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LIGHTING THE WAY OR STEALING THE SHINE? AN EXAMINATION OF THE DUALITY IN STAR SCIENTISTS' EFFECTS ON FIRM INNOVATIVE PERFORMANCE

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ABSTRACT

Do star employees enhance or constrain the performance of other employees in an organization? Using data from 456 biotechnology firms between 1973 and 2003, we highlight the duality of the effects that stars have on their colleagues' performance. We show that while colleagues of stars achieve greater productivity, they exhibit lower levels of innovative leadership. We further show that the productivity of stars' colleagues is highest when working alongside a star with broad expertise who collaborates frequently. In contrast, the opportunities that stars' colleagues have for innovative leadership are greatest alongside a star with *narrow* expertise who collaborates frequently. We offer insights into the role of human capital in achieving competitive advantage, suggesting that the value of human capital is contingent on its social context.

INTRODUCTION

A growing body of research in the organization and management literature suggests that a knowledge-based firm's success and viability are contingent on the quality and positioning of its human capital (Coff & Kryscynski, 2011; Paruchuri, 2010) and investments in relevant capabilities (Kor & Mahoney, 2005). Consequently, organizations make significant investments in recruiting star employees, who are regarded as highly productive and who have superior visibility in the external market (Groysberg, Lee, & Nanda, 2008; Oldroyd & Morris, 2012). Stars are commonly believed to positively affect firms' performance, not only directly through their individual contributions, but also indirectly by providing knowledge spillovers that improve their colleagues' productivity (Burke, Fournier & Prasad, 2007). Nevertheless, given the ample benefits conferred upon individuals of high status and power[1], stars are also likely to be motivated to protect and preserve their unique positions (Bunderson & Reagans, 2011). Thus, they may limit their colleagues' opportunities to assume leadership roles in a firm's work. By implication, stars may play a dual role in influencing their colleagues' performance – a possibility we explore in this paper as we seek to advance the extant research and examine the multitude of indirect effects stars may have in organizations.

We address another area in need of research attention, namely, the role of specific factors that may moderate the positive and negative effects that stars have on their colleagues' performance. We argue that a star's focus on collective rather than individualistic goals varies based on the star's orientation toward his or her exchange relationship with colleagues. Some stars may embrace a more balanced exchange relationship and thus prioritize collective goals. In contrast, other stars may maintain a less balanced pattern of exchange with colleagues and adopt more individualistic goals (Bunderson & Reagans, 2011). The primary aim of this paper, thus, is to develop a contingency model for the effects that star employees have on their colleagues'

[1] Status and power are distinct yet tightly coupled constructs (Bunderson & Reagans, 2011), especially for star scientists who benefit from both internal and external recognition of their value. For our purposes, we use status and power interchangeably.

performance in order to address the questions of how and under what conditions these effects in organizations vary. In this undertaking, we suggest that it is not merely the recruitment or presence of a star – but perhaps more importantly, the social context fostered by the characteristics of that star – that shapes innovative performance within organizations.

Building on the organizational power and learning literatures (Bunderson & Reagans, 2011), we consider two factors associated with the orientation of star employees toward power and exchange – the breadth of a star's expertise and the degree to which a star collaborates with his or her colleagues. The breadth of a star's expertise – which increases the likelihood of overlap in areas of expertise that the star and his or her colleagues have – is likely to expand the range of research and the colleagues to which the star can provide expertise, guidance, and influence. In addition, this breadth of expertise may extend the scope of the star's power and the knowledge domains that he or she seeks to protect as his or her own turf. In effect, we argue that broader expertise increases the applicability of a star's knowledge and power within a firm. However, the star may exercise this knowledge and power in multiple ways.

Collaboration has been previously linked to promoting frequent helping behavior, reciprocity, and the prioritization of group goals (Uzzi, 1997). Thus, we argue that stars who engage in broader collaboration will have a more positive effect on both their colleagues' productivity and their opportunities for innovative leadership. We further suggest that the extent to which the breadth of a star's expertise predicts the star's propensity to empower versus constrain colleagues' performance opportunities are shaped by the degree to which the star collaborates with colleagues. Finally, we submit that these two factors interact to predict the degree and utilization of a star's power as reflected in colleagues' productivity and opportunities for innovative leadership. By exploring this possibility, we deepen our arguments and analyses.

We test our predictions with a study of 456 dedicated U.S. biotechnology firms in the time period from 1973 to 2003. Whereas prior work has primarily examined the effects of star employees from the perspective of the knowledge spillovers that these stars bring to their firms, and has thus adopted a limited focus on the *positive* effects of stars on their colleagues' performance, we draw on key insights from the power and resource dependence literatures to examine the potentially dual roles that stars play in shaping their colleagues' performance opportunities. In particular, by examining the influence of stars through a power and resource dependence lens, we argue and demonstrate that while stars may enhance their colleagues' productivity, they may also limit their colleagues' opportunities to lead research. From the perspective of the resource-based view, such a constraint on the emergence of multiple innovative leaders in an organization may reduce the overall value of a firm's human capital (Hitt, Bierman, Shimizu, & Kochhar, 2001) as well as the firm's abilities to adapt to environmental changes (Sirmon, Hitt, & Ireland, 2007). Moreover, limiting the abilities of multiple individuals to lead innovation increases a firm's dependence on a star employee who is free to leave at will (Coff, 1999). Most importantly, we demonstrate that the effects of star employees on their colleagues' performance vary based not only on the type of performance outcome, but also on stars' individual attributes. By integrating human capital theory with the power literature, we offer insights for cross-disciplinary assessments of the role that high-status individuals play in the development of human capital and sustained competitive advantage.

THEORETICAL BACKGROUND

In knowledge-based industries the development of quality human capital constitutes an important component of any competitive strategy. Human capital represents a potential mechanism for creating value by transforming inputs into desired outputs (Hatch & Dyer, 2004). It also provides the scientific foundation and creative imagination necessary to identify opportunities for knowledge to be combined and recombined (Tzabbar, Aharonson & Amburegy, 2013). Furthermore, a firm's top human capital defines the firm's ability to build new capabilities, because this talent provides the firm's inimitable tacit knowledge (Almeida, Song, & Grant, 2002). It is such knowledge, when leveraged effectively (Hitt *et al*., 2001), that leads to quality, value, and innovative competence (Henderson & Cockburn, 1994).

Two facets of the performance of knowledge workers provide critical reflections of the quality of a firm's human capital: innovative leadership and productivity. Innovation refers to an activity whose goal is to recognize problems, generate new ideas and solutions, promote and build coalitions of supporters, and produce applicable models (Scott & Bruce, 1994). Innovative leadership reflects the ability of an organization's knowledge workers to initiate and lead innovation, and thus to shape and support the firm's technological direction and research program (Tzabbar, 2009). While innovation is often a collaborative effort involving multiple individuals, the leadership of individual research initiatives is often assumed by an expert with skills and experience in a relevant domain (Zucker, Darby, & Brewer, 1998). Accordingly, innovative leadership requires an individual to have the tacit know-how to recognize a problem and generate new ideas and solutions for solving it, the ability to promote and garner colleagues' support for proposals, and the expertise to produce an applicable prototype or model for the use and benefit of the organization or parts within it (Kanter, 1988).

Individuals' innovative leadership is especially critical for knowledge-based firms, which rely on the knowledge of a group of skilled professionals to develop creative solutions to complex problems (Tzabbar, McMahon, & Vestal, in press). As more employees in an organization possess the abilities, motivation, and opportunities to contribute intellectually to and assume leadership roles in the firm's work, the firm's collective human capital becomes more valuable (Ployhart & Moliterno, 2011). In addition, the likelihood that the firm's human capital will serve as a source of competitive advantage in the market increases (Hatch & Dyer, 2004). Furthermore, when more employees in an organization can lead the firm's knowledge creation efforts, the firm becomes better able to adapt to changes in the external market (Tzabbar, 2009) and less vulnerable to loss in the face of employees' turnover (Coff, 1999).

Knowledge workers' productivity, on the other hand, reflects their ability to attain repeated innovative success. Unlike innovative leadership, an individual's productivity does not necessarily require that he or she be well-versed in the entire innovative process. Rather, an individual's productivity may be more closely tied to his or her ability to efficiently access and effectively employ, rather than personally possess, the knowledge and tangible resources required for successful research in a familiar domain. Productivity can also result from the individual serving in a supporting – rather than a leadership – role to others. By extension, the overall productivity of a firm's knowledge workers is likely to depend on the accessibility of the requisite knowledge and resources within the firm, rather than on the exceptional expertise possessed by *all* of a firm's employees (Rothaermel & Hess, 2007; Zucker *et al.*, 1998).

The power of stars

Nevertheless, the potential for a firm's human capital to constitute a rare and inimitable source of value depends on the complex interaction between the attributes of the firm's employees and the nature of the work environment (Hitt *et al*., 2001). Many have argued that the presence of a star employee exerts a strong influence on the work environment, facilitating a rare simultaneous effect on colleagues' abilities, motivation and opportunities to perform in value-creating roles (Zucker & Darby, 2001). Transcending prior work that has primarily focused on the role of stars as boundary spanners and provided a more static view of their effects in organizations, we contend that stars' effects on their colleagues' performance may be most appropriately examined through the lens of power and resource dependence. These perspectives shed light on the conditions under which stars are most likely to leverage their knowledge, access to resources, and advantageous positions in external networks to improve the value-creating potential of the rest of a firm's human capital (Hitt *et al*., 2001).

Star employees have been defined as individuals who demonstrate disproportionately high levels of performance and have superior visibility in the external market relative to 'average' colleagues in an industry (Groysberg, *et al.*, 2008). A star employee's power and status is rooted in the uniqueness of his or her exceptional expertise (French & Raven, 1959), along with the access to valuable resources and opportunities that this expertise provides (Ibarra, 1993) both within and outside their firms (Hess & Rothaermel, 2011). The power of star scientists is reinforced by the scarcity, complexity, and tacitness of their knowledge, as well as environmental uncertainty, which makes their superior expertise and ability to direct a firm's research program effectively even more valuable and difficult to replace (Zucker *et al.*, 1998). Thus, stars may contribute to a firm's competitive advantage based on the rarity and inimitability of both their own individual performance contributions as well as the unique resources and knowledge they can leverage to benefit the broader performance potential of their colleagues.

Given the ample benefits conferred upon individuals of high status in organizations (Pfeffer, 1981), such individuals are particularly motivated to protect the uniqueness of the resources they control and invest significant efforts in preserving their positions of power (Overbeck & Park, 2006). The emergence of an alternative source or adequate substitute for a star's expertise among colleagues may represent a potential threat to a star's unique position (Casciaro & Piskorski, 2005), prompting stars to protect their turf in order to limit the opportunities of their colleagues to assume innovative leadership roles (Overbeck & Park, 2006).

Power, however, is rooted in the dyadic relationships and exchanges between individuals (Astley & Sachdeva, 1984). Stars can preserve their power and control over a firm's resources only to the extent to which they use these resources effectively to achieve some broadly accepted organizational goal (Willer, 2009) or when they employ these resources in a socially accepted manner (Overbeck & Park, 2006). In this regard, to maintain their advantageous status, stars must achieve some minimum level of symmetry in their exchanges with colleagues such that both they and their colleagues benefit from their interactions (Piskorski & Casciaro, 2006). Should a star fail to fulfill this expectation, his or her colleagues may respond by assigning the star lower status, demonstrating less openness to the star's influence (Willer, 2009), or reducing the extent to which they engage with the star in the future (Piskorski & Casciaro, 2006).

The incentive that stars have to preserve their own power while fostering mutual benefits in their exchanges with colleagues explains the duality we expect to find in the effects that stars have on their colleagues' performance. On one hand, increasing their colleagues' abilities, motivation, and opportunities for productivity may enhance stars' own productivity and prestige. Thus, stars may view such a prospect as a mutually beneficial, win-win option for the use of their time and resources. On the other hand, given that innovative leadership positions are more exclusive in nature and may dictate future resource allocations in a firm, stars may choose to constrain their colleagues' opportunities to lead research and influence a firm's technological direction in an effort to preserve their own power (Tzabbar, 2009).

The effect stars have on their colleagues' innovative productivity and leadership may vary further based on a star's orientation toward his or her exchange relationship with colleagues. Some stars may adopt a pattern of more balanced exchanges with an emphasis on collective goals. In contrast, others may develop relationships characterized by less balanced exchanges with an emphasis on individualistic goals (Bunderson & Reagans, 2011). In the present context, we argue that stars who engage in limited collaboration and those who have a narrow to moderate technological breadth in their expertise will be more likely to favor individualistic goals. Such stars may limit the opportunities of their colleagues to lead research. In contrast, stars who collaborate more frequently and have broader expertise will develop more balanced exchange relationships with their colleagues. Such stars may be more inclusive in providing innovative leadership opportunities (McClelland, 1975) as a means of facilitating the achievement of collective goals such as broader employee learning and development.

HYPOTHESES

Stars' impact on their colleagues' performance

The recruitment of star scientists provides incumbent scientists in a firm broad access to knowledgeable and influential others (Zucker *et al.*, 1998). Furthermore, as stars are experts and central players in the professional community, the recruitment of a star is likely to increase a firm's access to external sources of funding as well as other tangible resources that are valuable for innovative productivity (Liebeskind, Oliver, Zucker, & Brewer, 1996). Given that individuals rely on interpersonal ties as conduits for knowledge exchange (Parachuri, 2010), such improved access to tangible and intangible resources is likely to provide a star's colleagues with greater opportunities to pursue innovation relative to peers in firms who do not have such access (March, 1991). In turn, such access leads to increased productivity potential (Hess & Rothaermel, 2011).

In addition, the deep knowledge that stars have enables them to identify the most promising research opportunities and thus to lead a firm's research in fruitful directions (Zucker *et al*., 1998). As a result, a star's colleagues may encounter less uncertainty and fewer hurdles in their research initiatives, thereby further improving their innovative productivity. Furthermore, given that individuals seek to learn and model activities associated with desired outcomes, they are particularly apt to identify role models who have attained expert status in a particular context (French & Raven, 1959). This appeal is likely to motivate a star's colleagues to observe and model the star's work routines in an attempt to achieve similar effectiveness by adopting the behavioral norms conducive to research productivity (Wood & Bandura, 1989). In contrast, employees without the example of a star face greater difficulties in exploiting existing opportunities because they have no role model from whom to learn the most effective work practices for innovation (Burke *et al*., 2007). Accordingly, we hypothesize:

H1a: The recruitment of a star relates positively to the innovative productivity of the stars' colleagues.

While newly hired stars may provide colleagues with opportunities for improved productivity, stars also exercise control over key resources that they may use to advance their own research programs (Zucker & Darby, 2001), thereby increasing their colleagues' reliance on them for direction and support (Brass, 1984). When a star exercises control over a firm's research (Huckman & Pisano, 2006), the star's colleagues have less time and fewer resources to pursue their own research agendas (Huckman & Pisano, 2006), thus reducing their opportunities to assume leadership in the firm's innovative activities. Further, these constraints on colleagues' opportunities to gain experience in leading research hinder their development as innovative leaders, thus perpetuating their reliance on the star's expertise (Zucker *et al*., 1998).

Moreover, when there are large status differentials in a collective, members with lower status tend to perceive their work environment as less safe for experimentation. In such situations, these individuals are less likely to take on risky initiatives (Bunderson, 2003a). The fact that failure may significantly reduce the likelihood that low-status actors will be endorsed by high-status actors in a collective may further dampen the appetite of a star's colleagues for taking risks in leading their own research in the presence of a star (Eisenhardt & Bourgeois, 1988). Additionally, a lack of tolerance for mistakes and the firm's expectation that its star scientists will lead the organization's research (Overbeck & Park, 2006) limit the opportunities of non-star scientists to lead innovation even if the desire is present (Tzabbar, 2009).

In contrast, in a more symmetric social structure, colleagues have more opportunities to assume innovative leadership of more research efforts. In particular, when power and status among members of a collective are more balanced (e.g., when no star is present), individuals pay more attention to differences in the experience and expertise of all members (Bunderson, 2003a; 2003b). This more open perspective encourages broader involvement, enhances knowledge sharing and assimilation, and increases the willingness of all individuals to take the initiative in collective efforts (Edmondson, 2002). Accordingly, we hypothesize:

H1b: The recruitment of a star relates negatively to innovative leadership among his or her colleagues.

The roles of the breadth of a star's expertise and collaboration

As discussed above, the recruitment of a star provides colleagues with access to valuable knowledge. However, stars may vary in their interest in sharing tacit knowledge and in the control they exert over their colleagues' work. Building on extant research on social network theory (Burt, 1992) and team learning (Bunderson, 2003a, 2003b), we consider how the effects that stars have on their colleagues' productivity and innovative leadership vary with the degree to which a star's expertise spans a broad range of technologies, as well as with the degree to which a star collaborates with his or her colleagues.

***The breadth of a star's expertise*.** If the productivity of scientists is a function of access to tangible and intangible resources, the reduction of uncertainty, and direction through the research process, we argue that stars with broad expertise are more likely than stars with narrow expertise to have a positive influence on their colleagues' productivity. However, we expect this effect to diminish when a star has an exceptionally high level of breadth in his or her expertise.

Specifically, we expect the breadth of a star's expertise to improve the scope and quality of knowledge that the star attracts, integrates, and filters into a firm (Rothaermel & Hess, 2007). By implication, when a star has broader expertise, a larger pool of colleagues with a wider range of skills and interests gain exposure to the relevant, timely knowledge that the star brings to the firm (Liebeskind *et al*., 1996). Breadth in a star's expertise may also increase the star's centrality in the organization's workflow (Nerkar & Paruchuri, 2005) and thus the desirability of the star as a role model in the firm. This increased prominence allows the star to shape the attitudes, norms, and behaviors of a larger portion of the firm's workforce more easily (Wood & Bandura, 1989), thereby increasing motivation and facilitating work patterns that are conducive to effective and efficient research outcomes for more colleagues and the firm as a whole.

However, the benefits associated with increased access to knowledge, resources, and opportunities through a star are not without limits. In particular, integrating knowledge from multiple domains and sources requires processing time and effort. Each instance of knowledge exchange or request for a star's guidance represents a draw on the star's time and attention. Given individuals' finite cognitive capacities, at a certain point, constant information flows to and from a star may cause the star to experience social and informational overload (Schroder, Driver, & Streufert, 1967), subsequently hindering the star's ability and motivation to perform (Oldroyd & Morris, 2012) or provide knowledge- and resource-based benefits to colleagues. More specifically, given that the integration of multiple perspectives demands greater coordination, communication, and resources, information overload may override the benefits of any additional source of information. Thus, at a certain point the star's access to knowledge across more domains is not likely to benefit the performance of the star or his or her colleagues.

Empirical evidence lends support to this argument as well, with previous research demonstrating that information overload reduces employees' motivation to share information (Kirsh, 2001) and, in turn, decreases learning rates (Schilling *et al*., 2003). For this reason, while at low to moderate levels, increased breadth in a star's expertise is likely to improve colleagues' productivity due to the increased scope of the star's influence and provision of knowledge and resource access throughout the firm, at very high levels, we expect further increases in the breadth of a star's expertise to hinder the star's capacity to help colleagues. Therefore, we predict that the effect of the breadth of a star's expertise on colleagues' productivity will attenuate.

H2a: There is a diminishing positive relationship between the breadth of a star's expertise and colleagues' innovative productivity, such that at low and moderate levels of breadth of a star's expertise, colleagues' innovative productivity increases, but at higher levels of breadth, this positive effect weakens.

Stars whose expertise spans a broad range of knowledge domains are also positioned to exert more influence over the research directions of the firm as a whole, and thus may impose greater constraints on colleagues' opportunities to lead research (Ibarra, 1993). We argue, however, that the degree to which a star engages in turf protection, which limits colleagues' opportunities for innovative leadership, is likely to vary in a non-linear pattern with the breadth of a star's expertise.

The incentive for powerful individuals to engage in power-preserving activities and to minimize the opportunities of others to gain power stems from the motivation to maintain the uniqueness of their relative status in an organization (Ibarra, 1993). When a star draws his or her status from expert power rooted in just one or a few knowledge domains, the star's 'expertness' is vulnerable to redundancy given the emergence of other scientists in the firm who prove capable of leading research in any of the star's few areas of expertise. As a result, stars with narrow to moderate levels of expertise breadth are likely to be motivated to limit their colleagues' attempts to assert themselves as intellectual leaders in these areas. Such attempts would be regarded as infringing on the star's limited turf. As the breadth of a star's expertise increases, the number of knowledge domains across which the star may engage in turf protection also increases, enabling the star to constrain a larger number of colleagues in their attempts to assume innovative leadership in the firm's research (Van der Vegt, Bunderson, & Oosterhof, 2006). Such a situation translates into a negative relationship between the breadth of the star's expertise and colleagues' innovative leadership opportunities.

On the other hand, when a star draws his or her status from expert knowledge across a wide range of technologies, colleagues' leadership of research in one or several of the star's many knowledge domains poses less of a threat to the star's unique position in the organization. In fact, it may actually help the star manage the projects in his or her many areas of research. Specifically, given that innovation requires the integration and recombination of specialized knowledge (Henderson & Cockburn, 1994), in order to remain very productive, stars with broad expertise are more likely to seek out and rely on assistance from colleagues with specialized expertise in relevant domains. The resulting reciprocal exchange of knowledge is likely to create a pattern of mutual dependence between stars with broad knowledge and their colleagues (Casciaro & Piskorski, 2005). As a result, stars with very broad expertise may develop more balanced intellectual exchange relationships with their colleagues (Flynn, 2003). Such relationships require the adoption of a collective goal orientation and a willingness to relinquish control and invest time in sharing the tangible and intangible resources required for colleagues to assume innovative leadership (Van der Vegt *et al*., 2006). In contrast, stars with narrow and moderate breadth in expertise are likely to be less concerned about maintaining a balanced intellectual exchange with their colleagues. Therefore, they are more likely to adopt individualistic goals and assume a more directive and protective stance in their positions of power (Bunderson & Reagans, 2011).

Accordingly, we expect that the relationship between the breadth of a star's expertise and colleagues' innovative leadership will resemble a U shape – with colleagues' innovative leadership decreasing at low to moderate levels of breadth in the star's expertise and increasing at high levels of breadth in the star's expertise.

> *H2b: The breadth of a star's expertise demonstrates a U-shape relationship with colleagues' innovative leadership, such that at low and moderate levels of breadth of expertise, colleagues' innovative leadership decreases, but at higher levels of breadth, it increases.*

The extent of a star's collaboration. Collaboration entails ongoing task-based communication, which can produce a shared foundation for the efficient transfer of knowledge. Frequent collaboration helps team members learn about one another (Espinosa, Slaughter, Kraut, & Herbsleb, 2007). When stars and their colleagues have such opportunities, they develop a shared understanding – a collective way of organizing relevant knowledge. Prior collaboration is also one means by which common ground can be established, resulting in more effective communication through the development of relationship-specific heuristics, a unique language, and shared codes (Kogut & Zander, 1992). A shared language allows members to understand, recognize the value of, and absorb one another's knowledge more effectively, thus increasing efficiency in communication and reducing the resources required to exchange knowledge effectively over time (Harrison, Mohammed, McGrath, & Florey, 2003).

When people share a collective mind or mental models, they can coordinate work and perform more effectively and efficiently when trying to generate novel ideas (Vera & Crossan, 2005). Individuals know what the collective is trying to achieve, how to achieve it, and what assets each member brings to the collective task, as well as how their individual work contributes to the tasks of others and how to obtain cooperation from other members (Weick & Roberts, 1993). Such familiarity with who knows what in a collective results in a more efficient division of labor that assigns the most competent person to each role. Each person benefits most from the knowledge accumulated by other team members and the collective is better able to benefit from each member's unique knowledge (Reagans, Argote, & Brooks, 2005). With prior experience working together, members can start new tasks with a clearer anticipation of events, more effective routines, more accurate methods to convey and interpret meaning, and stronger predictions about the behavior of their peers (Cannon-Bowers & Salas, 1998). Furthermore, such familiarity reduces uncertainty and process losses because members spend less time acquiring information about each other at the beginning of each new task (Harrison *et al.*, 2003).

This increased efficiency and effectiveness resulting from collaboration between a star and colleagues is likely to facilitate information flows and enable a firm's scientists to tap firm-wide knowledge bases to increase their overall productivity (Azoulay, Zivin, & Wang, 2010; Oettl, 2012). Accordingly, we suggest that collaboration improves the ability of a star's colleagues to exploit available knowledge and opportunities as well as develop more efficient work routines that can increase their productivity.

H3a: The extent of a star's collaboration with colleagues relates positively to colleagues' innovative productivity.

The transfer of a star's explicit knowledge may increase colleagues' productivity, thereby helping colleagues while reinforcing the star's prestigious position in the firm. However, this transfer may also potentially undermine the star's expert status (French & Raven, 1959), which may reduce the star's motivation to train and enable others to lead research (Bunderson & Reagans, 2011). Here we suggest that trusting relationships developed through broad and frequent collaboration between a star and his or her colleagues may reduce the star's concerns and guarding of their unique positions in three ways. First, trust in relationships reduces the risk of opportunistic behavior in exchange (Granovetter, 1982). Such trust is likely to increase the star's willingness to share his or her tacit knowledge to promote colleagues' understanding of the innovation process. In particular, frequent collaboration is likely to buttress the star's belief that his or her colleagues' behavior is rooted in fairness, making the star confident that colleagues will not take advantage of any shared knowledge or leadership opportunities in ways that compromise the star's unique status or undermine the star's power in the firm. Thus, stars who collaborate with colleagues regularly may be less likely to guard their tacit knowledge and more likely to relinquish control over innovation because they have greater faith in their colleagues' goodwill (McEvily, Perrone, & Zaheer, 2003).

Second, trusting relationships are likely to increase a star's motivation to invest time and effort in knowledge exchange and to ensure that colleagues understand and use shared knowledge effectively. In relationships characterized by trust, both the source and the recipients are more willing to share and accept knowledge (Reagans & McEvily, 2003). The more team members collaborate, the more time and effort they are willing to invest on behalf of one another, including effort in the form of sharing and integrating tacit knowledge (Hansen, 1999) and support in resolving knowledge transfer-related challenges (Szulanski, 2000). Such a motivation may be rooted in psychological considerations, such as the desire to maintain balanced relationships (Heider, 1958). As a result, knowledge transfer and implementation are more likely to be successful when a star and his or her colleagues engage in ongoing collaboration, leading colleagues to be more effective in innovative leadership roles.

Third, and most importantly, by increasing familiarity and trust, collaboration fosters a star's prioritization of collectivistic over individualistic goals (Uzzi & Lancaster, 2003), which is likely to increase a star's concern for colleagues' collective development and success (Van der Vegt, de Jong, Bunderson, & Molleman, 2009). When such collective goals are prioritized, a star is likely to adopt a more encouraging and participatory interaction style, because the star recognizes the importance of broader capability distribution for the success of the organization (Nembhard & Edmondson, 2006). Thus, when collaboration between stars and colleagues is high, stars are likely to be more willing to relinquish innovative leadership opportunities to their colleagues, while still continuing to serve in an advisory role and share requisite tacit knowledge to ensure the success of colleagues' research initiatives. Accordingly, we expect:

H3b: The extent of a star's collaboration with colleagues relates positively to colleagues' innovative leadership.

The joint effect of the extent of a star's collaboration and the breadth of a star's expertise on colleagues' performance. Implicit in the arguments made above is that stars vary both in their tendency to collaborate and in the breadth of their expertise. While stars with broad expertise may have more opportunities to collaborate with their colleagues, some may prefer to limit the scope of their collaboration, while others may prefer to collaborate broadly and frequently. Accordingly, there may be variance in the effects that stars have on their colleagues' performance, not only between stars with narrow versus broad expertise, but also within each one of these groups, contingent on the degree to which a star collaborates with colleagues. By exploring this possibility, we seek to deepen our arguments and analyses. Thus, we examine the joint effect of a star's breadth of expertise and degree of collaboration on colleagues' performance.

Broad star expertise is likely to increase the scope of knowledge and the number of resources the star brings to the organization, the range of research opportunities to which the star provides access for his or her colleagues, and the number of colleagues on which the star may exert direct and indirect influence. Collaboration is argued to increase familiarity and thus the efficiency and effectiveness of work routines used by a star's colleagues in innovation (Espinosa *et al*., 2007). Stars with broad expertise collaborating frequently with their colleagues are likely to yield the highest levels of colleague productivity. More specifically, when familiar colleagues have more tangible and intangible (i.e., knowledge) resources at their disposal, they are best positioned to identify viable research opportunities and to fully exploit them through an effective division of labor, which in turn may increase the overall productivity of a star's colleagues. Accordingly, we expect that a high level of collaboration by a star combined with the broad inflow of knowledge into the organization that results from the star's expertise will result in significantly greater productivity for a star's colleagues.

H4a: The relationship between the breadth of a star's expertise and colleagues' innovative productivity is moderated by the degree of the star's collaboration, such that high collaboration increases the positive effect of expertise breadth at moderate levels of such breadth and reduces the attenuation of the effect at high levels of expertise breadth.

Drawing on our previous arguments related to collaboration, we argue that the U-shaped relationship between the breadth of stars' expertise and colleagues' innovative leadership may weaken as stars engage in greater collaboration. Specifically, given that collaboration fosters familiarity and trust, stars engaging in strong collaboration with colleagues may feel less threatened by their colleagues' assumption of innovative leadership roles and seek more balanced exchange relationships with their colleagues. Thus, such stars may be more willing to empower their colleagues by sharing their tacit knowledge of the innovation process (Van der Vegt *et al.*, 2006). Under circumstances of frequent collaboration, we expect that stars with narrow and moderately broad expertise will limit their turf protection activities, and those with very broad expertise are likely to be even more empowering due to their dependence on their colleagues. Thus, we expect that when stars collaborate extensively with their colleagues, the relationship between the breadth of the former's expertise and their colleagues' innovative leadership will be less negative at narrow and moderate levels of expertise breadth and more positive at high levels of expertise breadth. More formally, we predict:

H4b: The relationship between the breadth of a star's expertise and colleagues' innovative leadership is moderated by the degree of the star's collaboration, such that high collaboration reduces the negative effect at low levels breadth in the star's expertise and increases the positive effect at high levels of breadth in the star's expertise.

DATA AND METHODS

Research setting

We examine how and under what conditions the effects of star scientists on their colleagues' innovative productivity and leadership vary. Biotechnology exemplifies a knowledge-intensive, dynamic setting in which innovative productivity and leadership is reflected in scientists' patenting activities. Most knowledge that leads to scientific discoveries is embedded in inventors, so factors that influence inventors' abilities and motivation to perform are likely to affect a firm's overall performance significantly. The need for biotechnology firms to develop creative solutions to complex problems forces research directors to be very dependent on R&D members' unique knowledge, skills, and backgrounds, allowing various individuals to assume leadership roles (Amin & Roberts, 2008). Furthermore, dedicated biotechnology firms typically have one R&D unit that is responsible for all innovations, improving our ability to examine the direct effect of a star scientist on his or her colleagues. Given these characteristics, this research setting is an appropriate, interesting, and important context in which to test our hypotheses.

We obtained data from a population of small, dedicated and independent U.S. biotechnology firms founded between 1973 (the year of the Cohen-Boyer breakthrough involving recombinant DNA, often called the birth of modern biotechnology) and 2003. We identified firms using BioScan, the most comprehensive historical list of U.S. biotechnology firms. We cross-checked this information with the U.S. Companies Database (Bioworld), compiled by the North Carolina Biotechnology Center. We excluded all firms that were founded before 1973, the birth of biotechnology, or that were not independent entities, meaning we discounted subsidiaries. The final sample consists of 456 dedicated U.S. biotechnology firms. We then compiled life histories of all U.S. biotechnology firms during the specified period and then constructed a data set of all patented innovations generated by these firms. Finally, we identified all scientists involved in each patented innovation.

Star inventors. Star employees have been defined as highly productive individuals who have superior visibility in the external market relative to 'average' colleagues in an industry (Groysberg, *et al.*, 2008). While the precise operationalization of stars has varied across research contexts in empirical studies in this literature (Azoulay, *et al.*, 2010; Groysberg & Lee, 2009)[2], we follow previous research examining the biotechnology industry in identifying stars based on the quantity and impact of their cumulative research (Zucker & Darby, 2001). Specifically, to identify star scientists, we used the following formula:

$$InvPerformance = \left[\left(\frac{InvPat_{it}}{IndTenure_{it}}\right) \times AveForwardCite_{it}\right]$$

where $InvPat_{it}$ represents the number of patents for which scientist *i* applied by year *t*. We divided this number by scientist *i*'s tenure in the industry as of year *t*, represented by the number of years since the scientist's first patent application. Given that forward citations in patents provide the best proxy for a patent's impact, we multiplied our calculations by the average forward citations of scientist *i*'s patents received by year *t*. Finally, we compared each inventor's productivity score at time *t* with the industry average.

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[2] Some have used journal publications and grants as key indicators to identify star scientists. Our data collection effort revealed, however, that journal publications and grants are strongly associated with university inventors because private firms are not as motivated as universities to publish their research. Thus, we chose not to use journal publications as a criterion to identify stars. As such, our sample and measures are consistent with Zucker and Darby's (2001) research on star scientists.

Consistent with prior work (Zucker & Darby, 2001), our data shows a skewed distribution of inventor performance (bimodal distribution)[3]. Since highly skewed variables violate the assumption of multiple regressions and can distort relationships and significance tests, we followed prior work and distinguished between star and non-star employees by dichotomizing the variable. A scientist whose productivity score is at least two standard deviations above the industry average is defined as a star scientist. Given that we updated scientists' scores annually, we allowed for non-star scientists to become star scientists over time. We identified 531 star scientists during the study period (about 7 percent of the scientists in our sample), who were employed by 155 firms in our sample. Accordingly, we follow this standard procedure and operationalize the star firm as a dummy variable, where 1 indicates that a firm employs at least one star scientist.

Dependent variables

The two main outcomes of interest in this study are colleague productivity and innovative leadership. Following an approach used by many other researchers (Ahuja & Katila, 2001), we examined successful patent applications (not issuances, which can lag considerably) to indicate *inventor productivity*. To aggregate inventor productivity to the firm level, we chose to use the median rather than the mean number of patents for which a non-star scientist applied, because the mean is more susceptible to influence by extreme outliers. *Colleagues' innovative leadership* reflects the ability of an organization's (non-star) scientists to initiate and lead research from innovation to patenting. We operationalized *colleagues' innovative leadership* as the ratio of patents applied for by firm *i's* inventors where no star scientists were involved as co-inventors. We mean-centered both dependent variables in all analyses.

Independent variables

Star recruitment. Following a procedure developed by others (Tzabbar, 2009), we used patent data to locate instances in which an inventor filed a patent for firm *x* and then subsequently filed a patent for firm *y* and interpreted this sequence as indicating that firm *y* had recruited this

[3] Plotted results are available upon request.

scientist away from firm *x*. Overall, we observed 229 star recruitment events. It is worth noting one challenge to this procedure. If a scientist did not patent while employed at an organization, we had no record of his or her mobility. However, as we examine the mobility of highly prolific individuals who have the highest propensity to patent, we contend that inferring mobility using this method provides reliable data. To be safe, however, we can consider this sample as representing a subset of all hired star scientists.

Breadth of star's expertise. As some firms have more than one star scientist, we examined the effect of the breadth of expertise of the star with the highest level of expertise breadth**.** To assess the breadth of a star's expertise, we followed Hall (2002) and used a non-biased Herfindahl index for citations. We updated the star scientists' technological portfolio with each patent application. Using Tzabbar's (2009) 22 technological fields, we indexed each field by $j = 1, \ldots, 22$, so that the N_i patents that scientist i had at time t could each be assigned a technological field. We let N_{ij} denote the number of patents the ith scientist holds in category j. Subtracting this value from 1, the breadth of expertise variable is:

$$Breadth\ of\ Star\ Expertise = \left[1 - \sum_{j=1}^{22} \left(\frac{N_{ij}}{N_i}\right)^2\right]$$

Degree of star's collaboration. Consistent with previous research, we examined the breadth and frequency of star scientists' co-inventions with colleagues to capture the degree of star-colleague collaboration (Uzzi, 1996). Specifically, we computed the degree of a star's collaboration as the average level of co-invention frequency between star and non-star scientists in firm *s*,

$$Star\ Collaboration_s = \frac{\sum_{i=1}^{N_s} \sum_{j=1}^{N_s} z_{ijs} / \max(z_{ijs})}{N_s(N_s - 1)}, j \neq i,$$

where z_{ijs} (϶ {0,1,2,3,4}) is the frequency with which star scientist *i* co-invents with team members *j*; max (z_{ijs}) is the largest possible number of collaboration ties that scientist *i* could have within the firm; and N_s is the number of members in firm *s*. The degree of collaboration varies from 0 (no co-invention) to 1, which would imply a complete network containing all possible ties among incumbent scientists.

To test Hypotheses 4a and b, we interacted the degree of collaboration with the breadth of a star's expertise. To facilitate the interpretation of our results, we mean-centered the moderating variable terms and entered their main effects into the model.

Controls

Firm controls. Past behavior is argued to be a strong indication of future behavior. Accordingly, we accounted for the degree of colleagues' innovative productivity and leadership prior to the recruitment of star inventors. Public firms may be better able to fund research initiatives than private firms (Baum & Oliver, 1991), so we included a *Public Firm* control, equal to 1 if firm *y* is publicly traded and 0 if it is not. *Firm Age* is the natural logarithm of the years since the firm was incorporated. Some firms patented prior to their incorporation, though, in which case we adjusted the date of incorporation to the date of their first patent application. *Firm Size* is the natural logarithm of the number of employees in a firm, as reported in BioScan. Raising *Venture Capital* can enable a firm to support more research projects, so we used the natural logarithm of the dollar sum raised as the value of this control. Finally, *CEO Succession* may lead to the introduction of a new research agenda that disrupts organizational routines, so using BioScan reports about key personnel, hiring announcements in Lexis-Nexis, and firm contacts (Shen & Cannella, 2002), we coded this variable according to whether a firm appointed someone who was not previously part of the firm's TMT as its new CEO. Following prior research (Shen & Cannella, 2002), we used a three-year lagged measure of CEO succession to allow for sufficient time for new CEOs to exert their influence on human and social capital.

Other sources of knowledge flow. We included R&D alliances and scientist-hiring events to account for the possibility that these other sources of knowledge flow might affect scientists' innovative productivity and opportunities. An R&D alliance can be a source of information, so we controlled for the number of *Prior R&D Alliances* and the number of *In Progress R&D Alliances*. To account for the possibility that scientist recruitments and turnover affect the innovative routines of incumbent scientists, we included a *Recruitment* event, coded to equal 1 if such an event occurred in the previous three years, and 0 otherwise.

Another factor that may affect incumbent scientists' innovative output is the degree to which R&D members are geographically distributed, which influences coordination, communication, and control costs (Tzabbar, *et al.*, in press). We identified firm members' geographic locations from patent data. We also used an inverted Herfindahl index to measure the geographic dispersion of a firm's scientific members.

Research design

Testing our hypotheses required an analysis of two different firm samples. Specifically, to test our first two hypotheses we examined the effect of star recruitment on colleagues' innovative productivity and leadership in all 456 firms in our sample. However, the data introduced a unique challenge in testing the effect of recruitment, because many of the recruitment events represented star mobility to firms that already employed star scientists. To address this issue, we complemented this analysis with a comparison of colleague performance between star and non-star firms (i.e., assessing the effects of employment, rather than recruitment, of star scientists on the performance of non-star inventors). The rest of our hypotheses are focused on the characteristics of star inventors and therefore required that we analyze only the 155 firms that employed at least one star inventor.

Analysis

The cross-sectional (across firms) and time-series (over years) data suggest the appropriateness of panel data methodology. One challenge in examining the effect of stars' recruitment on their colleagues' performance is that the observable differences between firms with and without star scientists could be attributed to the initial differences in the quality of human capital between firms that hired a star and those that did not. We addressed this issue in few ways. First, we account for some of these differences in our analysis by employing a fixed-effects model. Our data encompassed virtually an entire population of dedicated and independent U.S. biotechnology firms, rather than random draws from a population, so they obviated a key assumption of random effects (Wooldridge, 2003). A Hausman test also indicated significant ($p < .01$) systematic differences in the coefficients of the random effects versus fixed-effects models, suggesting that the fixed-effects models were more appropriate.

Second, we corrected for potential endogeneity by employing a two-stage Heckman selection procedure (Heckman, 1979). In the first stage, we generated an inverse Mills ratio that accounts for the likelihood of recruiting a star inventor. Given that firms that exhibit a high level of innovative performance and have quality human capital can attract star scientists, we examined the effect of *prior firm patents* and *number of star inventors* on star recruitment. We then included this Mills ratio as an additional coefficient in the second stage where we examined the effects of our theoretical variables.

Descriptive Statistics

In Table 1, we present the means, standard deviations, and correlations among the independent and control variables. VIFs derived from an ordinary least squares regression and the modest correlations between the independent variables suggested that multicollinearity problems were unlikely (highest VIF = 3.1, well below the benchmark of 10). We took additional steps to avoid problems with multicollinearity by centering the variables used to test the predicted interactions. In addition to mean-centering the interaction terms to reduce multicollinearity, we estimated and tested the significance of groups of variables, compared against a series model, and examined the coefficients' standard errors for inflation to ensure that multicollinearity was not causing less precise parameter estimates (Kmenta, 1986).

--- Insert Table 1 about here ---

RESULTS

The effect of star recruitment on colleagues' innovative productivity and leadership

In Table 2, we detail the results pertaining to the main effects of star recruitment on colleagues' productivity and innovative leadership, addressing Hypotheses 1a-b.

Innovative productivity. The baseline Model 1 in Table 2 summarizes the effects of the inverse Mills ratio and control variables. As shown, the Mills ratio accounting for a firm's likelihood of recruiting star scientists is positive and significant. This finding reduces the possibility that the results are affected by unobserved relationships between the decision to recruit a star and incumbent scientist’s performance. Surprisingly, the effect of average scientist productivity prior to star recruitment is negative and significant. Factors such as being a public company, a large company, scientist recruitment, in-progress R&D alliances, and CEO succession all have a positive and significant effect on the productivity of a star’s colleagues. Venture capital and prior R&D alliances have a negative and significant effect on colleagues’ productivity.

Model 2 in Table 2 provides a test of Hypothesis 1a, which predicted that the recruitment of a star increases colleagues’ innovative productivity. As expected, the recruitment of star scientists relates positively and significantly ($\beta = .350$; $p < .01$) to colleagues’ productivity. On average, the innovative productivity of colleagues in firms that hired a star is 35 percent higher than that of scientists in firms that did not recruit a star inventor. However, since most of the recruitment events in our data were conducted by firms that already employed at least one star inventor, we compared firms with at least one star inventor and firms with no stars by including a dummy variable (Model 3). As shown, the presence of star inventors predicts the innovative productivity of non-star scientists, reflected in a positive and significant effect ($\beta = .478$; $p < .01$). This finding suggests that on average, the innovative productivity of non-star inventors in firms with star scientists is 48 percent higher than that of inventors in firms with no star scientists.

--- Insert Table 2 about here ---

Innovative leadership. The baseline Model 4 in Table 2 summarizes the effects of the inverse Mills ratio and control variables on colleagues’ innovative leadership. As shown, the effect of the Mills ratio accounting for a firm’s likelihood of recruiting star scientists is negative and significant. As expected, prior innovative leadership in a firm exerts a positive and significant effect on present innovative leadership. Similarly, firm age, size, venture capital investment, scientist recruitment, geographic dispersion and prior R&D alliances all have a positive and significant effect on non-star inventors' innovative leadership. CEO succession, however, has a negative and significant effect on innovative leadership.

Using Model 5, we test Hypothesis 1b, which predicted that the recruitment of a star reduces colleagues' innovative leadership. As expected, the recruitment of star scientists relates negatively and significantly (β = -.135; $p < .01$) to colleagues' innovative leadership. On average, the innovative leadership of colleagues in firms that hired a star is 14 percent lower than that of scientists in firms that did not recruit a star inventor. However, given that most of the recruitment events in our data were carried out by firms that already had at least one star inventor, we compared innovative leadership between firms with at least one star inventor and firms with no stars by including a dummy variable (Model 6). As shown, the presence of one or more stars exerts a negative and significant effect on the innovative leadership of non-star inventors (β = -.28; $p < .01$). On average, the innovative leadership of colleagues in firms with star scientists is 28 percent lower than in firms with no star inventors.

Roles of breadth of a star's expertise and degree of a star's collaboration

To determine whether the effect that stars have on colleagues' performance varies according to their degree of a star's collaboration and the breadth of a star's expertise, we focus our analysis next on the subsample of 155 firms that employ star scientists.

Colleagues' innovative productivity. Table 3 illustrates the effects of the breadth of a star's expertise and degree of collaboration on colleagues' innovative productivity. Model 1 introduces the control variables. In Model 2 we add the degree of a star's collaboration. Model 3 examines the independent effect of the breadth of a star's expertise. Model 4 includes both collaboration and breadth of expertise. Finally, Model 5 adds the interaction terms and represents our fully specified model.

--- Insert Table 3 about here ---

As shown in Model 3, we found support for Hypothesis 2a, which predicted a diminishing positive effect of the breadth of the star's expertise on colleagues' innovative productivity (β = 2.412; β = -3.073; $p < .01$). As indicated in Model 2, consistent with

Hypothesis 3a, we found that the relationship between the degree of a star's collaboration and colleagues' innovative productivity is positive and significant ($\beta = .129$; $p < .01$). Model 5, our fully specified model, confirms this initial support. To fully examine the breadth of a star's expertise on colleagues' innovative productivity, we plotted the effect in Figure 1. As the graph indicates, as the breadth of a star's expertise increases, the productivity of the star's colleagues increases. At high levels of breadth in a star's expertise (2sd above average), the effect attenuates but does not turn negative.

--- Insert Figure 1 about here ---

To examine the joint effect of star scientists' collaboration and the breadth of their expertise on colleagues' innovative productivity and test Hypothesis 4a, we interacted these two predictors. As shown in Model 5, the linear effect of the interaction between stars' collaboration and the breadth of their expertise on colleagues' innovative productivity is negative and significant ($\beta = -.414$; $p < .01$), and the square term is positive and significant ($\beta = .558$; $p < .05$). To evaluate the nature of this effect further, we plotted the results comparing the productivity of stars' colleagues at different levels of star collaboration and breadth of expertise (Figure 2). As predicted in Hypothesis 4a, our results suggest that stars who collaborate broadly and frequently with their colleagues increase their colleagues' productivity across all levels of breadth of expertise relative to stars who collaborate narrowly. Figure 2 further indicates that the effect of a star's collaboration on colleagues' innovative productivity is the highest when the star inventor has broad expertise relative to stars with narrow expertise. On the other hand, colleagues' productivity is significantly diminished in research environments where a star with narrow expertise collaborates infrequently with colleagues.

--- Insert Figure 2 about here ---

Colleagues' innovative leadership. Table 4 presents the effects of the breadth of a star's expertise and collaboration on colleagues' innovative leadership. Model 1 introduces the control variables. In Model 2 we add the degree of a star's collaboration. Model 3 examines the independent effect of the breadth of a star's expertise. Model 4 includes both the star's collaboration and the breadth of the star's expertise. Finally, Model 5 adds the interaction terms and represents our fully specified model.

--- Insert Table 4 about here ---

As shown in Model 3, we found support for Hypothesis 2b, suggesting that the breadth of a star's expertise has a diminishing negative effect on colleagues' innovative leadership (β = -1.841; β = -2.462; $p < .01$). As indicated in Model 2 and consistent with Hypothesis 3b, the relationship between a star's collaboration and colleagues' innovative leadership is positive and significant (β = .162; $p < .01$). Model 5, our fully specified model, confirms this initial support. To fully examine the effect of the breadth of a star's expertise on colleagues' innovative leadership, we plotted the effect in Figure 3. Overall, as expected, the results indicate that as the breadth of a star's expertise increases, colleagues' opportunities to lead research decline at a decreasing rate. More importantly, whereas the breadth of a star's expertise improves colleagues' productivity, it has a negative effect on colleagues' innovative leadership.

--- Insert Figure 3 about here ---

To examine the joint effect of star scientists' collaboration and the breadth of their expertise on colleagues' innovative leadership and test Hypothesis 4b, we again interacted these predictors. As shown in Model 5, the linear effect of the interaction between collaboration and the breadth of a star's expertise on colleagues' innovative leadership is positive and significant (β = .250; $p < .01$), and the square term is negative and significant (β = -.436; $p < .01$). To further evaluate the nature of this effect, we plotted the results comparing the innovative leadership of stars' colleagues at different levels of star collaboration and breadth of expertise (Figure 4). As shown, on average, stars' colleagues demonstrate higher levels of innovative leadership when working in a firm with a star inventor who collaborates broadly and frequently relative to colleagues employed alongside stars who collaborate narrowly and infrequently. As predicted in Hypothesis 4b, stars' colleagues demonstrate higher levels of innovative leadership when the star's expertise is narrow and when the star collaborates more frequently. In an environment where a star has broad expertise and collaborates narrowly, colleagues demonstrate the lowest levels of innovative leadership.

--- Insert Figure 4 about here ---

DISCUSSION

Our results highlight the duality of the effects that star employees have on their colleagues' performance. While stars' colleagues enjoy greater productivity, they have fewer opportunities to lead innovation in their firms. Our arguments and findings further reinforce an important theme in the strategic human capital literature, namely, that the value of human capital is contingent on the social environment in which it is employed (Groysberg & Lee, 2009). Specifically, we demonstrated that the frequency of stars' collaboration with their colleagues and the breadth of stars' expertise are important determinants of the effects that stars have on their colleagues' innovative outcomes. As expected, highly collaborative stars improve both the productivity and innovative leadership opportunities of their colleagues. Furthermore, our results indicate that the innovative productivity of a star's colleagues increases with increased breadth of a star's expertise. However, the breadth of a star's expertise breadth has a diminishing negative effect on colleagues' innovative leadership. Moreover, we show that colleagues' productivity is the highest in environments containing a star who has broad expertise and who collaborates frequently with colleagues. On the other hand, a star's colleagues' opportunities for innovative leadership are highest when the star has *narrow* expertise and engages in frequent collaboration.

Implications and contributions

Our arguments and findings advance our understanding of the effects of star employees on their colleagues' and firms' performance in several ways. First, prevailing wisdom suggests that star employees create disproportionate value for organizations by generating substantial increases in a firm's productivity (Zucker *et al*., 1998) and having positive spillovers on their colleagues' performance (Rothaermel & Hess, 2007). However, assuming such a static and monolithic view of the influence of stars in organizations underestimates the complex nature of their relationships with their colleagues and work environments. Thus, we introduce a power and resource dependence perspective to address the question of how stars impact their colleagues' performance. We maintain that this theoretical framework allows us to capture the dual and active nature of the influence that stars exert in firms more effectively than other approaches.

Implicitly our results suggest that the constraining effects that some stars may have on the opportunities of lower-status employees may reduce the overall value of a firm's collective human capital and thus the ability of the firm's human resources to function as a source of competitive advantage (Ployhart & Moliterno, 2011). Furthermore, limiting the number of scientists who can lead research projects reduces a firm's ability to adapt to competitive changes (Rothaermel & Hess, 2007), increases the firm's vulnerability to loss in the face of star turnover (Coff, 1999) and thereby reduces the firm's chances of long-term success (Teece, Pisano, & Shuen, 1997). Thus, our results suggest that, while stars tend to enhance a firm's short-term performance, in some circumstances a star's presence can threaten a firm's long-term viability.

Second, we provide insights into the contingencies associated with the effects that stars have on colleagues' productivity and innovative leadership. We suggest that the stars' orientations toward their exchange relationships with colleagues, which are determined by their breadth of expertise and frequency of collaboration, may influence whether stars have an empowering or constraining effect on colleagues' opportunities and performance. As such, our results highlight that a star's collective orientation to exchange can mitigate the negative effects of broad star power on colleagues' innovative leadership opportunities. These results are congruent with the findings of Bunderson and Reagans (2011) and Edmondson (1999), who highlighted the importance of developing collective goals to encourage lower-status members to learn and contribute to a firm's activities.

Third, by examining the conditions under which the effects that stars have on their colleagues' performance vary, we advance research on the resource-based view (RBV) of the firm. Consistent with the RBV, we propose that the effective utilization of a firm's key human resources (i.e., stars) in driving organizational success depends on a favorable alignment between the innovative goals adopted by the star and those valued by the organization. (Coff, 1997;

Penrose, 1959). When a firm's research program is tightly bound to and dependent on a star scientist's research agenda the star's effects on colleagues' performance are likely to be positive only to the extent that the star perceives that helping colleagues is consistent with the achievement of the star's personal goals and preservation of the star's power. On the other hand, when a firm embraces innovative aspirations that include developing quality human capital (i.e., among its non-star scientists) that can enable and sustain its competitive advantage in the longer term, a star may be more inclined to assist in colleagues' development through collaboration or the sharing of innovative leadership opportunities (Collins & Smith, 2006).

Limitations

Although our study surmounts some of the limitations of prior research, it suffers from its own shortcomings. Relying on patent information to define our key dependent and independent variables raises some traditional concerns, including the objections that not all patentable knowledge gets patented (Griliches, 1990) and that citations may not accurately reflect knowledge flows (Alcacer & Gittelman, 2006). Nevertheless, biotechnology firms are likely to patent any patentable technologies due to the strong appropriability regime for patents in this industry. Furthermore, the vagaries of citations actually provide a more conservative test of the significance of the results.

Our archival data cannot reveal a firm's motives for hiring a star or choices based on a star's characteristics. However, our regression analyses account for potential endogenous variables and firms' heterogeneity, thereby reducing the potential for alternative interpretations of our results. The risk of endogeneity and selection bias is also minimal, because our theory explores how the effects of stars vary. We emphasize that stars vary in their propensity to affect their colleagues' performance, based on both the type of performance outcome and the stars' personal characteristics. Future research should examine the impact of stars who switch firms; the limited number of star mobility events in our data prevented such an assessment in this study.

Conclusion

These limitations notwithstanding, our study provides a deeper understanding of the indirect effects that stars have on firm performance and underscores the importance of stars' individual characteristics in determining the nature of their impact. Even if stars improve their colleagues' abilities, motivation, and opportunities for productivity, stars' attempts to preserve their own power internally and externally can limit their colleagues' opportunities to develop richer innovation skills. Stars' propensities to collaborate and the breadth of their expertise also influence colleagues' opportunities for productivity and innovative leadership.

From a practical standpoint, firms interested in enhancing their status by hiring stars should recognize not only the benefits associated with the presence of a star, but also the social costs and potential risks of dependence on these high-status individuals. Stars may offer knowledge, skills, and resources that are not currently available to a firm, but firms rarely build innovative capabilities through this path alone. To exploit the key benefits associated with employing a star, firms must motivate stars to share their knowledge and skills, as well as grant other scientists the opportunity and support to learn new skills while also learning how to lead innovation.

Managers and practitioners should also recognize that in hiring and managing star employees, firms might be forced to accept an inherent tradeoff between immediate gains versus a sustainable competitive advantage. Specifically, whereas stars with broad expertise may improve their colleagues' productivity and thus maximize a firm's opportunities for short-term performance gains, the same stars are more likely to hinder their colleagues' opportunities to develop as innovative leaders, thereby threatening the long-term value associated with a firm's collective human capital. Thus, firms may be best advised to select and manage stars based on the current configuration of capabilities among their existing human capital and according to their short-term versus long-term performance needs.

REFERENCES

Ahuja, G. & Katila, R. 2001. Technological acquisitions and the innovation performance of acquiring firms: A longitudinal study. *Strategic Management Journal*, **22**(3): 197-220.

Alcacer, J. & Gittelman, M. 2006. How do I know what you know? Patent examiners and the generation of patent citations. *Review of Economics and Statistics*, **88**(4): 774-779.

Almeida, P., Song, J., & Grant, R. 2002. Are firms superior to alliances and markets? A cross-border investigation of knowledge building. *Organization Science*, **13**(2): 147-161.

Amin, A., & Roberts, J. 2008. Knowing in action: Beyond communities of practice. *Research Policy*, 37(2): 353-369.

Astley, W. G. & Sachdeva, P. S. 1984. Structural sources of intraorganizational power: A theoretical synthesis. *Academy of Management Review*, **9**(1): 104-113.

Azoulay, P., Zivin, J. S., & Wang, J. 2010. Superstar extinction. *The Quarterly Journal of Economics*, **125**(2): 549-589.

Baum, J. A. C. & Oliver, C. 1991. Institutional linkages and organizational mortality. *Administrative Science Quarterly*, **36**: 187-218.

Brass, D. 1984. Being in the right place: A structural analysis of individual influence in an organization. *Administrative Science Quarterly*, **29**: 518-539.

Bunderson, J. S. 2003a. Team member functional background and involvement in management teams: Direct effects and the moderating role of power centralization. *The Academy of Management Journal* **46**(4): 458-474.

Bunderson, J. S. 2003b. Recognizing and utilizing expertise in work groups: A status characteristics perspective. *Administrative Science Quarterly*, **48**(4): 557-591.

Bunderson, J. S. & Reagans, R. E. 2011. Power, status, and learning in organizations. *Organization Science*, **22**(5): 1182-1194.

Burke, M. A., Fournier, G., M, & Prasad, K. 2007. The diffusion of medical innovation: Is success in the stars? *Southern Economic Journal*, **73**(3): 588-603.

Burt, R. S. 1992. Structural holes. Cambridge, MA: Harvard University Press.

Cannon-Bowers, J. A. & Salas, E. 1998. Making decisions under stress: Implications for individual and team training. Washington, D. C.: American Psychological Association.

Casciaro, T. & Piskorski, M. J. 2005. Power imbalance, mutual dependence, and constraint absorption: A closer look at resource dependence theory. *Administrative Science Quarterly*, **50**: 167-199.

Coff, R., W. 1997. Human assets and management dilemmas: Coping with hazards on the road to resource-based theory. *Academy of Management Review*, **22**(2): 374-402.

Coff, R. W. 1999. When competitive advantage doesn't lead to performance: Resource-based theory and stakeholder bargaining power. *Organization Science*, 10(2): 119-133.

Coff, R. and Kryscynski, D. 2011. Drilling for micro-foundations of human capital based competitive advantages. *Journal of Management*, 37(5): 1429-1443.

Collins, C. J., & Smith, K. G. 2006. Knowledge exchange and combination: The role of human resource practices in the performance of high-technology firms. Academy of Management Journal, 49: 544-560.

Edmondson, A. C. 2002. The local and variegated nature of learning in organization: A group-level perspective. *Organization Science*, **13**: 128-146.

Eisenhardt, K. M. & Bourgeois, L. J. I. 1988. Politics of strategic decision making in high-velocity environments: Toward a midrange theory. *Academy of Management Journal*, **31**: 737-770.

Espinosa, J. A., Slaughter, S., A., Kraut, R., E., & Herbsleb, J., D. 2007. Familiarity, complexity, and team performance in geographically distributed software development. *Organization Science*, **18**(4): 613-630.

Flynn, F. 2003. How much should I help and how often? The effects of generosity and frequency of favor exchange on social status and productivity. *Academy of Management Journal*, **46**(5): 539-553.

French, J., R. P & Raven, B. 1959. The bases of social power. In D. Cartwright (Ed.), Studies in Social Power, Vol. 150-167. Ann Arbor, MI: University of Michigan Press.

Granovetter, M. 1982. The strength of weak ties: A network theory revisited. In P. Marsden, V & N. Lin (Eds.), Social structure and network analysis. Beverly Hills, CA: Sage.

Griliches, Z. 1990. Patent statistics as economic indicator: A survey. J*ournal of Economic Literature*, **34**(3): 1324-1330

Groysberg, B. & Lee, L.-E. 2009. Hiring stars and their colleagues: Exploration and exploitation in professional service firms. *Organization Science*, **20**(4): 740-758.

Groysberg, B., Lee, L.-E., & Nanda, A. 2008. Can they take it with them? The probability of star knowledge workers' performance: Myth or reality. *Management Science*, **54**: 1213-1230.

Hall, B. 2002. A note on the bias in the Herfindahl based on count data. In J. M. Trajtenberge (Ed.), Patents, citations and innovaiton. Boston: MIT Press.

Hansen, M., T. 1999. The search-transfer problem: The role of weak ties in sharing knowledge across organizations' subunits. *Administrative Science Quarterly*, **44**(1): 82-112.

Harrison, D. A., Mohammed, S., McGrath, J. E., & Florey, A. T. 2003. Time matters in team performance: Effects of member familiarity, entertainment, and task discontinuity on speed and quality. *Personnel Psychology*, **56**(3): 633-669.

Hatch, W. N. & Dyer, H., Jeffrey. 2004. Human capital and learning as a source of sustainable competitive advantage. *Strategic Management Journal*, **25**(12): 1155-1178.

Heckman, J. 1979. Sample selection bias as a specification error. *Econometrica*, 47(1): 153–61.

Heider, F. 1958. Psychology of interpersonal relations. New York: Wiley.

Henderson, R. & Cockburn, I., M. 1994. Measuring competence? Exploring firm effects in pharmaceutical research. *Strategic Management Journal*, **15**(Winter Special Issue): 63-84.

Hess, A. M. & Rothaermel, F. T. 2011. When are assets complementary? Star scientists, strategic alliances and innovation in the pharmaceutical industry. *Strategic Management Journal*, **32**: Forthcoming.

Hitt, M. A., Bierman, L., Shimizu, K., & Kochhar, R. 2001. Direct and moderating effects of human capital on strategy and performance in professional service firms: A resource-based perspective. *Academy of Management Journal*, **44**(1): 13-28.

Huckman, R. S. & Pisano, G. P. 2006. The firm specificity of individual performance: Evidence from cardiac surgery. *Management Science*, **52**(4): 473-488.

Ibarra, H. 1993. Network centrality, power, and innovation involvement: Determinants of technical and administrative roles. *Academy of Management Journal*, **36**(3): 471-501.

Kanter, R.M. 1988. When a thousand flowers bloom. In *Research in Organizational Behavior,* Staw, B.M. and Cummings, L.L. (eds). JAI Press, Greenwich, CT, Vol. 10: 169-211.

Kirsh, D. 2001. A few thoughts on information overload. *Intellectica,* 30: 19-51.

Kogut, B. & Zander, U. 1992. Knowledge of the firm, combinative capabilities, and replication of technology. *Organization Science*, **3**: 383-397.

Kor, Y. Y. and Mahoney, J. T. 2005. How dynamics, management, and governance of resource deployments influence firm-level performance. *Strategic Management Journal*, 26(5): 489-496.

Liebeskind, J. P., Oliver, A., Zucker, L. G. & Brewer, M. 1996. Social networks, learning, and flexibility: sourcing scientific knowledge in new biotechnology firms. *Organization Science*, **7**: 428-442.

March, J. G. 1991. Exploration and exploitation in organizaitonal learning. *Organization Science*, **2**: 71-87.

McClelland, C. D. 1975. Power: The inner experience. New York: Irvington Publishers.

McEvily, B., Perrone, V., & Zaheer, A. 2003. Trust as an organizing principle. *Organization Science*, **14**(1): 91-103.

Nembhard, I. M. & Edmondson, A. C. 2006. Making it safe: The effects of leader inclusiveness and professional status on psychological safety and improvement efforts in health care teams. *Journal of Organizational Behavior*, **27**(7): 941-966.

Nerkar, A. & Paruchuri, S. 2005. Evolution of R&D capabilities: Role of knowledge networks within a firm. *Management Science*, 51:771-785

Oettl, A. 2012. Reconceptualizing stars: Scientist helpfulness and peer performance. *Management Science*, **58**(6): 1122-1140.

Oldroyd, J. & Morris, S. Forthcoming. Catching falling stars: A human resource response to social capital's detrimental effect of information overload on valuable and visible employees. *Academy of Management Review*, **37**(3): 396-418.

Overbeck, J. R. & Park, B. 2006. Powerful perceivers, powerless objects: Flexibility of powerholders' social attention. *Organization Behavior and Human Decision Processes*, **99**(2): 227-243.

Parachuri, S. 2010. Intraorganizational networks, interorganizational networks, and impact of central inventors: A longitudinal study of pharmaceutical firms. *Organization Science*, **21**(1): 63-80.

Penrose, E. 1959. The theory of the growth of the firm. Oxford: Oxford University Press.

Pfeffer, J. 1981. Power in organizations. Marshfield, MA: Pitman.

Ployhart, R. E. & Moliterno, T. P. 2011. Emergence of the human capital resource: A multilevel model. *Academy of Management Review*, **36**: 127-150.

Reagans, R., Argote, L., & Brooks, D. 2005. Individual experience and experience working together: Predicting learning rates from knowing who knows what and knowing how to work together. *Management Science*, **51**(6): 869-881.

Reagans, R. & McEvily, B. 2003. Network structure and knowledge transfer: The effect of cohesion and range. *Administrative Science Quarterly*, **48**(2): 240.

Rothaermel, F. T. & Hess, A. M. 2007. Building dynamic capabilities: Innovation driven by individual-, firm-, and network-level effects. *Organization Science*, **18**(6): 898-921.

Schilling, M. A., Vidal, P., Ployhart, R., & Marangoni, A. 2003. Learning by doing something else: Variation, relatedness, and organizational learning. *Management Science*, 49: 39-56.

Schroder, H. M., Driver, M., J., & Streufert. 1967. Human Information Processing. New York: Holt, Rinelhart and Winston.

Scott, S. G., & Bruce, R. A. 1994. Determinates of innovative behavior: A path model of individual innovation in the workplace. *Academy of Management Journal*, 137:

580-607.
Shen, W. & Cannella, A. A. Jr. 2002. Power dynamics within top management and their impacts on CEO dismissal followed by inside succession. *Academy of Management Journal*, **45**(6): 1195.
Sirmon, D. G., Hitt, M. A., & Ireland, R. D. 2007. Managing firm resources in dynamic environments to create value: Looking inside the black box. *Academy of Management Review*, **32**(1): 273-292 .
Szulanski, G. 2000. The process of knowledge transfer: A diachronic analysis of stickiness. *Organizational Behavior and Human Decision Processes*, **82**(1): 9-27.
Teece, D. J., Pisano, G., & Shuen, A. 1997. Dynamic capabilities and strategic management. *Strategic Management Journal*, **18**(7): 509-533.
Tzabbar, D. 2009. When does scientist recruitment affect technological repositioning? *Academy of Management Journal*, **52**(5): 873-896.
Tzabbar, D. Aharonson, S. B. & Amburgey, T. L. 2013. When does tapping external sources of knowledge result in knowledge integration? *Research Policy*, **42**: 481-494.
Tzabbar, D., McMahon, S., & Vestal, A. Forthcoming. Do geographically dispersed teams enhance novelty of invention? *Organization Science*.
Uzzi, B. D. 1996. The sources and consequences of embeddedness for the economic performance of organizations: The network effect. *American Sociological Review*, **61**: 674-698.
Uzzi, B. D. 1997. Social structure and competition in interfirm networks: The paradox of embeddedness. *Administrative Science Quarterly*, **42**: 35-67.
Uzzi, B. & Lancaster, R. 2003. Relational embeddedness and learning: The case of bank loan managers and their clients. *Management Science*, **49**(4): 383-399.
Van der Vegt, G. S., Bunderson, J. S., & Oosterhof, A. 2006. Expertness diversity and interpersonal helping in teams: Why those who need the most help end up getting the least. *Academy of Management Journal*, **49**(5): 877-893.
Van der Vegt, G. S., de Jong, S. B., Bunderson, S., J, & Molleman, E. 2009. Power asymmetry and learning in teams: The moderating role of performance feedback. *Organization Science*, **1**(21): 347-361.
Vera, D. & Crossan, M. 2005. Improvisation and innovative performance in teams. *Organization Science*, **16**(3): 203-224.
Weick, K. & Roberts, K. 1993. Collective mind in organizations: heedful interrelating on flight decks. *Administrative Science Quarterly*, **38**(3): 357-381.
Willer, R. 2009. Groups reward individual sacrifice: The status solution to the collective action problem. *American Sociological Review*, **74**: 23-43.
Wood, R. E. & Bandura, A. 1989. Social cognitive theory of organizational management. *Academy of Management Review*, **14**: 361-384.
Wooldridge, J. M. 2003. Fixed effects estimation of the population-averaged slopes in a panel data random coefficient model problem. *Econometric Theory*, **19**: 411-412.
Zucker, L. G. & Darby, M. R. 2001. Capturing technological opportunity via Japan's star scientists: evidence from Japanese firms' biotech patents and products. *The Journal of Technology Transfer*, **26**(1): 37-58.
Zucker, L. G, Darby, M., & Brewer, M. 1998. Intellectual human capital and the birth of U.S. biotechnology enterprises. *American Economic Review*, **88**(1): 290-306.

Table 1: Means, standard deviations, and correlations

	Variable	Mean	SD	1	2	3	4	5	6	7	8	9	10	11
1	Innovative productivity	0.16	0.55											
2	Innovative leadership	0.61	0.44	-0.08										
3	Breadth of star's expertise	0.04	0.11	0.56	-0.06									
4	Star collaboration	0.38	1.50	0.63	-0.09	0.39								
5	Prior innovative leadership	0.06	0.23	-0.13	0.29	-0.12	-0.03							
6	Prior innovative productivity	0.07	0.30	-0.12	0.24	-0.11	0.01	0.61						
7	Public firm	0.35	0.48	0.14	-0.02	0.09	0.08	0.05	0.03					
8	Firm size (log)	2.70	1.37	0.34	0.55	0.29	0.33	0.22	0.21	0.20				
9	Firm age (log)	1.89	0.82	0.19	0.48	0.19	0.20	0.00	-0.01	0.08	0.52			
10	Venture capital (log)	5.75	2.27	0.12	0.09	0.13	0.07	-0.07	-0.06	-0.01	0.13	0.20		
11	Scientist recruitment event	0.17	0.38	0.15	0.28	0.13	0.15	0.13	0.13	-0.04	0.37	0.22	0.09	
12	Geographic dispersion	0.45	0.71	0.00	0.06	0.00	-0.01	0.08	0.03	-0.01	0.03	-0.03	-0.10	0.03
13	Prior R&D alliance	2.12	6.49	0.23	0.17	0.15	0.22	0.09	0.08	0.37	0.54	0.29	-0.03	0.12
14	In-progress R&D alliance	1.63	4.52	0.23	0.19	0.16	0.22	0.10	0.09	0.38	0.55	0.29	-0.02	0.14
15	CEO succession	0.00	0.01	0.04	0.22	0.00	0.07	-0.01	-0.01	-0.01	0.06	0.02	-0.05	-0.01

		12	13	14
13	Prior R&D alliance	0.02		
14	In-Progress R&D alliance	0.02	0.79	
15	CEO succession	-0.00	0.10	0.08

Table 2: Two-stage regression analysis for stars' colleagues' innovative productivity and leadership

	Innovative Productivity			Innovative Leadership		
	Model 1	**Model 2**	**Model 3**	**Model 4**	**Model 5**	**Model 6**
Star recruitment		0.35*			-0.14*	
		(0.04)			(0.02)	
Star firm			0.48*			-0.28*
			(0.02)			(0.01)
Prior innovative productivity	-0.41*	-0.42*	-0.42*			
	(0.03)	(0.02)	(0.02)			
Prior innovative leadership				0.37*	0.36*	0.30*
				(0.02)	(0.02)	(0.02)
Public firm	0.08*	0.08*	0.06*	-0.10*	-0.10*	-0.09*
	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)
Firm size (log)	0.06*	0.06*	0.05*	0.19*	0.19*	0.20*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.00)
Firm age (log)	-0.02	-0.01	-0.01	0.19*	0.19*	0.19*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Venture capital (log)	-0.02*	-0.02*	-0.01	0.02*	0.02*	0.02*
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)
Scientist recruitment event	0.10*	0.09*	0.06*	0.02*	0.02*	0.04*
	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)	(0.01)
Geographic dispersion	-0.18	-0.19*	-0.13*	0.26*	0.27*	0.24*
	(0.06)	(0.06)	(0.05)	(0.03)	(0.03)	(0.03)
Prior R&D alliance	-0.07*	-0.07*	-0.05*	0.01*	0.00	-0.01*
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)
In-progress R&D alliance	0.07*	0.07*	0.05*	-0.00	0.00	0.01*
	(0.01)	(0.01)	(0.01)	(0.00)	(0.00)	(0.00)
CEO succession	1.10*	0.94*	0.81*	-0.54*	-0.48*	-0.38
	(0.37)	(0.35)	(0.31)	(0.19)	(0.19)	(0.17)
Mills ratio	0.04*	0.03*	0.02*	-0.02*	-0.02*	-0.01*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Constant	*0.06*	*0.03*	*0.02*	*-0.54*	*-0.37*	*-0.34*
Wald Chi2	*4188.7*	*4495.7*	*6105.5*	*4038.5*	*4177.4*	*5064.9*
R-squared	*0.24*	*0.26*	*0.39*	*0.41*	*0.42*	*0.52*
Observations	6529	6529	6529	6529	6529	6529

Table 3: Two-stage analysis for the joint effect of the breadth of star's expertise and collaboration on colleagues' innovative productivity

Innovative productivity	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Star collaboration		0.13*		0.12*	0.15*
		(0.01)		(.01)	(0.01)
Breadth of star's expertise			2.41*	1.83*	3.04*
			(0.49)	(0.45)	(0.64)
Breadth of star's expertise			-3.07*	-2.25*	-3.98*
			(0.81)	(0.75)	(1.09)
Breadth of star's expertise× collaboration					-0.41*
					(0.14)
Breadth of star's expertise× collaboration					0.56 *
					(0.26)
Prior innovative leadership	-0.62*	-0.51*	-0.53*	-0.44*	-0.43*
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Public firm	0.07	0.06	0.07	0.06	0.06
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Firm size (ln)	0.15*	0.13*	0.13*	0.12*	0.11*
	(0.03)	(0.02)	(0.03)	(0.02)	(0.02)
Firm age (ln)	0.22*	0.07*	0.18*	0.05	0.03
	(0.04)	(0.03)	(0.03)	(0.03)	(0.03)
Venture capital	0.07*	0.06*	0.06*	0.05*	0.05*
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Mobility event	-0.04	-0.04	-0.03	-0.03	-0.04
	(0.05)	(0.04)	(0.04)	(0.04)	(0.04)
Geographic dispersion	-0.49*	-0.37*	-0.42*	-0.33*	-0.33*
	(0.19)	(0.16)	(0.18)	(0.16)	(0.16)
Prior R&D alliance	-0.01	-0.01	-0.01	-0.01	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
In-progress R&D alliance	0.00	0.01	0.00	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
CEO succession	-0.06	-0.34	0.18	-0.15	-0.19
	(0.56)	(0.50)	(0.53)	(0.49)	(0.48)
Mills ratio: likelihood of star recruitment	1.655*	1.263*	1.31*	1.06*	0.99*
	(0.30)	(0.25)	(0.30)	(0.26)	(0.26)
Constant	*-0.71*	*-0.51*	*-0.62*	*-0.44*	*-0.43*
Wald Chi2	*2,418*	*3,293*	*2,777*	*3555*	*3,658*
R-squared	*0.208*	*0.388*	*0.281*	*0.435*	*0.449*
Observations	*2028*	*2028*	*2028*	*2028*	*2028*

Table 4: Two-stage analysis for the joint effect of the breadth of star's expertise and collaboration on colleagues' innovative leadership

Innovative leadership	**Model 1**	**Model 2**	**Model 3**	**Model 4**	**Model 5**
Star collaboration		0.16*		0.14**	0.14*
		(0.00)		(0.00)	(0.00)
Breadth of star's expertise			-1.84*	-1.44*	-2.15*
			(0.16)	(0.16)	(0.23)
Breadth of star's expertise			2.46*	1.92*	3.20*
			(0.28)	(0.27)	(0.39)
Breadth of star's expertise× collaboration					0.25*
					(0.05)
Breadth of star's expertise× collaboration					-0.44*
					(0.09)
Prior innovative leadership	0.56*	0.51*	0.56*	0.52*	0.52*
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Public firm	-0.10*	-0.09*	-0.09*	-0.08*	-.083*
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Firm size (ln)	0.18*	0.18*	0.18*	0.19*	0.19*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Firm age (ln)	0.08*	0.07*	0.04*	0.09*	0.10*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Venture capital	-0.03*	-0.03*	-0.03*	-0.02*	-0.02*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Mobility event	0.07*	0.06*	0.05*	0.05*	0.05*
	(0.02)	(0.02)	(0.02)	(0.01)	(0.01)
Geographic dispersion	0.25*	0.21*	0.18*	0.16*	0.17*
	(0.07)	(0.06)	(0.06)	(0.06)	(0.06)
Prior R&D alliance	-0.03*	-0.02*	-0.02*	-0.02*	-0.02*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
In-progress R&D alliance	0.03*	0.03*	0.03*	0.02*	0.02*
	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)
CEO succession	-0.31	-0.31	-0.31	-0.14	-0.12
	(0.18)	(0.18)	(0.18)	(0.18)	(0.17)
Mills ratio: likelihood of star recruitment	-0.61*	-0.50*	-0.19*	-0.22*	-0.20*
	(0.11)	(0.09)	(0.10)	(0.08)	(0.09)
Constant	*-0.09*	*-0.09*	*-0.09*	*-0.09*	*-0.10*
Wald Chi2	*6705*	*8554*	*9359*	*10556*	*10813*
R-squared	*0.212*	*0.329*	*0.351*	*0.378*	*0.420*
Observations	*2028*	*2028*	*2028*	*2028*	*2028*

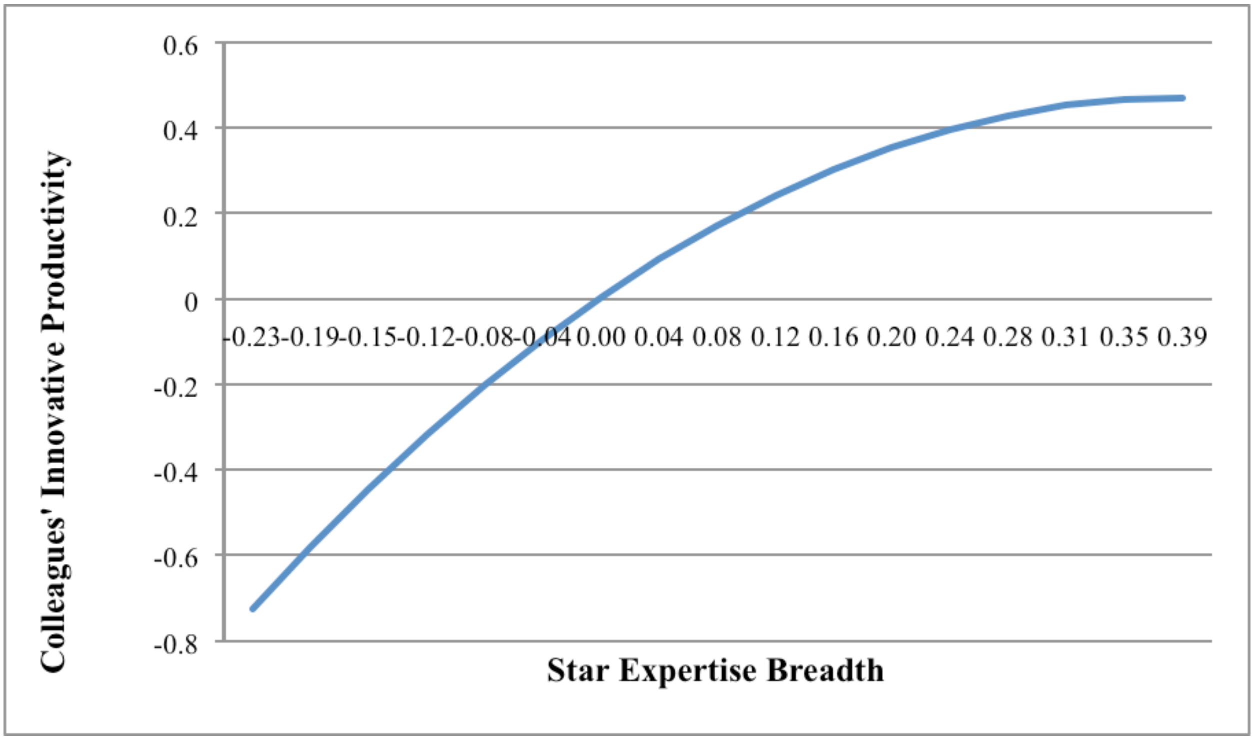

Figure 1: The effect of the breadth of a star's expertise on colleagues' innovative productivity

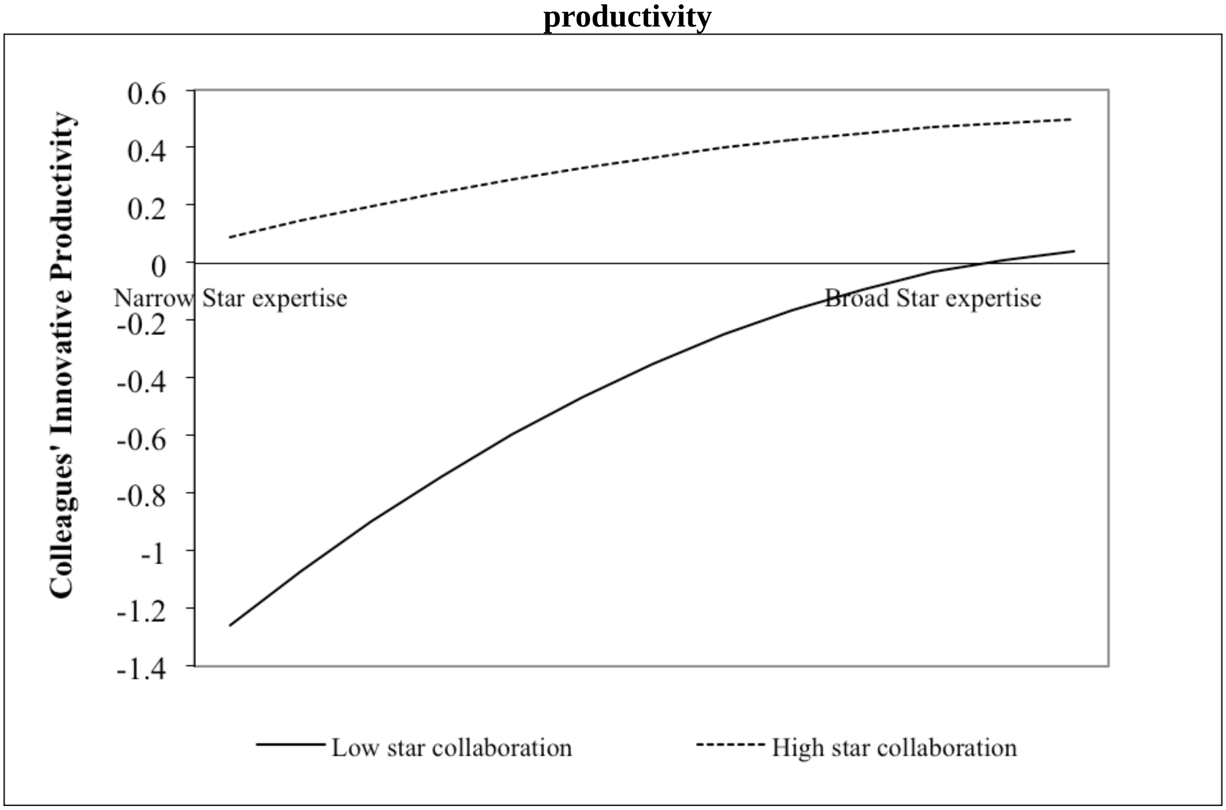

Figure 2: The joint effect of the breadth of a star's expertise and collaboration on colleagues' innovative productivity

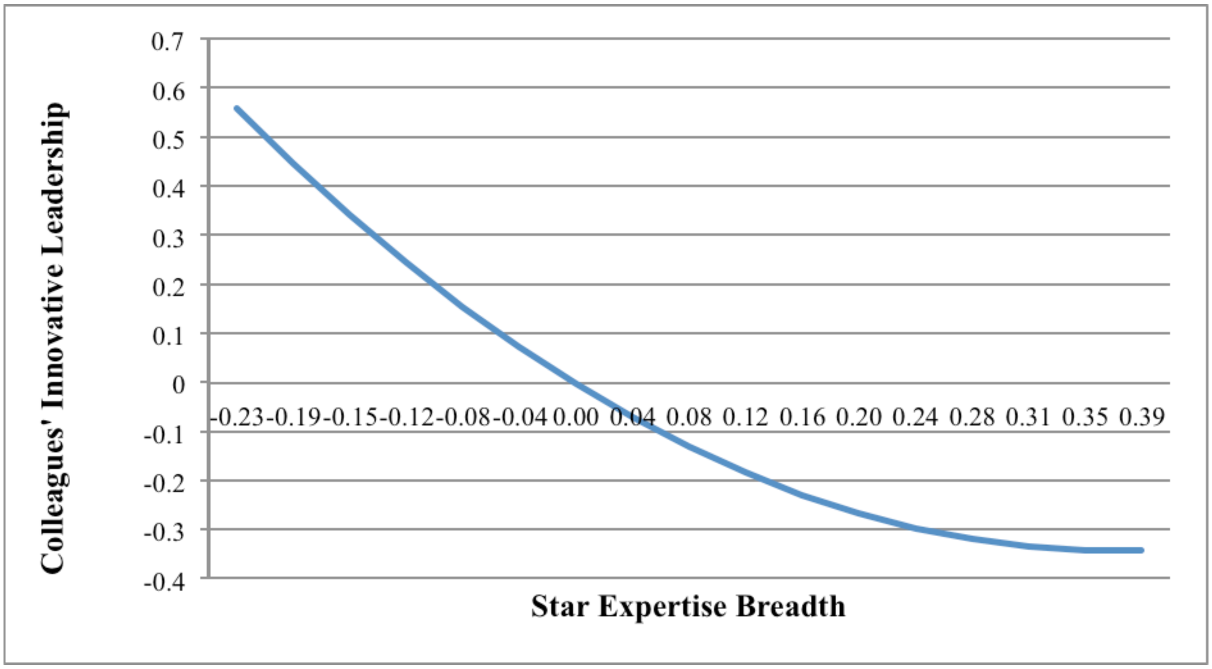

Figure 3: The effect of the breadth of a star's expertise on colleagues' innovative leadership

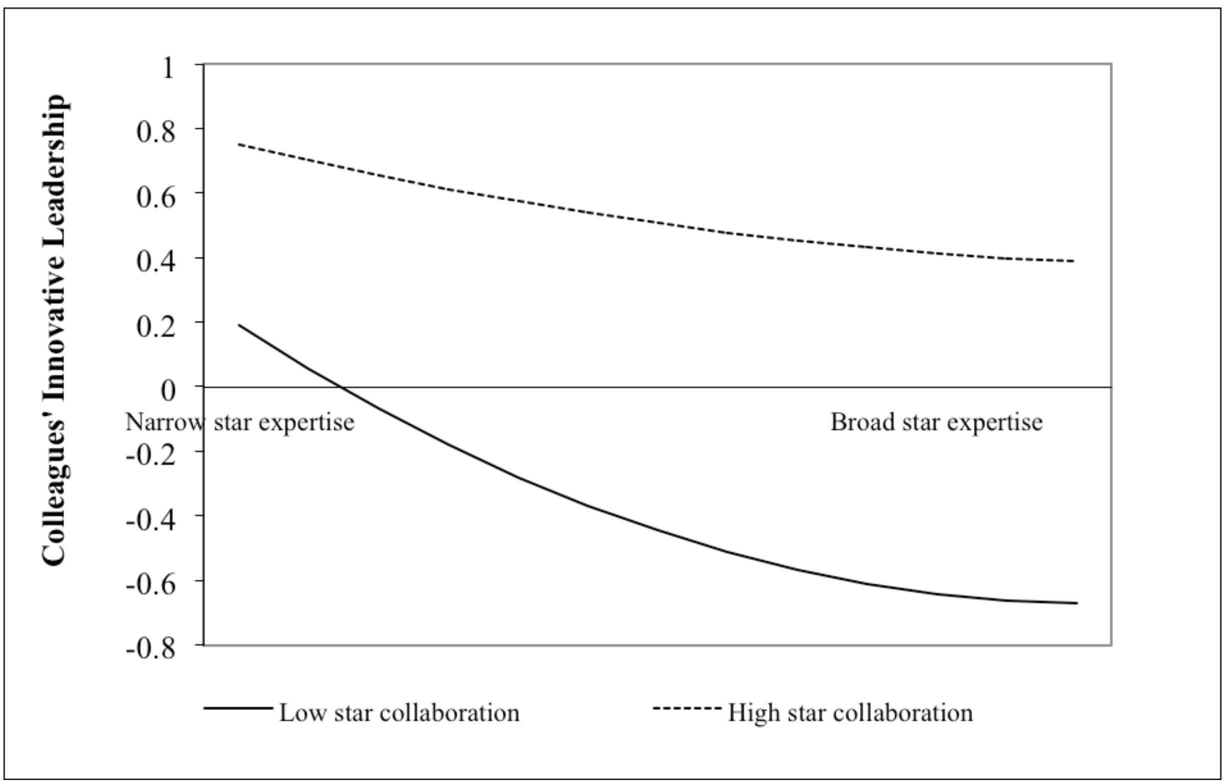

Figure 4: The joint effect of the breadth of a star's expertise and collaboration on colleagues' innovative leadership