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MONETIZING SOCIAL TIES: A QUASI-EXPERIMENT ON THE EFFECTS OF INCENTIVES ON INFORMAL KNOWLEDGE SHARING

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Abstract: Social networks have been shown to play an important role for knowledge sharing—a key driver of organizational success and a source of competitive advantage—by facilitating information flows among individuals. Despite their importance, however, relatively little is known as to whether organizations can directly influence informal networks among employees. In this paper, building on social network theories as well as previous findings regarding the motivational effects of incentives, we explore the extent to which direct interventions in the form of (performance-contingent) monetary incentives may affect employees' position in the informal network. In particular, leveraging longitudinal network data from employees working for a multinational organization, we design and implement a quasi-experiment based on a managerial intervention that incentivizes some employees to increase their prominence as knowledge providers within the informal network. We find that monetary incentives are associated with increases in employees' network prominence, and that variations in individuals' networking behavior mediate the link between managerial incentives and network prominence. Our study suggests that although organizations may be effective at directly shaping informal networks, they may also fundamentally change the processes through which people informally connect with one another.

MONETIZING SOCIAL TIES: A QUASI-EXPERIMENT ON THE EFFECTS OF MONETARY INCENTIVES ON INFORMAL KNOWLEDGE SHARING

Knowledge sharing—defined as the process through which one individual is affected by the experience of another—is a key mechanism for organizational success and a source of competitive advantage (Zander and Kogut, 1995; Argote and Ingram, 2000). Because a significant amount of the knowledge that organizations possess is embedded within its individual members, interactions among employees represent a key mechanism for disseminating information and expertise (Borgatti and Cross, 2003). Despite the pivotal role of knowledge sharing in the success of organizations, scholars have documented the existence of multiple factors that can impede it, such as geographical distance, organizational subcultures, and differences in professional backgrounds (Katz and Allen, 1982; Hansen, 1999; Tortoriello, Reagans, and McEvily, 2012; Szulanski and Lee, 2018). Thus, a central issue for managers is understanding ways in which knowledge sharing can be encouraged, in the face of interpersonal and organizational barriers that challenge it.

Research on reward systems provides valuable insights to understand the processes that might encourage knowledge sharing within organizations. For example, monetary incentives can encourage knowledge sharing through formal interactions, such as contributions during work meetings (Bartol and Srivastava, 2002) and contributions to centralized organizational knowledge repositories (Constant, Sproull, and Kiesler, 1996; Garud and Kumaraswamy, 2005). Although helpful in improving scholarly understanding of the relationship between incentives and knowledge sharing, this stream of research only provides a partial account of the phenomenon. Knowledge sharing is not bound only to formal organizational mechanisms, as informal interactions also play a paramount role in shaping the way in which knowledge

spreads among people (Krackhardt and Hanson, 1993; Hansen, 1999; Gulati and Puranam, 2009; McEvily, Soda, and Tortoriello, 2014; He et al., 2020). Indeed, a long research tradition on organizational networks has shown that social ties are influential for innovation (Reagans and McEvily, 2003; Burt, 2004), creativity (Perry-Smith, 2006), and the diffusion of best practices (Hansen, 1999). Acknowledging the importance of such ties, past research has focused on understanding the social mechanisms underlying tie formation, but it has overlooked the role that formal incentives may have in shaping knowledge sharing via informal ties. Indeed, it is unclear, for instance, whether reward systems can alter motivations to share knowledge and thus can lead to unintended consequences for informal, discretionary relationships (Gneezy and Rustichini, 2000; Bandiera, Barankay, and Rasul, 2009).

A key element underpinning informal knowledge sharing is the motivation of individuals to connect with and provide knowledge to others (Reagans and McEvily, 2003; Reinholt, Pedersen, and Foss, 2011). Past research shows that central connectors—those who are the go-to person for most of their colleagues—play a central role for organizations because they increase the spread of knowledge (Cross and Prusak, 2002). In addition, providing knowledge to others has been shown to be important not only for the receiver, but also for the giver (Krackhardt and Porter, 1985; Ibarra, 1992; Ibarra and Andrews, 1993). By informally sharing knowledge with other organizational members, individuals engage in conversations in which they are likely to explore problem domains, learn about others' expertise or experiences, and build relationships that they can leverage in the future (Brown and Duguid, 1993).

Given that a critical factor for organizational success rests on employees sharing their knowledge through informal ties, can managers use monetary incentives to directly increase the size of their employees' knowledge provision networks? To answer this research question,

we conducted a field quasi-experiment based on longitudinal network data capturing knowledge-sharing informal interactions among 332 employees working for a multinational organization. This research design allowed us to investigate changes in employees' knowledge provision networks following a managerial intervention that altered the variable pay structure of 60 employees, incentivizing them to become key informal providers of knowledge. That is, under this new incentive system, some employees were financially rewarded based on a networking performance indicator—being sought by others for knowledge support—which was not directly under their control. In particular, we refer to this construct as network prominence, which captures the extent to which an employee is sought for advice by many others (Kilduff and Krackhardt, 1994). Additionally, we refer to monetary incentives to indicate pay for performance rewards linked to changes in employees' prominence in the informal knowledge network.

Rewarding employees contingent on others seeking knowledge from them poses a challenge, since those being incentivized have limited control over who comes to them for knowledge. As such, these employees faced a system of "broad incentives" because their rewards were at least partially dependent on others' decisions and actions to establish informal knowledge ties with them (Puranam, Raveendran, and Knudsen, 2012). Drawing on research on incentives and social networks, we develop predictions about the effects of monetary incentives on individual network prominence as well as the mechanisms through which incentivized employees may enact their social networks to achieve their objective. Specifically, we argue that incentivized employees should react positively to incentives by creating more knowledge ties with others, with the anticipation of tie reciprocation. Moreover, given the well-established assumption that creating and maintaining ties is costly (Hill and Dunbar,

2003), we contend that incentivized individuals will attempt to maximize the probability of reciprocal knowledge ties by targeting "familiar" others—such as individuals with whom they another type of social tie (e.g., friendship), individuals with whom they share a common third party, individuals with whom they are similar, and individuals who are more physically proximate. We speculate that incentivized individuals select such contacts in anticipation that the contacts are more likely reciprocate relative to "unfamiliar" others. Thus, central to our theory is that lay theories regarding reciprocity influence the formation of knowledge-sharing ties. In line with this contention, we find that incentivized employees increase their prominence in the knowledge provision network and that variance in incentivized employees' network positions can be linked to changes in their networking behavior.

Investigating through a field quasi-experiment whether and how monetary incentives—in the form of variable compensation—influence individuals' prominence in the knowledge network, this paper makes four main contributions. First, it advances research on intraorganizational knowledge sharing by demonstrating the conditions under which organizational members may be more willing to create knowledge-based ties with one another (Borgatti and Cross, 2003; Reagans and McEvily, 2003). Second, it adds to growing research in organization theory and design on the relationship between formal organization and informal social structures, showing the effect that formal features—such as monetary incentives—may have on emergent informal structures (McEvily, Soda, and Tortoriello, 2014; Clement and Puranam, 2018; Yakubovich and Burg, 2019). Third, this paper joins the growing literature in social network research that investigates the role of strategic interventions aimed at shaping informal patterns of interactions (Valente, 2012; Banerjee et al., 2018; Hasan and Koning, 2020). Finally, our theory and results contribute to research on the potentially unintended

consequences of incentive designs (Kerr, 1975; Larkin, Pierce, and Gino, 2012; Gubler, Larkin, and Pierce, 2016; Dahl and Pierce, 2020), showing that while the incentive system was designed to expand and diversify organizational members' networks, it actually led to exploitation of pre-existing social structures.

THEORY AND HYPOTHESES

Organizational Efforts to Shape Informal Networks

Organizational research has recognized that informal patterns of interactions among employees are a key mechanism underlying knowledge sharing, and thus represent a source of competitive advantage that is difficult to observe and replicate (Argote and Ingram, 2000). Unfortunately, as aptly pointed out by Krackhardt and Stern (1988: 123) an effective social structure "does not occur naturally, but must be designed consciously and carefully." To facilitate knowledge flows through informal channels and increase employees' network prominence, organizations commonly try to orchestrate emerging interactions through indirect, formal interventions aimed at facilitating tie formation. That is, insofar as organizations have attempted to shape informal ties, they have focused on designing interventions that could indirectly alter the probability of two individuals to connect, such as relocating branches or implementing open space offices. For example, studying employees working for an e-commerce company, Lee (2019) suggests that reconfiguration in the spatial proximity among employees determines increased informal interactions that is conducive to more exploration. In a similar vein, van den Bulte and Moenaert (1998) found that communication flows among R&D teams that were previously separated enhanced after their co-location in a new facility. More recently, studying entrepreneurs in India, Hasan and Koning (2020) designed a field experiment to investigate the effect of joint tasks on social networks. They found that formally assigning

individuals to product development teams significantly affected the formation of informal interactions, such as friendship and advice.

Much of the above-mentioned literature portrays organizational interventions to modify social networks as an indirect process, in which informal ties are shaped incidentally. While we agree that research on indirect interventions has greatly increased our understanding of interpersonal dynamics, it is valuable to investigate whether organizations can shape informal knowledge sharing among employees through more direct interventions, such as pay for performance incentives linked to social networks.

Monetary Incentives and Network Prominence

Throughout the literature on informal networks within organization, scholars have found that variation in individuals' network centrality correspond to different status, power, and resource benefits.[1] For example, employees who bridge disconnected groups within organizations are more likely to be promoted, have better ideas, and receive higher compensation (Burt, 2004). In line with earlier research (Brass, 1984), Krackhardt's (1990) study of a small entrepreneurial firm demonstrated that employees' power corresponds with their network centrality. Individual network positions have also been found to reflect status, where centrality is indicative of rank in a status hierarchy (Podolny, 2001). The underlying assumption of the majority of this research is that knowledge exchanges—facilitated by social network connections—can provide resource advantages and opportunities for individuals within an organizational context (Rodan and Galunic, 2004).

[1] Network centrality represents a family of measures that can capture different features of an individual centrality in a network. For example, power is usually measured with Bonancich's centrality (Bonacich, 1987), while bridging across groups is usually captured with betweenness centrality (Freeman, 1976).

Following these findings, research has sought to determine how individuals come to occupy such beneficial networks positions. The quest for understanding the antecedents of network positions has fueled a long-lasting debate between two schools of thought: one that emphasizes individual agency, and another that emphasizes structural determinism (Emirbayer and Goodwin, 1994; Casciaro, Gino, and Kouchaki, 2014). Individual agency—the idea that individuals play an active role in determining their networks by purposefully creating ties—has focused primarily on individual differences to explore ways in which social actors can enact their social networks (Klein et al., 2004; Oh and Kilduff, 2008; Sasovova et al., 2010). And although there has been some evidence that suggests that teaching organizational members network concepts, such as brokerage, can improve their individual performance (Burt and Ronchi, 2007), it is not altogether apparent how individuals might change their network positions and increase their prominence provided that it is not solely determined by them. Indeed, structural determinism—the idea that constraints and opportunities created by the social structure itself leave little room for individual choice in enacting ties—argues that networks fundamentally limit the capacity of any one individual to solely determine her position in that network. Moreover, tie formation is an agentic behavior that requires the convergence of two parties (Clement and Puranam, 2018).

Nevertheless, certain behavioral consistencies that are prevalent within networks suggest that individual may influence the creation of relationship, which may in turn affect their network prominence (Monge and Contractor, 2001; Dahlander and McFarland, 2013). The notion that individuals may have an active role in determining their social structures is further corroborated by recent research, which has shown how some social networks configurations—such as brokerage—can be better understood as a process, rather than a static phenomenon, in which

individuals strategically create and drop ties to achieve their goal (Obstfeld, 2005; Lingo and O'Mahony, 2010; Obstfeld, Borgatti, and Davis, 2014). In a similar vein, Buskens and Van de Rijt's (2008) game theory study of network dynamics shows that focal actors enact their social structures by occupying specific network positions to optimize their underlying payoff structure.

This line of research shows that what matters with respect to an individual willingness and ability to exert agency is her motivation to do so. In organizational settings, such a motivation to shape structures rests on the fact that employees are rewarded based on the outcomes, or secondary outcomes, stemming from their network prominence (e.g., good ideas, creativity, etc.) rather than their network prominence directly. An important assumption in this line of reasoning is that there is no causal ambiguity in the path between network prominence and positive outcomes. Simply, employees are assumed to have perfect knowledge about which network position will be more conducive to their success, and then in turn, shape their networks accordingly. However, a more realistic assumption is that causal attribution biases may limit an individual's ability to determine causal paths between network prominence and their relative outcomes. Introducing monetary incentives for occupying specific network positions could decrease causal ambiguity, thus increasing employees' motivation to become prominent. Thus, we contend that rewarding employees based on their network prominence increases their overall motivation to achieve this particular position.

Hypothesis 1: Incentivized individuals will increase their network prominence to a greater extent than non-incentivized individuals.

Networking Mechanisms Linking Monetary Incentives to Network Prominence

In the previous section, we argued that introducing monetary incentives will increase individuals' prominence as knowledge providers in the organizational informal knowledge

network. We have not yet explored, however, potential mechanisms of this effect. What do individuals do to achieve their goals? We address this question using a social networks lens, thus investigating the extent to which networking behaviors—defined as individuals' attempts to develop social ties with others who "have the potential to assist them in their achievements" (Forret and Dougherty, 2004: 420)"—change in response to monetary incentives.

Drawing on Puranam and colleagues' (2012) framework, we argue that rewarding employees through pay for performance incentives based upon outcomes that are only partially under their control, such as in the case of network prominence, represents a condition of *epistemic interdependence*. Awarding incentives for outcomes not fully under an employee's control is commonplace within organizations, such rewards total sales or customer satisfaction ratings, and require the employee to anticipate what behaviors will produce their desired results. Specifically, the decision of incentivized individuals to form a new tie or not with a colleague depends on them predicting whether that targeted colleague will reciprocate the tie, in turn increasing the employee's network prominence.[2] As such, incentivized individuals may form knowledge ties with those who they believe are more likely to reciprocate.

Given the well-established assumption that individuals have finite "social budgets" that restrict how many network connections they can build and maintain (Hill and Dunbar, 2003), we argue that incentivized individuals face a relationship investment problem of how to best allocate their time and interpersonal efforts in order to maximize the probability of achieving their network-based objective. Acknowledging the importance of reciprocation, we theorize

[2] According to Puranam and colleagues' (2012) framework, two agents are epistemically interdependent if at least one agent "faces broad incentives" and she is "scheduled to act before knowing the action of the other" (2012: 427). In our context, incentivized actors are rewarded based on the other agents' actions and incentivized actors do not observe others' networking actions before forming new ties. Thus, the optimal action of an incentivized agent depends on a prediction of what the other agent will do.

that incentivized individuals are more likely to build new ties with "familiar" others, such as friends, those with whom they share common third parties, those who are similar to them, and those who are more physically proximate, because these contacts potentially offer a lower risk of non-reciprocation relative to "unfamiliar" others. In line with the epistemic interdependence perspective (Puranam, Raveendran, and Knudsen, 2012), incentivized actors will rely on relational heuristics to develop predictive knowledge about others' likelihood of reciprocating a tie. Viewed in the language of relationship investment, familiar others provide known payoffs, especially when compared to the uncertain value of establishing new relationships with unfamiliar others. We theorize that, when actors face epistemic interdependence, they will be less likely to invest their finite social budget in unfamiliar, riskier connections.

Our theoretical focus on reciprocity is not incidental. A rich literature on the emergence and evolution of social relationships pinpoints reciprocity as a key mechanism informing human interactions. For example, paraphrasing Cicero, Gouldner states in his foundational work that "there is no duty more indispensable than that of returning a kindness" (1960: 161), thus speaking to the philosophical foundation of reciprocity. Expanding this intuition, Blau argued that reciprocity resides at: "[...] the core of the exchange concept" (1963: 140). More recently, Putnam linked reciprocity to the idea of social capital pointing out that it is the "[…] the touchstone of social capital" (2000: 134). The norm of reciprocity is the key building brick of any social community and molds the *homo reciprocus* (Becker, 1956) who behaves by giving back what received by others in a system of relational "rights and duties" (Gouldner 1960: 169). Moving from a pure dyadic perspective, Simmel (1950) argued that social equilibrium and cohesion could not exist without "the reciprocity of service and return

service," and that "all contacts among men rest on the schema of giving and returning the equivalence."

In sum, although incentivized actors do not have direct control over who comes to them for advice, they may strategically control their knowledge-seeking behavior in search of reciprocation. To minimize the risk on non-reciprocation, they will adopt a set of networking behaviors that we develop below.

Knowledge Outreach. Despite both cognitive and time constraints that place an upper limit on the number of relationships that can be maintained (Roberts et al., 2009; Dunbar, 2008; Milardo, Johnson, and Huston, 1983), we argue that, on average, incentivized actors should become more proactive and build more informal ties (i.e., engaging in knowledge outreach). The formation of network ties ensures that incentivized employees enter the consideration set of other employees. By proactively seeking advice and forming ties, incentivized employees create a conduit of information through which their targets have the possibility to learn about incentivized actors' competencies and knowledge, thus making them aware of the resources that can be accessed by reciprocating (Hasan and Koning, 2019). Knowledge interactions—including asking proactively advice from other—is a way that individuals have also to show their knowledge and expertise. As a rich and influential research stream shows, gaining respectfulness enhances reciprocity (Lawler, 2001; Cialdini, 2003), helpfulness (Settoon and Mossholder, 2002) and commitment to the relationship (Flynn and Brockner, 2003). Thus, entering the consideration set by embracing a more proactive networking behavior is the first stage toward reciprocity. Building ties opens up the possibility that those sought for advice will reciprocate the tie based on the "duties and rights" logic that the norm of reciprocity embodies (Newcomb, 1956; Montoya and Insko, 2008), thus increasing incentivized actors' prominence in the

knowledge network. Finally, because knowledge ties are intrinsically instrumental, and thus less characterized by emotional closeness between parties, the constraints on the absolute size of individuals that an ego can maintain should be mitigated (Roberts et al., 2009), thus making the activation of networking behavior easier. In sum, in a knowledge context we hypothesize that those who seek many others for advice will also be sought more.

Hypothesis 2a: Incentivized individuals will increase their knowledge outreach to a greater extent than non-incentivized individuals.

Hypothesis 2b: Knowledge outreach will mediate the effect between performance-contingent incentives and network prominence.

Embeddedness. The tendency of individuals to form a relationship if they have common third parties is another important driver triggering tie-formation decisions. This tendency is based on the transitivity principle (Wasserman and Faust, 1994), according to which two individuals are more likely to be connected if they have one or more other acquaintances in common.

A rich stream of research shows that embedded ties—dyadic relations with a shared third party—are more stable over time (Krackhardt, 1999). These particular ties induce trust and commitment in the relationship, creating information redundancy that allows for greater capacity to transmit information (Uzzi, 1996; Reagans and McEvily, 2003; Aral and Van Alstyne, 2011; Ter Wal et al., 2016). Although such a redundancy clashes with efficiency (Burt, 1992), it enhances the likelihood of reciprocity. Research on network closure shows that ties cemented through common third parties can be useful because they embody shared norms, common identities, routines, and pre-aligned interests and perspectives (Obstfeld, 2005). Therefore, network ties with common third parties reduce information asymmetries (Krackhardt, 1999) and

facilitate the development of trust between parties since they allow the possibility of social sanctioning, preventing parties to behave counter-normatively (Buskens, 2002). Thus, by choosing alters with common third parties, incentivized individuals increase the chances of cooperation and reduce the risks of non-reciprocation.

Hypothesis 3a: Incentivized individuals will increase the number of knowledge ties with common third parties to a greater extent than non-incentivized individuals.

Hypothesis 3b: Common third parties knowledge ties will mediate the effect between performance-contingent incentives and network prominence.

Tie multiplexity. A long research tradition shows the importance of friendship ties in interpersonal dynamics (Krackhardt and Stern, 1988; Casciaro and Lobo, 2008). Granovetter's idea of tie strength includes emotional attachment (1973), which constitutes a base of trust and provide support to individuals in the face of uncertainty (Ibarra and Smith-Lovin, 1997; Krackhardt, 2003). In our research context, given the revised system of incentives, we posit that treated individuals will tend to form multiplex ties by pairing knowledge ties with friendship ties.

In choosing among contacts, there are at least two mechanisms that would predict that incentivized actors will prefer to form advice ties with contacts who are also friends. First, incentivized actors may believe that the risk of non-reciprocation is lower among friends than among non-friends, because affective-based ties entail repeated interactions that are conducive to trust and soften perception of competition between parties (Lazega and Van Duijn, 1997; Lazega and Pattinson, 1999).

Second, creating an advice tie with an existing friend transform a single-type relationship into a multiplex one, in the sense that actors "share multiple bases for interaction in a dyad" (Verbrugge, 1979: 1287). Multiplexity—the presence of multiple types of relationships between

two actors—is a manifestation of relational pluralism (Shipilov et al., 2014), which has been found to have a positive and linear effect on subsequent tie formation. From a network dynamics standpoint, multiplex ties improve exchange stability among individuals by increasing complex information sharing and reciprocal learning (Rogan, 2014). By virtue of an informational accrual mechanism (Ferriani, Fonti, and Corrado, 2013), multiplex ties provide opportunities for a more fine-grained understanding of alters' competencies, knowledge, and reliability (Gulati and Gargiulo, 1999). Moreover, multiplex ties have been found to lay at the core of social embeddedness and contribute to increase feelings of reciprocity and trust among parties (Uzzi, 1996). In addition to more accurate information about alters, tie multiplexity also offers a closer and reciprocal monitoring of others' behavior (Ferriani, Fonti, and Corrado, 2013).

Hypothesis 4a: Incentivized individuals will increase their multiplexity of knowledge and affective ties to a greater extent than non-incentivized individuals.

Hypothesis 4b: Multiplexity of knowledge and affective ties will mediate the effect between performance-contingent incentives and network prominence.

Homophily. A rich research tradition shows that homophily—the tendency for individuals to connect disproportionately with others who are "alike in some designated respect" (Lazarsfeld and Merton, 1954: 23) —is a pervasive mechanism in social networking and applies to numerous types of individual attributes, including sociodemographic characteristics, behaviors, attitudes and psychological traits (McPherson, Smith-Lovin, and Cook, 2001). As aptly pointed out by Rivera and colleagues (2010: 94), "homophily appears to strongly affect attachment because people expect a priori that self-similar alters are more likely to accept them and be trustworthy," thus mitigating potential costs that are associated with making connections. In our research context, incentivized actors may be more likely to form ties with homophilous

others because they may hold the belief that their potential contacts could find it easier to reciprocate a tie coming from a similar other than from a dissimilar other. Further, homophily with a potential target improves predictability of behavior, and fosters reciprocity and trust (Ibarra, 1992; Chiang and Takahashi, 2011). Although the extent to which two individuals are similar to each other can be assessed along a number of dimensions, past research shows that gender is a particular salient, easy to observe homophily dimension (Ibarra, 1992; Kleinbaum, Stuart, and Tushman, 2013; Greenberg and Mollick, 2017).

Hypothesis 5a: Incentivized individuals will increase knowledge ties with same-gender alters to a greater extent than non-incentivized individuals.

Hypothesis 5b: Knowledge ties with same-gender alters will mediate the effect between performance-contingent incentives and network prominence.

Propinquity. In addition to relational and assortative mechanisms, propinquity—defined as the tendency of individuals to interact more frequently with others who are physically close to them—is another important mechanism describing tie formation dynamics (Allen and Fustfeld, 1975; Rivera, Soderstrom, and Uzzi, 2010; Reagans, 2011). A great deal of research shows that social relationships are more likely to occur between proximate individual because being proximate encourages chance encounters and opportunities for interaction (Allen and Cohen, 1969; Kossinets and Watts, 2006; Dahlander and McFarland, 2013; Catalini, 2018). In addition to increasing the likelihood of tie formation between two individuals, proximity could also affect the extent to which social ties get reciprocated or not. In particular, assuming that reciprocity is a pervasive mechanism of social interactions, a lack of reciprocity among peers could be interpreted as a counternormative behavior (Goffman, 1963). Increasing visual contact and the likelihood of interactions between individuals, proximity may work as a control

mechanism, making non-reciprocation of a tie more difficult for individuals. Incentivized actors, therefore, should be more likely to form ties with physically-close colleagues, as proximity should reduce the risk of non-reciprocation.

Hypothesis 6a: Incentivized individuals will increase knowledge ties with physically close others to a greater extent than non-incentivized individuals.

Hypothesis 6b: Knowledge ties with physically close others will mediate the effect between performance-contingent incentives and network prominence.

We summarize all our hypotheses as well as the theoretical framework in Figure 1.

Insert Figure 1 about here

DATA AND METHODS

Research Context

Our research context originates from a large, vertically integrated multinational company (hereafter called "BigCo"). BigCo, which at the time of our data collection had annual net sales of more than $7 billion, is considered the leader in its market. Starting in the early 60s as a small third party producer, BigCo has rapidly grown through an ambitious acquisition strategy that allowed the company to become a top player in its industry in a short period of time.

We conducted our study in the Human Resources (HR) function, which is composed of twelve distinct areas of activities. People working in this function are responsible for all the processes of human capital management, both at global and local level, such as man power planning, budgeting and labor costs, talent acquisition and recruiting, compensation and benefits, career and development, learning, mobility, corporate welfare, organizational climate, internal communication, culture management and diversity, employer branding, people metrics and reporting, IT human resources, industrial relations, organization and workflow design, payroll.

Being a global company, BigCo pursues a people strategy that consists in standardizing processes and spread best practices across its offices, in order to operate as a "community of practices," that is a group of people that learn from each other by interacting regularly. In an annual workshop, the Chief Human Resources Officer (CHRO) explained his view on this point: *"Today I do not have organizational charts. I hope that my collaborators around the world feel part of a network rather than organizational boxes. Such network is a social infrastructure that works together with our formal organization, but it is more flexible and adaptable. The network among us is the agile infrastructure to get our knowledge and our best practices flowing. Thus, this is key for our growth."* The decision of the company to introduce monetary incentives based on network metrics was made precisely to increase the willingness of employees to informally share knowledge, transforming personal knowledge and experience into a "social good," thus making knowledge more readily available to others without imposing strict rules or policies of knowledge exchange.

Study Design

We approached the CHRO, in the context of a larger research project, to perform a social network analysis of the HR function. After the first wave of data collection, we prepared a social network report for the CHRO and delivered a presentation about the status quo of the HR function and its network. Following the report, we designed an intervention, in concert with the leaders of the organization, by altering the firm's existing management-by-objectives[3] (MBO) system to include pay-for-performance incentives based on social networks. The intervention targeted only a select group of employees, while the remaining members of the HR community

[3] An MBO is one of the key components of the performance evaluation system, and it goes into the variable pay structure.

kept their traditional incentive system, in which the variable component of the compensation was linked to the achievement of set goals and evaluated with the yearly performance appraisal.

After collecting and analyzing the first wave of network data, we provided the organization with individual-level network metrics, which were used to design the networking objectives (hereafter referred to as the treatment). More specifically, the treatment was tailored to be equally challenging and consisted of increasing one's relative network prominence—*indegree centrality*—in the informal advice network. The networking objective was 20 percent of the overall MBO and the total MBO was applied to 30 percent of the annual gross salary. As an example, an employee earning an annual gross salary of $100,000 who reaches her networking objective will earn an additional $6,000.

There are two reasons underlying the decision to use this specific pay for performance. First, although informal knowledge sharing entails both providing and seeking advice (i.e., indegree and outdegree centrality), rewarding employees based on their indegree centrality was the only viable way to set up a system of incentives based on networking performance. Indeed, introducing a pay-for-performance compensation scheme based on employees' knowledge-seeking behavior (i.e., outdegree centrality) would have introduced tremendous individual incentives to "game the system": profit-maximizing employees would simply select every single name in a social network survey roster, thus increasing their knowledge-seeking behavior, to achieve their objective. Second, indegree centrality has several properties that make it a relatively robust measure of centrality, even in the presence of incomplete or imperfect survey response (Costenbader and Valente, 2003; Hasan and Bagde, 2015). Given that a big part of employees' variable payment is contingent on collecting precise relational data, indegree

centrality provides a robust measure that could minimize concerns arising from potential low or biased response rates.

We considered employees that were selected for the revised MBO program as the treatment group and employees that were not included in the revised MBO program as the control group. Employees were assigned to experimental conditions based on selected organizational covariates. After interviewing the CHRO, however, we were able to understand the rationale that was used during the assignment phase and control for these factors in our statistical analyses. In particular, balancing formal and informal elements, the CHRO selected employees who were high in the formal organizational rank, had many prior informal contacts, and worked outside the United States. There were at least two reasons underlying this decision. First, because the goal of the organization was to encourage knowledge sharing within the HR community, selecting senior, more prominent managers would increase the odds of a successful initiative because such employees may be not only more likely to provide useful knowledge, but also more likely to be professionally aligned with the nature of the revised system of incentives. Second, linking a sizeable portion of employees' variable compensation to networking metrics has important implications from a perceived justice point of view, as individuals have limited direct control over relational dynamics. Thus, by carefully selecting employees for the revised system of incentives, the organization may limit the possibility of employees perceiving a goal to be outside their locus of control.

Because employees were selected for treatment based on observed covariates, we refer to our study as a quasi-experiment rather than a field experiment. The term quasi-experiment applies to studies that "resemble randomized field experiments but lack the researcher control or random assignment characteristic of a true experiment" (Remler and Van Ryzin, 2010). These

are typically observational studies in which there is no random assignment to treatment, but the researcher may control the assignment to the treatment condition or may know the factors that were used to assign individuals to conditions.

Network Data

To test whether introducing incentives affects employees' prominence in the informal advice network, we analyze data on the networks of employees working for a multinational organization. The population consists of all employees working for the global HR function and data were collected over 17 months. During this period, we collected data at two points in time: before and after the introduction of the revised MBO system. Besides data on demographic variables, the organization provided us with names of employees who were selected for the intervention. We also conducted several open-ended interviews with the HR chief and the top management team which helped us better understand the organization and its key processes.

In addition to the intervention and demographic data, we surveyed employees about their social networks. Specifically, we collected network data using a free-choice-aided name generator (Wasserman and Faust, 1994), in which we asked respondents to fill in the names of people to whom they turned for advice on work-related issues. In particular, we asked: "Please choose the people to whom you turn to seek advice on work-related issues." Employees also reported people with whom they were friends. As employees started typing the first letters of their contacts' name or surname, the online survey tool suggested the names of employees matching the letters inserted. Each survey took an average of twenty minutes to complete and yielded response rates of 79 percent and 80 percent in Time 1 and Time 2, respectively. To be able to compute variables capturing changes in individuals' ego-network, we then excluded employees who were not in both waves of the survey, yielding a sample size of 332 individuals.

Out of this 332 employees, 60 received the revised MBO program. This approach allows us to have full data for both network predictors and criterion variables.

Measures

Dependent Variable. Our dependent variable measures a focal employee's change in prominence in the knowledge network following the managerial intervention (i.e., Time 2 – Time 1). We capture social network prominence using *indegree centrality*, which is a count of the number of employees who report going to the focal employee for informal advice on work-related problems.

Independent Variable. The primary independent variable for our analyses is a dummy variable, *pay for performance* incentive, which was coded as one if an employee was selected to receive the revised MBO program, and zero otherwise.

Mediators. To test our hypotheses about the mechanisms linking monetary incentives to network positions, we created a number of variables capturing changes in focal actors' ego-network size and composition. Because we are interested in understanding whether employees react to incentives by altering their networking behavior, we created our mediating variables based on changes in individuals' ego-network outgoing ties. To create the variable *outreach change*, for each employee we first counted the number of colleagues she sought advice from on work-related problems after the intervention, and subtracted this value from the number of colleagues she sought advice from before the intervention, thus obtaining a change score. In a similar vein, *multiplex ties change* is a difference in the number of alters in a focal actor's knowledge network that she listed as friends. That is, we capture changes in the degree to which an individual seeks knowledge-related support from alters with whom she has a friendship tie. Specifically, we asked the following question in the survey: "Please choose the people who you

consider good friends." Thus, this variable ranges from negative values in case a focal actor seeks less knowledge from friends, to positive values in case of increased multiplexity. *Embedded ties change* captures the difference in the number of alters a focal actor has in common with the individuals she seeks advice from. That is, this variable takes negative values when a focal actor decreases advice seeking from alters with whom she has common third parties, and positive values in case of increased knowledge seeking from shared connections. Similarly, homophilous ties is a variable capturing the number of alters in a focal actor's knowledge ego-network who share her same gender. Thus, *homophilous ties change* measures the delta before and after the intervention. Finally, we measured the distance in (thousands of) miles between a focal actor and all those alters she seeks advice from. To do so, we first calculated the geographical distance among a focal actor and her alters' office locations, using information we received from the organization itself. In particular, we first geocoded each of the 57 office locations in our dataset assigning latitude and longitude coordinates. Then, we computed physical distances between any two employees' locations using the Stata package geodist, which computes geodetic distances (i.e., the length of the shortest curve between two points along the surface of a mathematical model of the earth). In other words, this variable captures how far away any employee goes to acquire informal knowledge. Thus, the variable *distance ties change* captures the change score in the sum of the distance, summed across alters, before and after the intervention.

Controls. We also include a set of control variables to account for factors that could simultaneously affect our dependent and independent variables. In particular, we controlled for a set of variables—organizational rank, perceived social prominence, and working outside the United States— that informed the CHRO's treatment-assignment decision. We use

organizational rank, which is an ordinal variable with six levels (1 = Top Executive, 2 = Director, 3 = Manager, 4 = Associate Senior, 5 = Associate, and 6 = Assistant), *network size at Time 1*, which is a proxy for perceived social prominence before the intervention, and *working in the U.S.*, which is a dummy variable that takes value one if an employee works in a United States office, and zero otherwise. Controlling for *organizational rank* is important because employees higher in the organizational rank may be sought for informal advice more often than employees at lower levels. Controlling for pre-intervention network size allows to take into account path dependency mechanisms (Ahuja, Soda, and Zaheer, 2012), while including a dummy for employees working in the United States allows to control for dependencies in the error term arising from geography. In addition to these variables, we also include additional demographic controls that we obtained from the company, such as gender, internal tenure, and working experience. *Male* is a dummy variable that takes value one for male employees and zero otherwise. *Company tenure* captures how long an employee has worked for the organization. Starting from employees' hiring dates, which we received from the organization itself, we calculated how many days elapsed from the first day at work until the survey was administered. We then converted days to years dividing the number by 365. *Working experience* is an ordinal variable measuring the experience employees have accumulated in their professional careers. It has the following six levels: 1 = 0-2 years; 2 = 3-5 years; 3 = 6-10 years; 4 = 11-15 years; 5 = 16-20 years; 6 = more than 20 years. We received information about employees' working experience from the organization itself. Finally, when estimating the effects on network prominence of ego-network composition mediators—that is, change scores for *embedded ties*, *multiplex ties*, *homophilous ties,* and *distance ties*—we controlled for *outreach change* to account for changes in the relative size of the ego-networks.

Estimation Approach

The unique characteristics of our quasi-experimental design require particular consideration, especially in terms of the causal inference of the direct effect of our treatment. Assignment mechanisms affect not only the probability of being exposed to a treatment, but also the extent to which a researcher can be confident that the average causal effect is an unbiased estimate of the causal effect for the population. When the assignment is not random but conditioned on an observed variable, such as in a regression discontinuity design, the ignorability assumption is met and unbiased estimates are obtained by including the observed assignment variable in the model (Shadish, 2002; Rubin, 2004). In other words, if the covariates with bearing on assignment are included in the models, the assignment of individuals to experimental groups is independent of potential outcomes (Shadish, 2010). Accordingly, in our study, given that employee's assignment to treatment was based upon known variables that we account for in our models coupled with the temporal ordering of the treatment and outcome measurement, increases our confidence that the presented estimates of the direct effect are not biased by endogeneity.

To account for the assignment to treatment, we took the prescribed steps for including the observed assignment variable in the models. First, we ran a probit model to estimate the probability of being treated as a function of employees' covariates (Heckman, 1979). Then, we used the parameter estimates obtained by this treatment equation to compute the inverse Mills ratio (IMR) for each observation and entered this ratio as a control into our models estimating differences in networking behavior and prominence between treated and control employees. Table 1 shows descriptive statistics for the treated and control groups, and Table 2 shows the results of a probit regression predicting the likelihood of receiving the treatment as a function of

individual-level covariates. In particular, Model 1 shows the association between treatment assignment and those covariates indicated by the CHRO. All coefficients are statistically significant and have anticipated signs. Model 2 also includes additional observable covariates in our dataset that we thought might also predict assignment to conditions, such as gender, company tenure, and working experience. These variables are not statistically significant and do not substantially improve the predictive power of the model. Hence, we account for the covariates used to determine treatment assignment in all of our subsequent models.

Because our theory seeks to explain not only whether monetary incentives have a direct effect on network prominence, but also the mechanisms through which incentivized employees change their network position, we used mediation analysis to test our hypotheses. Specifically, we tested whether changes in a focal actors' tie formation mediate the relationship between *pay for performance* incentives and *indegree centrality*, which would suggest that networking behavior is a primary factor in explaining the influence of monetary incentives on prominence.

While the ignorabilty assumption and temporal precedence are met for the treatment in our design, they are not met for our mediating variables. Ideally, providing causal evidence for a mediator also requires manipulation of the mediator and a third wave of measurement, which was not feasible at our field site and rarely addressed in experimental research (Galperin et al., 2020). We tested this relationship using parametric regression models and bootstrapped bias-corrected confidence intervals based on 1,000 replications for the indirect effects (Preacher and Hayes, 2004).

Insert Table 1 and Table 2 about here

RESULTS

Table 3a reports descriptive statistics and correlations for all variables used in our analyses. Although all analyses are based on the change scores, we nevertheless reported pre- and post-intervention network variable descriptive statistics in Table 3b to convey a clearer picture of the data. Moreover, to convey more information, in Figure 2 we graphed our raw data displaying individuals' changes in the outcome variable (*indegree centrality*) as a function of their assignment condition (treatment vs. control), as well as the average change for both groups.

Insert Table 3a, Table 3b, Figure 2, and Table 4 about here

Table 4 shows the results of our models. In particular, Panel A tests our first hypothesis, which predicted that monetary incentives would increase employees' prominence in the knowledge network. Model 1 reports a model without controls, showing a statistically significant and positive effect of monetary incentives on network prominence ($\beta = 2.85$, $p < 0.001$). That is, holding everything else constant, moving from the control to the experimental condition is associated with a 2.85 increase in *indegree centrality* in the knowledge provision network. This result holds when all control variables are added to the model, as shown in Model 2 ($\beta = 2.78$, $p < 0.001$), providing support for Hypothesis 1.

In the subsequent panels in Table 4, we begin to explore the mechanisms that could account for such a positive association. We begin by testing whether treated employees expand their knowledge outreach to a greater extent than employees in the control group, and whether engaging in more active knowledge-seeking behavior operates as a mechanism linking monetary incentives to changes in network prominence. Supporting Hypothesis 2a, Model 3 in Panel B shows that monetary incentives have a positive and statistically significant association with knowledge outreach ($\beta = 2.91$ $p = 0.002$). In model 4, we find that knowledge outreach increases

network prominence ($\beta = 0.08$, $p = 0.015$). Further, we estimated the indirect effect of monetary incentives via knowledge outreach on our dependent variable—*indegree centrality*. As shown in Panel B, the 95-percent bias-corrected confidence interval for the size of the indirect effect excluded zero (0.021, 0.625), indicating that increases in knowledge outreach mediated the link between our variables of interest, thus supporting Hypothesis 2b.

Model 5 and 6 in Panel C test whether treated employees increase their embedded ties, and whether such the formation of these ties results in an increase in their network prominence. Supporting Hypothesis 3a, Model 5 shows that the effect of pay for performance on embedded ties is positive and statistically significant ($\beta = 10.59$, $p < 0.001$), suggesting that, compared to the control group, treated employees tend to form more knowledge-seeking tie with embedded alters. In Model 6, we find that change in embedded ties increases network prominence ($\beta = 0.091$, $p < 0.001$). Then, we tested whether a change in embedded ties mediated the relationship between the treatment condition and network prominence. More specifically, we estimated the indirect effect of monetary incentives via embedded ties on our dependent variable, network prominence. As shown in Panel C, the 95-percent bias-corrected confidence interval for the size of the indirect effect excluded zero (0.467, 1.716), thus supporting Hypothesis 3b and suggesting that seeking knowledge from embedded ties results in increased network prominence.

Model 7 and 8 in Panel D test the effect of multiplex ties. Model 7 shows that the estimated coefficient of pay for performance on change in multiplex ties is positive and statistically significant ($\beta = 1.071$, $p = 0.001$), thus supporting Hypothesis 4a. That is, incentivized employees tend to restructure their ego-network to include more multiplex ties compared to employees in the control group. Next, we sought to explore whether changes in multiplex ties mediate the link between incentives and centrality. In Model 8, we find that

change in multiplex ties is associated with increases in network prominence ($\beta = 0.206$, $p = 0.039$). Further, the 95 percent bias-corrected confidence interval for the size of the indirect effect excluded zero (0.007, 0.654), thus providing suggestive evidence that seeking knowledge from friends is associated with higher indegree centrality.

The models presented in Panel E test for the effect of homophily. Contrary to our predictions, we do not find an effect of pay for performance on gender homophily ($\beta = –0.43$, $p = 0.119$), and we do not find support for Hypothesis 5a and 5b. That is, incentivized employees do not increase the extent to which they seek knowledge from same gender alters after the intervention. In line with this result, Model 9 and 10 show that gender homophily does not mediate the relationship between monetary incentives and network prominence, as the bias-corrected confidence interval for the size of the indirect effect includes zero (–0.003, 0.492).

Finally, in Model 11 and 12 in Panel F we look at the effects of propinquity. Hypothesis 6a proposed that incentivized employees are more likely to seek knowledge from physically close alters, which in turn should result in increases network prominence. The direct effect of pay for performance is not statistically significant ($\beta = 1.267$, $p = 0.187$ in Model 11), suggesting that incentivized employees do not change the composition of their ego-networks to reduce physical distance from their contacts. Additionally, the bias-corrected confidence interval for the size of the indirect effect includes zero (–0.265, 0.040), indicating that treated employees do not seem to leverage this mechanism of tie formation more than control group employees. Thus, neither Hypothesis 6a nor Hypothesis 6b are confirmed. Put differently, our results suggest that gender homophily and propinquity do not inform treated actors' decisions to restructure their ego-networks.

Robustness Checks

Omitted Variable Bias. We ran additional tests to check the extent to which our findings could be vulnerable to unobserved heterogeneity between monetary incentives and indegree centrality. Although unlikely, the CHRO might have been subconsciously biased in his assignment decision. In our specific case, it could be that an unmeasured individual characteristic, like a psychological trait, might be correlated with both being assigned to the experimental condition and the likelihood to be sought to for knowledge, thus biasing our results. For example, individuals high in extraversion could be more likely to be selected for the treatment and, at the same time, more likely to receive knowledge ties from others.

We also performed a Generalized Sensitivity Analysis (GSA) to assess the extent to which our estimates are sensitive to unobserved heterogeneity (Harada, 2012). GSA starts from the residuals of the outcome model of interest to generate multiple "pseudo-unmeasured" variables that change the test statistics of the independent variable of interest (in our case, monetary incentives). Through a series of sensitivity parameters, GSA aims at capturing the amount of correlation an omitted variable should have with a predictor and predicted variable in order to make the predictor no longer significant at the conventional level of 0.05. The output of the analysis consists of a graph of correlations with the independent variable (treatment) distributed on the x-axis and correlations with the dependent variable (indegree centrality) distributed on the y-axis. A contour line provides a graphical benchmark of how strongly correlated a confounding effect would need to be with both the independent and dependent variables of interest simultaneously in order to change the critical value of the statistical significance and thus impair the causal association between the two.

Insert Figure 3 about here

Figure 3 depicts the results of a sensitivity analysis for the effects of monetary incentives on network prominence in the knowledge provision network. In this graph, we show *organizational rank* as a filled-in square to ease the interpretation of the analysis. We know that *organizational rank*, if left out, is a clear confounder causing endogeneity: it correlates positively with being assigned to the treatment condition and it could also affect informal knowledge sharing dynamics. Figure 3 indicates that for an omitted variable to impair the causal relationship between predictor and outcome, its correlation with these two variables would have to be more than double the correlation with *organizational rank*. Although this is theoretically possible, it is also quite unlikely, thus enhancing support for the robustness of our findings to the risk of omitted variable bias.

Networking Disengagement. Finally, to rule out a potential alternative explanation according to which monetary incentives change both volume and composition of knowledge networks not due to increases in treated employees' networking effort, but due to decreases in control employees' effort (i.e., networking disengagement), we calculate the average number of outgoing ties before and after the managerial intervention for both groups. Our analyses indicate that employees in the control group, on average, slightly increased their knowledge outreach compared to the prior year, suggesting that our results are not driven by a decrease in networking effort from the control group.

DISCUSSION

It is a truism that organizations benefit from knowledge exchange among their members and that a pervasive flow of knowledge is a key mechanism to scale up individuals' knowledge to a collective good. It is also well recognized that the emerging informal network of interactions operating "behind the chart" may largely influence and shape both the quantity and the quality of

knowledge exchanges within organizations (Krackhardt and Hanson, 1993). Moreover, organizations can leverage internal networks to accelerate behavior change and diffusion of innovations (Valente, 2012). In this paper, we contribute to scholarly understanding of knowledge sharing and network dynamics by addressing the key question of whether and how informal knowledge interactions may be directly influenced by organizational decision makers (Valente, 2012; Yakubovich and Burg, 2019; Hasan and Koning, 2020). In answering this question, our study also explores how managerial interventions may alter individual networking and shape informal, emerging patterns of interactions among organizational members (McEvily, Soda, and Tortoriello, 2014). In particular, trying to offer an accurate understanding of the divergences and convergences between individual behavior and what organizational choices prescribe, we give renewed attention to the long-lasting conceptual debate in organization and network theory counterpoising agency to structure (Giddens, 1976; Ranson, Hinings, and Greenwood, 1980; Stevenson and Greenberg, 2000; Ahuja, Soda, and Zaheer, 2012).[4] In doing so, we also answer recent calls for greater emphasis on understanding networking processes vis-à-vis network structural properties (Bensaou, Galunic, and Jonczyk-Sédès, 2014; Casciaro, Gino, and Kouchaki, 2014) as well as the mechanisms by which actors exert agency (Gulati and Srivastava, 2014).

In showing that individuals react to performance-based monetary incentives to improve their network centrality in the knowledge provision network, our research provides suggestive evidence for the idea that managerial interventions can differentially enable certain kinds of networking behavior and encourage forms of relational commitment that can converge with or diverge from organizational purposes. Individual agency—the ability to enact relational spaces

[4] This issue is addressed in several foundational contributions of organization theory, for instance: Merton, 1940; Selznick, 1943; Gouldner, 1954; Blau, 1963; Crozier, 1964.

by undertaking purposive actions that advance self-interest—is well investigated in network research (Coleman, 1990; Burt, 1992; Emirbayer and Goodwin, 1994; Ahuja, Soda, and Zaheer, 2012). For example, Burt's (1992) seminal work on the social structure of competition highlights the entrepreneurial role of network actors in generating valuable structural configurations. However, as argued by Burger and Buskens (2009), while the idea of structural entrepreneurship implies that individuals attempt to self-select into beneficial positions, the micro-level mechanisms leading to this structural outcome remain largely unclear.

We contribute to this discussion by disentangling how the inducements generated by managerial interventions interplay with agency of incentivized individuals, who deliberately change their portfolio of ties to maximize benefits. In particular, it is important to notice that, albeit incentivized individuals are more active in their networking efforts, their actions are not exercised in a *vacuum* but rather unfold in a social space that may provide opportunities and constraints to those actions (Tasselli, Kilduff, and Menges, 2015). More specifically, our findings suggest that individuals not only engage in a more intense relational proactivity aimed at creating new ties (i.e., knowledge outreach), but also focus their networking efforts by targeting alters who are already part of their social space (i.e., friends, those with common alters, and multiplex ties). Put differently, incentivized individuals seem to focus their instrumental action on the closer social context that arguably they see as a "resource," which can be harnessed more effectively (Gulati and Srivastava, 2014). Our theory and results are suggestive of the fact that the social space in which individuals are plunged—composed of friends, common alters, and multiplex ties—provides them with opportunities for network action while, at the same time, imposes constraints on that action (Stevenson and Greenberg, 2000; Rivera, Soderstrom, and Uzzi, 2010). As such, this argument is in line with Blau's (1994) theory of the structural context

of action as well as with the idea of "constrained agency" proposed by Gulati and Srivastava (2014).

Drawing on past research that suggests a complex interplay between agency and structure, in which these forces are "simultaneously exogenous and endogenous" (Gulati and Srivastava, 2014: 7), our contribution also takes on the challenge of discussing the outcomes and consequences of this intertwined relationship. Specifically, our research can foster novel discussion on the consequences, and the potential tradeoffs, arising from stimulating agency through monetary incentives in a social context, such as intraorganizational networks, characterized by norms and pre-existing relationships. We believe that this is an important, potentially overlooked, argument in a scholarly debate that is mainly focused on investigating how structure shapes behavior, relegating our understanding of how agency operates within a social context to an ancillary role. In particular, building on Gulati and Srivastava's (2014: 7) work conceptualizing social networks as a "set of resources that are accessible to actors," we argue that focal actors take advantage of their existing social structures when exerting agency triggered by incentives. This is evident in our results showing that incentivized individuals harness their actual ties—both instrumental and affective, as well as direct and indirect—as a resource when engaging in purposive networking. Interestingly, physical proximity and homophily do not seem to follow this logic, as they are not leveraged by incentivized individuals in their networking actions.

Furthermore, we argue that the tension between the stimulus to individual networking and the opportunities and constraints originating from social structures could generate outcomes that may be only partially aligned with the purposes of the organization. In our experimental setting, although the goal of the revised system of incentives was to enhance knowledge sharing

within the organization, we find that incentivized individuals "localized" their increased networking efforts by connecting with those who were proximate to them in the social space. In particular, incentivized individuals reshaped the composition of their informal knowledge networks by deepening their existing ties, overlapping instrumental and affective ties, and increasingly relying on transitivity in the formation of new ties. As such, despite the original purpose of the organization was to use monetary incentives to guide agency and transform knowledge sharing into a "community of practice"—in which knowledge sharing is globally-oriented, more pervasive, and cuts across formal boundaries—the creation of a market for social ties rendered employees' networking efforts more entrenched in their existing social space.

Finally, our study advocates for the importance of developing broader theories that encompass different levels of analysis (Coleman, 1990; Klein, Dansereau, and Hall, 1994). In particular, our work can be conceptualized according to Coleman's (1990) seminal theoretical framework on the relationship between macro-level outcomes and micro-level action, and vice versa. Indeed, the introduction of performance-contingent monetary incentives represents a macro-level action designed by the organization to achieve a macro-level outcome—the creation of a community of practice. This particular macro-level action determined changes in attitudes at the micro-level, as incentivized individuals became more willing to enact their social space. Increased willingness to exert agency triggered specific individual (micro-level) networking behavior, leading incentivized individuals to selectively target their contacts. And, as theorized by Coleman, this ultimately led to specific macro-level structural configurations in the informal knowledge network, that is, the derivation of "macro-outcomes from combinations of individuals' actions" (1990: 19). As explained before, however, insofar as individuals leveraged their existing networks to achieve their objective, the transition from micro-level action to

macro-level outcomes through the aggregation of individual networking behavior may have been misaligned with the original purpose of the organization.

Organization and network scholars have fueled a long-lasting debate on agency vis-à-vis structure, focusing on the extent to which actors can exercise agency in the face of structural constraints. Contributing to recent research on the co-existence between agency and structure (Tasselli, Kilduff, and Menges, 2015; Gulati and Srivastava, 2014), we advanced a theory of constrained agency, in which individuals enact their social space by harnessing the opportunities within their existing networks.

Managerial Implications

Beyond our theoretical contributions, two key managerial implications should be highlighted. First, past research shows that women tend to suffer a gender disadvantage with respect to social capital, because, holding constant social structures, they extract less benefits from their positions than their male counterparts (Burt, 1998; Lutter, 2015). Our research suggests that monetary incentives may be an important tool to mitigate this particular gap. Indeed, insofar as monetary incentives increase employees' network prominence—irrespective of gender—organizations motivated to reduce gender penalties could modify their compensation schemes by systematically targeting women in the allocation of incentives.[5]

Second, although our findings suggest that organizations can encourage the creation of informal ties, thus directly increasing the density of their informal knowledge networks, it is important to ensure that incentive systems are aligned with organizational goals. This is important to notice, since global increases in network density may conceal significant variation at the local level. That is, just as an organization may increase its network density by

[5] We have estimated models with an interaction term between monetary incentives and gender but the relative coefficient was not statistically significant.

encouraging employees to create ties across departments, another organization may become globally denser as a result of more knowledge ties within already highly-siloed departments. The benefits of these configurations are contingent on the specific goal the organization is trying to achieve. In our context, by amplifying the effect of such processes as embeddedness and multiplexity, pay for performance incentives may encourage the formation of ties among people who are more likely to be alike and possess similar knowledge, potentially reducing social learning across groups and fostering the creation of echo chambers (Krackhardt and Hanson, 1993; Aven and Zhang, 2016; Szulanski and Lee, 2018). The question, then, is how to set up a system of incentives that is in sync with company goals.

Limitations and Future Research

Despite its strengths, our work has limitations that present avenues for future research. First, although we took several steps to account for differences between experimental conditions, future studies may incorporate randomized assignment to mediators to ensure unbiased estimation. Despite these concerns, however, this study allowed us to investigate our research question for genuine ties within a natural environment, thus increasing the generalizability of our findings.

Second, a challenge for any experimental design on actual network, including ours's is the possibility of spillover effects, where the treatment affects employees beyond those being selected. Nevertheless, for our study we contend that the possibility of potential spillover effects helps to render our test more conservative because estimated differences between the treatment and control groups would have been even more accentuated in the absence of contamination. In addition to their methodological ramifications, spillover issues may provide interesting theoretical hypotheses that could be explored in further research. For example, what would

happen if incentives were to be made public, such that everyone would have accurate information on who is incentivized? Would awareness of such incentives breed suspicions of inauthenticity toward treated employees, thus limiting alters' willingness to reciprocate interactions?

Third, our arguments on the effect of performance-contingent monetary incentives focus on the idea that treated individuals become more proactive in their networking behavior, thus increasing the volume and composition of their informal ties. That is, proactivity is triggered by a situational stimulus. We do not investigate, however, the possibility of heterogeneous treatment effects based on individual differences. In particular, a large stream of research on organizational behavior and social psychology has started to investigate the role of proactive personality in the development of social capital (Crant, 2000; Thompson, 2002; Parker, Williams, and Turner, 2006). Future research should investigate whether proactive personality interacts with organizational incentives to explain variance in networking behavior.

Finally, our network variables are based on employees' survey responses, and thus potentially prone to recall bias—a lingering issue in studies employing survey instruments (Bernard, Killworth, and Sailer, 1982). Future research may seek to replicate our findings by capturing informal ties through objectively-measured interactions, such as email exchanges or RFID tags.

Conclusion

Knowledge sharing through informal ties is a key means through which organization can leverage their collective expertise and learning (Zander and Kogut, 1995; Argote and Ingram, 2000). Despite the importance of informal ties for organizational success, prior research has provided little insights to organizational decision makers with respect to the possibility of

directly influencing such ties. Our results demonstrate that organizational interventions can directly shape social networks, albeit they may also trigger ripple effects fundamentally changing basic network evolution dynamics. Knowledge sharing is one of many outcomes affected by informal ties. Future research might examine how performance-contingent monetary incentives might affect organizational learning, policy adoption, and innovation diffusion.

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TABLES

Table 1. Descriptive Statistics of Individual-Level Variables for the Treatment and Control Group prior to Treatment

Variable	Treated Group		Control Group	
	Mean	**S.D**	**Mean**	**S.D.**
Organizational Rank [+]	2.43	0.98	4.00	1.07
Network Size	12.22	7.14	4.82	4.64
Working in the U.S. (0/1)	0.35	0.48	0.44	0.50
Male (0/1)	0.48	0.50	0.22	0.42
Company Tenure (years)	6.48	4.72	8.60	7.92
Working Experience	3.08	1.28	2.82	1.45
Number of Observations	60		272	

Note. [+] Reverse-Coded Variable.

Table 2. Estimates of a Probit Model Predicting Assignment to Treatment Condition as a Function of Pre-Treatment Individual-level Covariates

Variable	Model 1	Model 2
Organizational Rank [+]	–0.67***	–0.65***
	(0.13)	(0.13)
Network Size	0.07***	0.08***
	(0.02)	(0.02)
Working in the U.S.	–0.57*	–0.55*
	(0.26)	(0.27)
Male		0.15
		(0.21)
Company Tenure (Years)		–0.04
		(0.02)
Working Experience		–0.003
		(0.11)
Constant	0.89	1.03
	(0.48)	(0.61)
Number of Observations	332	332
Pseudo R^2	0.38	0.40
Log-likelihood	–97.21	–94.58

Note. * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$. Robust Standard Errors in Parentheses.
[+]Reverse-Coded Variable.

Table 3a. Descriptive Statistics and Correlations among Variables of Interest

Variable		Mean	S.D.	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1)	*Indegree Centrality Change*	1.88	3.41													
(2)	*Pay for Performance (1/0)*	0.18	0.39	0.32												
(3)	*Outreach Change*	1.11	5.29	0.19	0.13											
(4)	*Multiplex Ties Change*	0.63	2.08	0.24	0.27	0.50										
(5)	*Embedded Ties Change*	10.08	30.55	0.38	0.27	0.85	0.55									
(6)	*Homophilous Ties Change*	0.58	3.12	0.08	0.07	0.87	0.45	0.43								
(7)	*Distance Ties Change* •	0.74	7.01	0.07	0.12	0.65	0.35	0.34	0.51							
(8)	*Organizational Rank* +	3.72	1.22	–0.24	–0.50	–0.06	–0.10	0.24	–0.07	0.02						
(9)	*Working in the U.S. (1/0)*	0.42	0.50	0.11	–0.07	0.10	0.04	–0.11	0.13	–0.08	–0.02					
(10)	*Network Size (Time 1)*	6.15	5.90	0.17	0.48	–0.04	0.15	–0.37	–0.03	–0.02	–0.48	0.11				
(11)	*Male (1/0)*	0.27	0.45	0.10	0.22	0.04	0.12	0.02	0.00	0.04	–0.24	–0.02	0.25			
(12)	*Company Tenure (Years)*	8.22	7.49	–0.05	–0.11	–0.01	0.00	–0.04	0.01	–0.04	0.02	0.00	–0.02	–0.02		
(13)	*Working Experience*	2.86	1.43	–0.06	0.07	–0.01	0.01	–0.13	0.00	–0.02	–0.23	–0.09	0.12	0.08	0.64	
(14)	*inverse Mills ratio*	1.94	0.91	–0.23	–0.56	–0.01	–0.12	0.24	–0.01	–0.02	0.88	0.20	–0.67	–0.31	0.28	–0.06

Note. + Reverse-Coded Variable. • Measured in 1,000 miles. Correlations greater than |.10| are statistically significant at $p < 0.05$.

Table 3b. Descriptive Statistics of Social Network Variables at Time 1 and Time 2

	Time 2		Time 1		
Variable	**Mean**	**S.D.**	**Mean**	**S.D.**	**Change (T2 – T1)**
Indegree Centrality	5.35	5.97	3.46	4.62	1.88
Outreach	4.54	5.79	3.43	3.98	1.11
Multiplex Ties	1.42	2.27	0.79	1.35	0.63
Embedded Ties	20.25	35.32	10.17	17.69	10.08
Homophilous Ties	2.94	3.24	2.36	2.09	0.58
Distance Ties	3.26	8.56	2.52	7.04	0.74

Table 4. The Effects of Monetary Incentives on Indegree Centrality through Outreach, Embeddedness, Multiplexity, Homophily, and Propinquity ($N = 332$)

	Panel A: Effects of Pay for Performance on Network Prominence							
	DV: Indegree Centrality Change (H1)				**DV: Indegree Centrality Change (H1)**			
	Model 1				**Model 2**			
Variables	β	Robust SE	95% CI		β	Robust SE	95% CI	
Pay for Performance	2.849***	0.570	1.728	3.970	2.775***	0.723	1.353	4.197
Organizational Rank +					1.361	1.189	–0.979	3.700
Network Size (Time 1)					–0.197	0.115	–0.424	0.030
Working in the U.S.					2.372*	1.002	0.401	4.344
Male					–0.152	0.516	–1.166	0.863
Company Tenure					0.145*	0.073	0.002	0.288
Working Experience					–0.373*	0.163	–0.692	–0.053
inverse Mills ratio					–3.310	2.107	–7.456	0.836
Constant	1.368***	0.181	1.012	1.723	2.873*	1.105	0.700	5.047
R^2	0.10				0.16			
F	24.98***				6.34***			

	Panel B: Effects of Pay for Performance on Network Prominence through Outreach							
	DV: Outreach Change (H2a)				**DV: Indegree Centrality Change**			
	Model 3				**Model 4**			
Variables	β	Robust SE	95% CI		β	Robust SE	95% CI	
Pay for Performance	2.911**	0.938	1.065	4.756	2.537***	0.574	1.407	3.667
Outreach Change					0.082*	0.034	0.016	0.148
Organizational Rank +	1.473	1.589	–1.653	4.600	1.240	0.960	–0.648	3.128
Network Size (Time 1)	–0.322	0.164	–0.645	0.001	–0.171	0.100	–0.367	0.025
Working in the U.S.	2.798	1.471	–0.097	5.693	2.143*	0.892	0.388	3.899
Male	0.154	0.738	–1.297	1.605	–0.164	0.445	–1.039	0.711
Company Tenure	0.107	0.103	–0.095	0.309	0.136*	0.062	0.014	0.258
Working Experience	–0.043	0.280	–0.593	0.507	–0.369*	0.169	–0.701	–0.037
inverse Mills ratio	–3.066	2.899	–8.770	2.638	–3.059	1.752	–6.506	0.387
Constant	1.058	1.704	–2.294	4.410	2.787**	1.028	0.764	4.810
R^2	0.053				0.171			
F	2.26*				7.39***			

Indirect Effect (H2b)	β	95% Bias-Corrected CI	
PFP → Outreach → Indegree	0.238	0.021	0.625

	Panel C: Effects of Pay for Performance on Network Prominence through Embedded Ties							
	DV: Embedded Ties Change (H3a)				DV: Indegree Centrality Change			
	Model 5				Model 6			
Variables	β	Robust SE	95% CI		β	Robust SE	95% CI	
Pay for Performance	10.594***	2.544	5.589	15.598	1.573**	0.540	0.510	2.636
Embedded Ties Change					0.091***	0.012	0.068	0.114
Organizational Rank +	25.229***	4.252	16.864	33.594	–1.055	0.927	–2.878	0.769
Network Size (Time 1)	–1.263**	0.441	–2.131	–0.395	–0.056	0.092	–0.238	0.126
Working in the U.S	15.349***	3.953	7.571	23.126	0.747	0.837	–0.899	2.394
Male	–0.314	1.971	–4.191	3.564	–0.136	0.408	–0.938	0.667
Company Tenure	1.447***	0.275	0.906	1.987	0.004	0.059	–0.112	0.121
Working Experience	–0.933	0.747	–2.403	0.537	–0.284	0.155	–0.589	0.021
Outreach Change	4.875***	0.149	4.582	5.167	–0.362***	0.064	–0.488	–0.235
inverse Mills ratio	–42.540***	7.760	–57.807	–27.274	0.810	1.679	–2.493	4.113
Constant	–16.376***	4.555	–25.338	–7.414	4.276***	0.961	2.385	6.168
R^2	0.798				0.306			
F	141.02***				14.14***			
Indirect Effect (H3b)					β		95% Bias-Corrected CI	
PFP → Embedded Ties → Indegree					0.964		0.467	1.716

	Panel D: Effects of Pay for Performance on Network Prominence through Multiplex Ties							
	DV: Multiplex Ties Change (H4a)				DV: Indegree Centrality Change			
	Model 7				Model 8			
Variables	β	Robust SE	95% CI		β	Robust SE	95% CI	
Pay for Performance	1.071**	0.321	0.439	1.702	2.317***	0.581	1.174	3.460
Multiplex Ties Change					0.206*	0.099	0.010	0.401
Organizational Rank +	0.730	0.536	–0.325	1.785	1.090	0.958	–0.794	2.974
Network Size (Time 1)	–0.015	0.056	–0.125	0.094	–0.168	0.099	–0.363	0.027
Working in the U.S.	0.463	0.499	–0.518	1.444	2.048*	0.889	0.299	3.797
Male	0.097	0.249	–0.392	0.586	–0.184	0.443	–1.055	0.687
Company Tenure	0.043	0.035	–0.025	0.111	0.127*	0.062	0.005	0.249
Working Experience	–0.020	0.094	–0.205	0.166	–0.365*	0.168	–0.695	–0.035
Outreach Change	0.189***	0.019	0.152	0.226	0.043	0.038	–0.032	0.118
inverse Mills ratio	–1.083	0.979	–3.009	0.843	–2.837	1.746	–6.272	0.599
Constant	–0.813	0.575	–1.943	0.317	2.954**	1.026	0.935	4.973
R^2	0.307				0.182			
F	15.87***				7.15***			
Indirect Effect (H4b)					β		95% Bias-Corrected CI	
PFP → Multiplex Ties → Indegree					0.220		0.007	0.654

	Panel E: Effects of Pay for Performance on Network Prominence through Homophilous Ties							
	DV: Homophilous Ties Change (H5a)				DV: Indegree Centrality Change			
	Model 9				Model 10			
Variables	β	Robust SE	95% CI		β	Robust SE	95% CI	
Pay for Performance	–0.430	0.275	–0.971	0.111	2.369***	0.567	1.253	3.485
Homophilous Ties Change					–0.391**	0.114	–0.616	–0.166
Organizational Rank +	0.540	0.460	–0.365	1.445	1.451	0.946	–0.411	3.313
Network Size (Time 1)	–0.054	0.048	–0.148	0.040	–0.192	0.098	–0.385	0.001
Working in the U.S.	0.819	0.428	–0.022	1.660	2.463**	0.883	0.726	4.201
Male	–0.416	0.213	–0.835	0.004	–0.327	0.440	–1.193	0.540
Company Tenure	0.042	0.030	–0.017	0.100	0.152*	0.061	0.032	0.273
Working Experience	0.017	0.081	–0.142	0.176	–0.362*	0.166	–0.689	–0.036
Outreach Change	0.516***	0.016	0.484	0.547	0.283***	0.068	0.150	0.416
inverse Mills ratio	–1.216	0.839	–2.867	0.435	–3.535*	1.729	–6.936	–0.133
Constant	0.139	0.493	–0.831	1.108	2.841**	1.012	0.851	4.832
R^2		0.772				0.200		
F		121.46***				8.04		
Indirect Effect (H5b)					β		95% Bias-Corrected CI	
PFP → Homophilous Ties → Indegree					0.168		–0.003	0.492

	Panel F: Effects of Pay for Performance on Network Prominence through Distance Ties							
	DV: Distance Ties Change (H6a)				DV: Indegree Centrality Change			
	Model 11				Model 12			
Variables	β	Robust SE	95% CI		β	Robust SE	95% CI	
Pay for Performance	1.267	0.959	–0.619	3.153	2.585***	0.576	1.452	3.717
Distance Ties Change •					–0.038	0.033	–0.103	0.028
Organizational Rank +	2.525	1.602	–0.627	5.678	1.335	0.963	–0.559	3.230
Network Size (Time 1)	–0.131	0.166	–0.458	0.196	–0.176	0.100	–0.372	0.020
Working in the U.S.	–0.379	1.490	–3.310	2.552	2.129*	0.892	0.374	3.884
Male	–0.153	0.743	–1.615	1.308	–0.170	0.445	–1.045	0.705
Company Tenure	0.074	0.104	–0.130	0.277	0.139*	0.062	0.017	0.261
Working Experience	0.122	0.282	–0.432	0.676	–0.364*	0.169	–0.696	–0.033
Outreach Change	0.873***	0.056	0.763	0.983	0.115*	0.044	0.027	0.202
inverse Mills ratio	–3.445	2.925	–9.199	2.308	–3.189	1.755	–6.641	0.263
Constant	–3.114	1.717	–6.491	0.263	2.670*	1.033	0.637	4.702
R^2		0.454				0.175		
F		29.69***				6.78***		
Indirect Effect (H6b)					β		95% Bias-Corrected CI	
PFP → Distance Ties → Indegree					–0.048		–0.265	0.040

Note. All tests are two tailed; *** $p < .001$, ** $p < .01$, * $p < .05$; + Reverse-Coded Variable. • Measured in 1,000 miles; Bias-Corrected CI are based on 1,000 bootstrap replications.

FIGURES

Figure 1. Theoretical Model

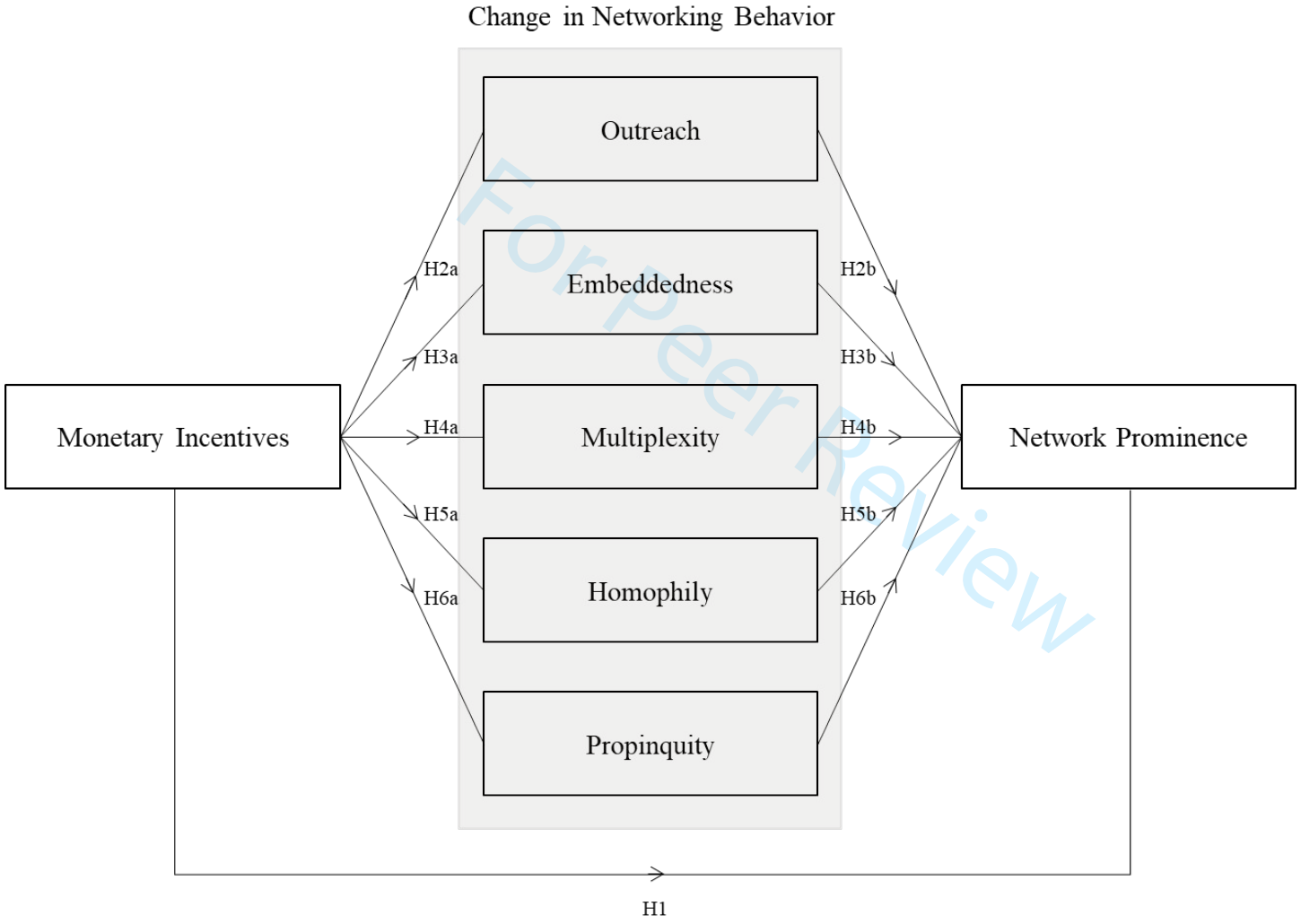
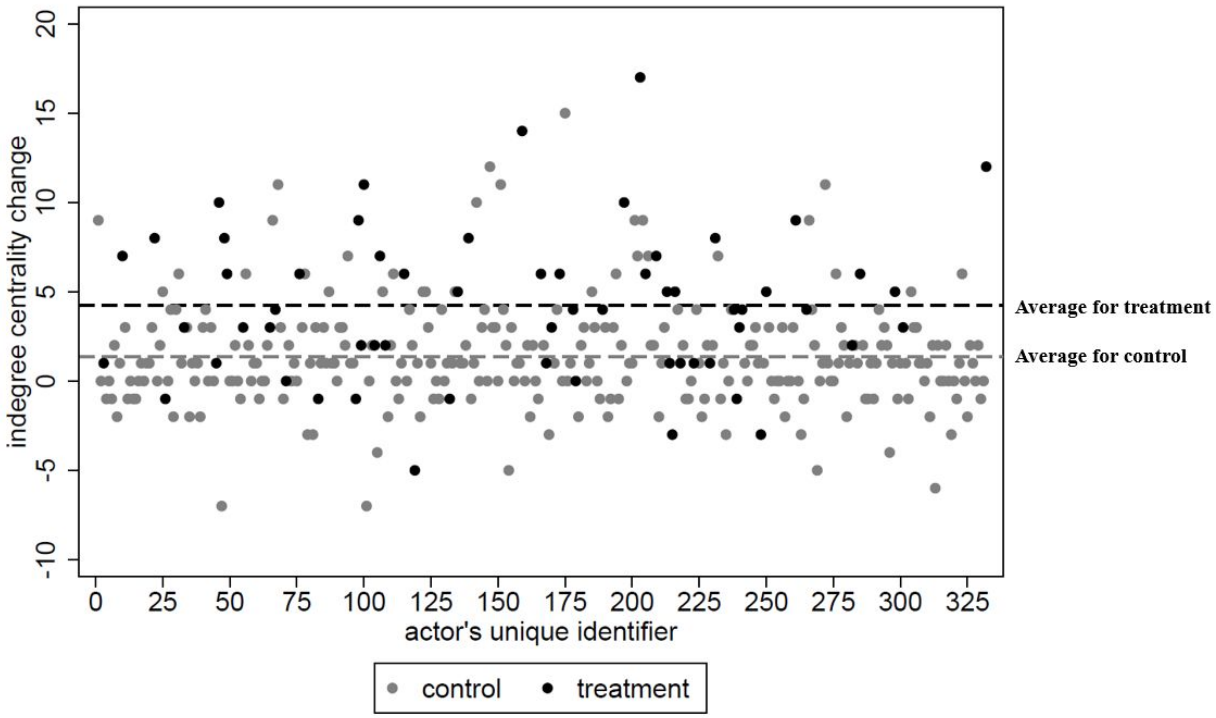
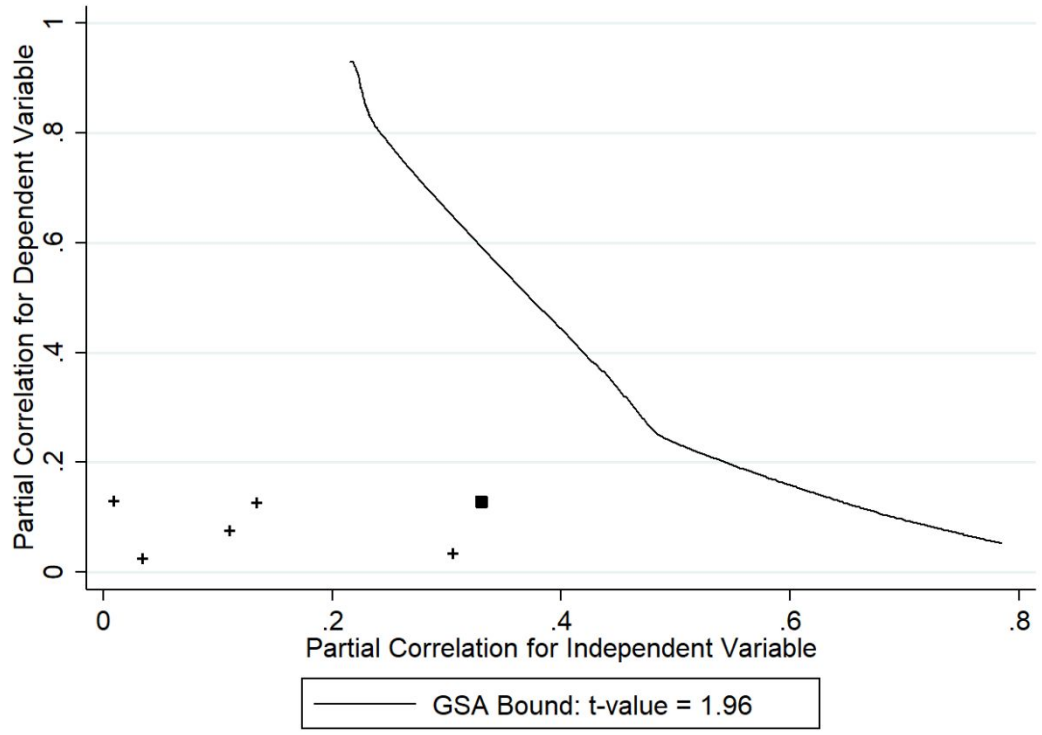


Figure 2. Change in individuals' *indegree centrality* for treatment and control groups.



Note. Each dot represents an employee in our dataset. Black dots are organizational members in the treatment group, while grey dots are those in the control group. The two dotted lines represents the average change in *indegree centrality* for each group.

Figure 3. Generalized Sensitivity Analysis Plot



Note. The graph plots two elements: the points representing the correlations of the covariates in Model 2 of Table 4, excluding the inverse Mills ratio, with the treatment (monetary incentives) on the x-axis and the outcome (i.e., indegree centrality) on the y-axis, and a contour curve representing the threshold of these correlations for an omitted variable, beyond which the coefficient of monetary incentives becomes non-significant at the $p < 0.05$ level for a two-tailed test. The figure shows that all of the covariates used in our model fall well below this curve. For a potential confounder to impair our findings its correlation with these dependent and independent variables would have to be more than double the correlation with organizational rank (filled-in square).