

ysis of noisy information networks: demo, SIGMOD, New York

- Moustafa WE, Namata G, Deshpande A, Getoor L (2011) Declarative Analysis of noisy information networks. In: ICDE GDM workshop, Hannover
- Mozafari B, Zeng K, Zaniolo C (2012) High-performance complex event processing over xml streams. In: SIGMOD, Scottsdale
- Muthukrishnan S (2005) Data streams: algorithms and applications. Now Publishers, Boston/Hanover
- Newman MEJ (2003) The structure and function of complex networks. *SIAM Rev* 45(2):167–256
- Pujol J, Erramilli V, Siganos G, Yang X, Laoutaris N, Chhabra P, Rodriguez P (2010) The little engine (s) that could: scaling online social networks. In: SIGCOMM, New Delhi
- Ramakrishnan R, Ullman JD (1995) A survey of deductive database systems. *J Log Program* 23(2):125–149
- Scott J (2012) Social network analysis. Sage, London
- Valle ED, Ceri S, Barbieri DF, Braga D, Campi A (2008) A first step towards stream reasoning. In: FIS, Vienna, pp 72–81
- Valle ED, Ceri S, van Harmelen F, Fensel D (2009) It's a streaming world! Reasoning upon rapidly changing information. *IEEE Intell Syst* 24(6):83–89
- Zhao P, Aggarwal CC, Wang M (2011) gSketch: on query estimation in graph streams. *VLDB* 5:193–204

Stress Model

- ▶ [Visualization of Large Networks](#)

Structural and Locational Properties

- ▶ [Path-Based and Whole-Network Measures](#)

Structural Attribute

- ▶ [Collective Classification, Structural Features](#)

Structural Autonomy

- ▶ [Structural Holes](#)

Structural Holes

Alona Labun¹ and Rafael Wittek²

¹Jeugdhuip Friesland, Leeuwarden, The Netherlands

²Theoretical Sociology – Department of Sociology, University of Groningen, Groningen, The Netherlands

Synonyms

[Brokerage](#); [Middlemen](#); [Network entrepreneurs](#); [Social capital](#); [Structural autonomy](#)

Glossary

Secondary Hole Gaps in the networks of a focal actor's primary contacts

Dyadic Constraint Degree to which a focal actor's primary contact can constrain exchange opportunities with third parties

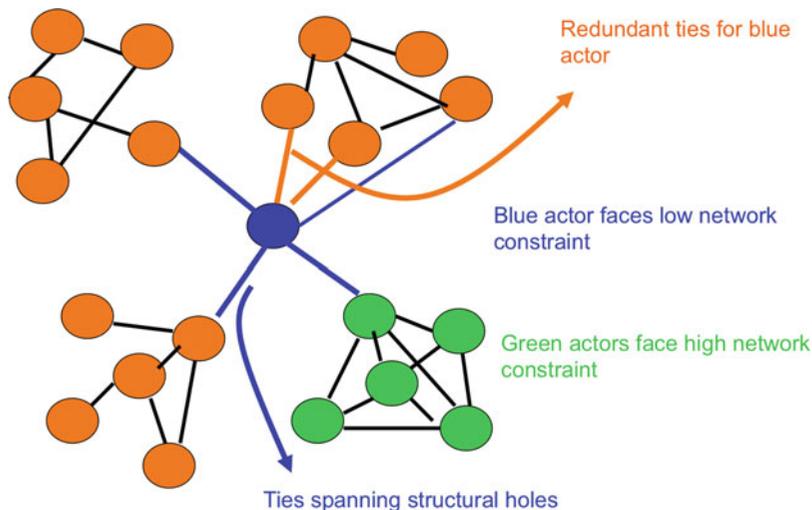
Aggregate Constraint The sum of dyadic constraints imposed on a focal actor by all his contacts

Redundant Tie A tie to a cluster of contacts to which a focal actor already has ties with other actors

Effective Size The number of non-redundant contacts in a focal actor's personal network

Definition

A structural hole refers to an “empty space” between contacts in a person's network. It means that these contacts do not interact closely (though they may be aware of one another). Actors on either side of the structural hole have access to different flows of information (see Fig. 1). Structural holes therefore reflect “an opportunity to *broker* the flow of *information* between people, and *control* the projects that bring together people from opposite sides of the hole” (Burt 2000).



Structural Holes, Fig. 1

Several measures are used to capture structural-hole networks.

Effective network size is an elementary building block in all structural-hole measures. It is composed of three elements: First, the *proportion* of an actor i 's time and energy invested in a relation with q :

$$p_{iq} = (z_{iq} + z_{qi}) / \left[\sum_j (z_{ij} + z_{ji}) \right], \quad (1)$$

$z_{iq}, z_{qi}, z_{ij}, z_{ji}$ represent time or energy actor i invests in q , i in j , and j in i , respectively.

Second, the *marginal strength* of j 's relation with q :

$$m_{jq} = (z_{jq} + z_{qj}) / \max(z_{jk} + z_{kj}) \quad j \neq k. \quad (2)$$

m_{jq} is the marginal strength of contact j 's relation with actor q . Z_{jq} is the network variable measuring the strength of the relation from j to q and $\max(z_{jq})$ is the largest of j 's relations with anyone (Burt 1992:51).

Third, the *redundant portion* (RP) of i 's network. The portion of i 's relation with j that is redundant to i 's relations with other primary contacts is defined as the following:

$$RP = \sum_q p_{iq} m_{jq}. \quad (3)$$

Effective size (ES) is obtained by aggregating across all of i 's primary contacts j :

$$ES = \sum_i \left[1 - \sum_q p_{iq} m_{jq} \right]. \quad (4)$$

The effective size of i 's network ranges from 1 (network provides one single contact) to N (all contacts are non-redundant), with N being the number of all contacts in i 's network. The *efficiency* of an actor's network is computed as the effective size divided by the number of actors in the network.

Dyadic constraint C_{ij} measures the degree to which an actor j imposes structural constraint on the focal actor i . Dyadic constraint is highest in a situation where the focal actor's network is inefficient (i.e., he or she invests time and energy in the relation to someone whose network lacks structural holes and is also tied to other contacts in the focal person's network). A low dyadic constraint originates from actors who do not have many ties to a focal person's contacts. Dyadic constraint is a function of effective size:

$$C_{ij} = \left(p_{ij} + \sum_q p_{iq} p_{qj} \right)^2. \quad (5)$$

C_{ij} = level of constraint that contact j poses on focal actor i ; p_{ij} , p_{iq} , p_{qj} see Eq. (1).

Aggregate constraint indicates the extent to which an actor is constrained by the structure of the network involving other members of his or her group. High constraint values indicate low autonomy: the actor has few structural holes, i.e., little entrepreneurial opportunities. Technically, aggregate constraint is the sum of all contact-specific dyadic constraints in an actor's network. This indicator is also the most frequently used one in structural-hole research.

Hierarchy (H) indicates the extent to which aggregate constraint on ego is concentrated in a single alter. If the total constraint on the person is concentrated in a single other actor, the hierarchy measure will have a higher value. If the constraint results more equally from multiple actors in a person's network, hierarchy will be less. The hierarchy measure, in itself, does not assess the degree of constraint. Independently of the constraint on a focal actor, it measures inequality in the distribution of constraints on a focal person across the other actors in its neighborhood.

$$H = \left(\frac{C_{ij}}{C/N} \right). \quad (6)$$

C_{ij} = level of constraint that j poses on i ; C = sum of constraint (from an actor's network) across all N relationships of an actor; N = number of contacts in the actor's network; C/N = mean level of constraint per contact; and the ratio is 1 for contact j posing an average level of constraint.

Oligopoly Primary structural holes were defined as the aggregate of all dyadic constraint on a focal actor. Contact j 's constraint on a focal actor i was defined as the product of two terms (Burt 1992:62): (1) the network time and energy i invested to reach j multiplied by (2) the lack of structural holes around j . The second term, in

turn, is the product of two conditions: (a) the lack of primary structural holes between the contact j and others in the player's network and (b) the lack of secondary structural holes between the contact and others outside the network who could replace the contact. Burt refers to this second term as the *oligopoly*: "a measure of the organization of players within the cluster around contact j such that it would be difficult to replace j , or threaten him with being replaced, by some other player in the cluster" (Burt 1992:62).

Hole signatures of a focal actor's network describe "the distribution of opportunity and constraint across the individual relationships in a player's network" (Burt 1992:62). Hole signatures can be graphically represented, with the time and energy devoted by a focal actor i to a specific alter j (p_{ij}) delimiting the upper boundary and the dyadic constraint (c_{ij}) defining the lower boundary. Hole signatures allow to assess structural features of a focal actor's network (clique, center-periphery, leader hierarchy, and leaderless hierarchy).

Hole depth The depth of a structural hole reflects "the ease with which it can be developed for control and information benefits" (Burt 1992:42–44). The depth of a hole between two actors is a function of both the degree of cohesion between two players and the degree of structural equivalence of their ties to others: in the ideal-typical structural hole, both actors are neither connected nor do they have equivalent relations to others. A deep structural hole characterizes two unrelated actors with equivalent ties to third parties: they are "competitors in the same market." In a shallow structural hole, two actors have a tie, but do not share equivalent relations to third parties.

Historical Background

Structural-hole theory and the related measures can be seen as the confluence of three streams of work. First, during the late 1960s and early 1970s, Harrison White and his group (now often referred to as the Harvard School),

formalized ideas focusing on the absence of ties between individuals (“gaps”). This resulted in the development of *blockmodeling* algorithms, which grouped structurally equivalent nodes into blocks, and identified “zero blocks” – nodes that did not share similar relations with third parties. These “zero blocks” have qualities similar to structural holes.

Second, the article “*The Strength of Weak Ties*” by one of White’s graduate students (Granovetter 1973) produced the counterintuitive empirical finding that in some situations – like job search, the topic of Granovetter’s study – individuals benefit more from weak ties (like acquaintances) rather than strong ties (like friends or relatives), because one’s weak ties can provide access to circles of information we usually are not familiar with. The “strength” of an interpersonal tie is a linear combination of the amount of time, the emotional intensity, the intimacy (or mutual confiding), and the reciprocal services which characterize each tie. Strong ties represent closer friendship and greater frequency of interaction, whereas weak ties correspond to acquaintances (Granovetter 1973). Members of closely knit groups connected through strong ties tend to be exposed to similar sources of information. Truly novel, valuable information is often likely to come from more distant acquaintances who may serve as a conduit to hard-to-reach parts of the network. A key proposition in Granovetter’s argument is that “all bridges are weak ties,” which rules out that strong ties can be bridges (also known as the “forbidden triad” assumption). However, Burt (1992:27) argues that the main source of benefits in a network is not the weakness of the tie, but the hole it spans. From this perspective, the focus on the weakness or strength of a tie even obscures the importance of control benefits. “Bridge strength is an aside in the structural hole argument, since information benefits are expected to travel over all bridges. Benefits vary between redundant and non-redundant ties” (Burt 1992:30).

But Granovetter’s article by now is among the most frequently cited papers in the social sciences. In addition to stimulating much sub-

stantive research, e.g., on job search, it also sparked the interest for social network indicators reflecting an individual’s *centrality* in the network (Freeman 1979). *Degree* centrality captures communication *activity* and has been defined by the number of ties an actor has with others in the network or the number of others who choose a focal actor. *Betweenness* centrality reflects the potential for *control* of communication and has been defined as the extent to which an actor has control over other actors’ access to various regions of the network. *Closeness* centrality captures either *independence* or *efficiency* and has been conceptualized as an actor’s ability to access independently all other members of the network. *Eigenvector centrality* (Bonacich 1987:1172) measures centrality as the summed connection to others, weighted by their centralities. This measure allows to distinguish situations in which being connected to others with many contacts (powerful others) is advantageous for a focal actor (as is the case in communication networks), from situations in which being connected to powerful others is a liability (as is the case in bargaining situations). These centrality measures only partly capture the essence of structural holes, mainly because they are less sensitive to the gaps in the networks of a focal actor’s primary contacts.

Third, Burt was among the first who did a serious effort to ground structuralist reasoning on a behavioral micro-foundation. Many of the ideas presented in his 1992 book on structural holes – including the core argument on structural autonomy – had actually been elaborated in detail about a decade earlier in his *Toward a Structural Theory of Action. Network Models of Social Structure, Perception and Action* (Burt 1982). Here, he exposes the rational choice framework underlying structural-hole theory. A key assumption is that individuals are purposeful actors, who strive for improving their well-being by evaluating the costs and benefits of different action alternatives, taking into consideration structural constraints. Individuals in similar network positions face similar constraints. As a result, the network is simultaneously an indicator

of entrepreneurial opportunity and of motivation (Burt 1992:35).

By combining an innovative structural approach with a theory of action, Burt's structural-hole framework significantly advanced previous network research, which clearly lacked a behavioral micro-foundation.

Structural-Hole Theory

In social networks, access to advantageous structural positions is not equally distributed across all actors: some group members may be positioned at the interface between multiple groups with access to boundary-spanning links, while others are positioned in the middle of a single tightly knit group. Structural holes offer two main benefits.

Information benefits come in three forms: access, timing, and referrals. A network rich in structural holes provides one with *access* to non-redundant sources of information originating in multiple, noninteracting parts of the network. It also increases the likelihood of receiving information earlier than individuals in less advantageous network positions (*timing*) and that others talk positively about the focal actor in their own networks (*referrals*).

Control benefits of structural holes result from the opportunity to either play two unrelated parties out against each other (*tertius gaudens*) or to bring them together (*tertius iungens*). In both cases, the third party can reap benefits.

Structural-hole theory further assumes actors to strategically and proactively creating and manufacturing their social network. This means that actors will actively develop the information and control benefits of existing structural holes and manage the constraint of absent structural holes (Burt 1992:230). They have three strategies to achieve this: they can *withdraw* from a contact, they can *expand* their network by adding a contact's competitor to their network, or they can "leave the constraint-generating network in place but to manage the offending constraint by *embedding* it in a second relationship over which you have more control" (Burt 1992:233).

Key Applications

Structural-hole theory has stimulated considerable empirical research on networks, mostly in and between organizations, as well as on entrepreneurship. It was used to explain a wide range of outcomes at the level of individuals and organizations.

Performance With information being a critical resource in organizational settings (McCall 1979; Mechanic 1962; Pettigrew 1972; Pfeffer 1981), individuals rich in structural holes have a better opportunity to manipulate information for their purpose. According to a meta-analysis (Balkundi et al. 2009), and a recent review (Brass 2011), spanning structural holes increased performance or innovation for the focal actor (Ahuja 2000; Burt 1992, 2004; Mehra et al. 2001; Seibert et al. 2001). Disconnected networks help brokers realize value by offering them the opportunity to transfer ideas from one isolated group to another, a process that involves recognizing when solutions current in one part of the network are likely to have applications elsewhere in the network (Hargadon and Sutton 1997).

Promotions Knowing whom to consult for information and aid becomes of crucial importance at times of competition for career opportunities within organizations. In his work "*Structural Holes*" (1992), Burt has systematically explored the network effects on career advancement within the firm. According to his analysis, a configuration of network ties that creates opportunities for brokering and entrepreneurialism (i.e., a network full of structural holes) enhances career opportunities for actors competing for promotions within organizations (Burt 1992, 2005). The findings of another study on social networks and mobility at the workplace further substantiated Burt's claims that the network structures most conducive to maximizing access to information, resources, and brokerage opportunities (i.e., large, sparse networks) are a meaningful determinant of intra-organizational advancement (Podolny and Baron 1997).

Creativity A network "rich in structural holes" has also been found to facilitate the development of novel valuable ideas by increasing the actor's

ability to merge the distinct sources of information in new ways, thus boosting individual creativity. The empirical findings suggest that between-group brokers are more likely to have a vision advantage, express ideas evaluated as valuable, and are less likely to have ideas dismissed (Burt 2004). Moreover, brokerage appears to provide the opportunity for social “gatekeeping” – regulating the access of others to the tightly knit group one belongs to, while at the same time controlling the ways in which one’s own group members learn about information coming from other groups (Burt 2004).

Power Occupying a strong or weak structural position in the network has recently been found to affect the inferences organizational actors draw about one another (Labun 2012). In particular, the empirical evidence suggests that the more an individual is constrained by the structure of his network, the more likely he is to attribute power to others. Embeddedness in networks “poor in structural holes” implies a condition of dependence and limited autonomy (Burt 1992), potentially triggering feelings of helplessness and apprehension, and thereby contributing to increased number of power attributions to other group members (Labun 2012).

Trust and gossip Trustworthy and confidential collegial environment may be advantageous when establishing informal cooperation and forming alliances against powerful third parties. According to Burt’s study on trust and gossip in social networks (2001), gossip can act as a strategic tool in this process, allowing the group members to control their fellow members’ actions and to weaken the reputation of competitors. The manipulation of information flow to one’s own advantage becomes easier when employees occupy brokerage positions in the organizational network – connect to colleagues who are not connected with one another. The more trust exists in an employee network, the further negative gossip echoes, so that single incidents of negative gossip can have far-reaching impacts (Burt 2001). Thus, people may ensure norms of cooperation and punish the uncooperative actors (i.e., the untrustworthy group members) through gossiping – by spreading reputation-harming

information about them in the broader informal network (Burt 2005).

The gender contingency effects The synthesis of the informal social network theories with research related to career advancement of women has generated interesting insights. Burt (1998) argued that women often lack sufficient legitimacy in their organizations and therefore need to “borrow” social capital (i.e., structural holes) from a strategic partner (sponsor) in order to get promoted. Whereas senior male managers indeed benefit more from a personal network rich in structural holes, women (as well as junior and non-White managers) fare better with a hierarchical network, in which a tie to an influential “sponsor” provides access to this person’s entrepreneurial network (Burt 1998).

The hierarchy contingency effects Actor’s position in an organizational hierarchy may serve as one of the conditions under which either structural-hole networks or cohesive networks are likely to provide the focal actor with advantages. Burt (1997) showed that the benefits of structural holes flow mainly to members of senior management. Other research has shown that the benefits of cohesion flow mainly to people occupying lower hierarchical levels in organizations, for whom issues of organizational identity and belonging remain salient for potential career advancement (Podolny and Baron 1997).

The cultural contingency effects Another contingent factor that has been found to moderate the effect of structural holes includes the specific cultural and organizational context in which the mechanisms of social capital operate. In stark contrast to the results of studies using Western samples, the empirical findings of Xiao and Tsui (2007) show that in a collectivistic Chinese culture, structural holes in an employee’s career network tend to be detrimental to the employee’s career development. Moreover, it has been suggested that the network consequences of social capital may differ across organizations: whereas in a market-like, low commitment organizational culture, structural holes bring positive returns to individual actors, it is network closure that appears to bring advantages to the actors by

facilitating trust, reciprocity, and reputation in a clan-like, cohesive, high-commitment organization with a strong cooperative culture (Lazega 2001; Xiao and Tsui 2007).

Future Directions

The existing work utilizing the insights from Burt's structural-hole theory has recently been extended in a number of interesting directions, namely, explicit inclusion of actor characteristics, agency, and cognitions, as well as increasing use of longitudinal (dynamic) research designs. Drawing inspiration from the leading ideas of social network research, new theory and innovative hypotheses are being proposed, providing additional valuable insights.

Actor characteristics Researchers have increasingly started to incorporate personality variables in their study designs (e.g., self-monitoring) as potential predictors of variance in network outcomes (Kilduff and Krackhardt 2008; Mehra et al. 2001). People with different self-monitoring orientations have been suggested to occupy different structural positions. High self-monitors, relative to low self-monitors, tend to ingratiate themselves into distinctly different social circles of acquaintances with few links between these clusters and thereby occupy structural holes. Burt's (2005:34) "structural entrepreneur personality index" quantifies the individual inclination to exploit social resources. Structural entrepreneurs recognize the opportunities offered by structurally advantageous positions and place themselves in the "hole" by initiating ties with actors from opposite sides of the hole who can subsequently be played off against each other. This recent work challenges the ideological refusal of the traditional social network research to acknowledge ways in which individual actors differ in their attributes and actively explore the possibility of complementary synergies between actors and network structure (Kilduff and Brass 2010). Future research on personality and social networks is likely to be generative of compelling insights on the link between individual attributes and structural outcomes.

Agency Social network research also moves forward by explicitly assuming that actors differ in their abilities, skills, and motivation to take advantage of advantageous network positions. The earlier research has shown that some individuals can choose not to reap the profits derived from their network (Burt 1992). Drawing on these earlier findings, the more recent studies suggest that the more strategically skilled group members enjoy greater access to network resources and appear to be more competent at utilizing and leveraging these resources to advance their career and performance (Ferris et al. 2007; Labun 2012; Wei et al. 2012). This work uncovers the comprehensive role that individual strategic skills may play in the process of network resource building. Following this line of analysis, the incorporation of additional types of personal or social influence skills that may affect network resource development would be an interesting and fruitful avenue for future research. Moreover, future work might consider more closely the question of how much control actors have over the networks that constrain and enable their behaviors (Kilduff and Brass 2010).

Cognition Another research area drawing from the core concepts of social network program puts a special emphasis on subjective meanings (i.e., cognitions) inherent in networks rather than on "concrete" relations such as exchanges between actors (Kilduff and Brass 2010). The cognitive social network research line has led to the conceptualization of networks as "prisms" through which others' reputations and potentials are perceived, as well as "pipes" through which resources flow (Podolny 2001). Perceived status of one's exchange partners may indeed act as a distorting prism filtering attributions concerning the focal individual (Labun 2012): having a trust relationship with a superior had a significant positive effect on other's perceptions of one's power. The role of cognitions inherent in networks was further accentuated in a study demonstrating that individuals tend to bias perceptions to highlight small world features of clustering and connectivity (Kilduff et al. 2008): across four different organizational friendship networks, people have been found to perceive more "small worldedness"

than was actually the case, including the perception of more network clustering than actually existed and the attribution of more popularity and brokerage to the perceived popular than to the actually popular.

Network dynamics Finally, longitudinal research designs that allow considering and effectively addressing the dynamic nature of networks is likely to drive the social network research program forward. The very recent analytical developments (Snijders et al. 2010) allow unraveling and tackling the intriguing novel phenomena concerning interpersonal network change, coevolution of networks, and individual behavior (e.g., friendship, music preferences, and alcohol consumption (Steglich et al. 2006); friendship and smoking behavior (Mercken et al. 2010)), as well as different types of networks (e.g., friendship and gossip (Ellwardt et al. 2012); friendship and power (Labun 2012)). For example, the friendship and power study showed that power perceptions breed friendship (Labun 2012). Through a power attribution to a colleague, an individual may signal his or her trust in the colleague's competence, thereby triggering a friendship nomination from/facilitating friendship with him or her. The multiplex effect showed up also when analyzing the conditions that influence the formation of social ties (i.e., friendship) to the high-power organizational actors. However, in this case, the relationship between two networks appeared to depend on individual's strategic orientations (Labun 2012). This emergent research contributes to a better understanding of the coevolution of multiplex networks as well as networks and individual behavior, thereby allowing us to fully grasp the antecedents, dynamics, and consequences of the "informal organization."

Using a game theoretic model of network formation, Buskens and Van de Rijt (2008) confirm Burt's own speculation that when the monopoly on structural entrepreneurship is lifted, structural advantages most likely disappear (Burt 2005): when everyone strives for structural holes, no one will be able to maintain a structural advantage in the long run (Buskens and Van de Rijt 2008).

It would be interesting to perform further empirical studies in different types of organizational settings to help elucidate the dynamics of structural holes. The ongoing methodological advancements and the theoretical insights gained from the above-mentioned recent work are certainly beneficial for the future development and possible extension of existing structural-hole research.

Cross-References

- ▶ [Actor-Based Models for Longitudinal Networks](#)
- ▶ [Centrality Measures](#)
- ▶ [Exchange Networks](#)
- ▶ [Exponential Random Graph Models](#)
- ▶ [Futures of Social Networks: Where Are Trends Heading?](#)
- ▶ [Game Theory and Social Networks](#)
- ▶ [Personal Networks: The Intertwining of Ties, Internet and Geography](#)
- ▶ [Social Capital](#)
- ▶ [Social Influence Analysis](#)
- ▶ [Trust in Social Networks](#)

References

- Ahuja G (2000) Collaboration networks, structural holes, and innovation: a longitudinal study. *Adm Sci Q* 45:425–455
- Balkundi P, Wang L, Harrison DA (2009) Bridging the gap: consequences of structural hole spanning at multiple levels. Working paper, SUNY, Buffalo
- Bonacich P (1987) Power and centrality: a family of measures. *Am J Sociol* 92:1170–1182
- Brass DJ (2011) A social network perspective on organizational psychology. In: Kozlowski SWJ (ed) *The oxford handbook of organizational psychology*. Oxford University Press, New York
- Burt RS (1982) *Toward a structural theory of action*. Academic, New York
- Burt RS (1992) *Structural holes: the social structure of competition*. Harvard University Press, Cambridge
- Burt RS (1997) The contingent value of social capital. *Adm Sci Q* 42:339–365
- Burt RS (1998) The gender of social capital. *Ration Soc* 10:5–46
- Burt RS (2000) The network structure of social capital. *Res Organ Behav* 22:345–423

- Burt RS (2001) Bandwidth and echo: trust, information, and gossip in social networks. In: Casella A, Rauch JE (eds) *Networks and markets: contributions from economics and sociology*. Russell Sage, New York, pp 30–74
- Burt RS (2004) Structural holes and good ideas. *Am J Sociol* 110:349–399
- Burt RS (2005) *Brokerage and closure: an introduction to social capital*. Oxford University Press, Oxford
- Ferris GR, Treadway DC, Perrewe PL, Brouer RL, Douglas C, Lux S (2007) Political skill in organizations. *J Manage* 33:290–320
- Freeman LC (1979) Centrality in social networks: conceptual clarification. *Soc Netw* 1:215–239
- Granovetter M (1973) The strength of weak ties. *Am J Sociol* 6:1360–1380
- Hargadon AB, Sutton RI (1997) Technology brokering and innovation in a product development firm. *Adm Sci Q* 42:716–749
- Kilduff M, Brass DJ (2010) Organizational social network research: core ideas and key debates. *Acad Manage Ann* 4:317–357
- Kilduff M, Krackhardt D (2008) *Interpersonal networks in organizations*. Cambridge University Press, Cambridge
- Labun A (2012) *Social networks and informal power in organizations*. ICS Dissertation series, Groningen, p 194
- Lazega E (2001) *The collegial phenomenon: the social mechanisms of cooperation among peers in a corporate law partnership*. Oxford University Press, Oxford
- McCall MW (1979) Power, authority, and influence. In: Kerr S (ed) *Organizational behavior*. Grid, Columbus, pp 185–206
- Mechanic D (1962) Sources of power of lower participants in complex organizations. *Adm Sci Q* 7: 349–364
- Mehra A, Kilduff M, Brass DJ (2001) The social networks of high and low self-monitors: implications for workplace performance. *Adm Sci Q* 46:121–146
- Pettigrew AM (1972) Informational control as a power resource. *Sociology* 6:187–204
- Pfeffer J (1981) *Power in organizations*. Pitman, Marshfield
- Podolny JM (2001) Networks as the pipes and prisms of the market. *Am J Sociol* 107:33–60
- Podolny JM, Baron JN (1997) Resources and relationships: social networks and mobility in the workplace. *Am Sociol Rev* 62:673–693
- Seibert SE, Kraimer ML, Liden RC (2001) A social capital theory of career success. *Acad Manage J* 44: 219–237
- Wei L, Chiang FFT, Wu L (2012) Developing and utilizing network resources: roles of political skill. *J Manage Stud* 49:381–402
- Xiao Z, Tsui AS (2007) When brokers may not work: the cultural contingency of social capital in Chinese high-tech firms. *Adm Sci Q* 52:1–31

Recommended Reading

- Buskens V, Van de Rijdt A (2008) Dynamics of networks if everyone strives for structural holes. *Am J Sociol* 114:371–407
- Ellwardt L, Steglich CEG, Wittek R (2012) The co-evolution of friendship and gossip in workplace social networks. *Soc Netw* 34:623–633
- Kilduff M, Crossland C, Tsai W, Krackhardt D (2008) Network perceptions versus reality: a small world after all? *Organ Behav Hum Decis Process* 107:15–28
- Mercken L, Snijders TAB, Steglich CEG, Vartiainen E, de Vries H (2010) Dynamics of adolescent friendship networks and smoking behavior. *Soc Netw* 32:72–81
- Snijders TAB, Van de Bunt GG, Steglich CEG (2010) Introduction to stochastic actor-based models for network dynamics. *Soc Netw* 32:44–60
- Steglich CEG, Snijders TAB, West P (2006) Applying SIENA: an illustrative analysis of the co-evolution of adolescent's friendship networks, taste in music, and alcohol consumption. *Methodology* 2:48–56

Structural Measure, Link Mining Metric

- ▶ [Role Discovery](#)

Structural Roles

- ▶ [Querying Volatile and Dynamic Networks](#)

Structuralism

- ▶ [Network Analysis in French Sociology and Anthropology](#)

Subgraph Count

- ▶ [Motif Analysis](#)