizational behavior, and enterprise development. Dr. Aarstad has published in highly ranked journals such as Entrepreneurship Theory and Practice, PNAS – Proceedings of the National Academy of Sciences of the United States of America, International Journal of Epidemiology, and Annals of Tourism Research. The author would like to thank David Krackhardt for his permission to use the data.

Dr. Jarle Aarstad, Bergen University College, Faculty of Engineering, PO Box 7030, NO-5020 Bergen, Norway; Tel: +47 555 87926; E-mail: jarle.aarstad@hib.no

---