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EMPLOYEE MOBILITY, SPIN-OUTS, AND KNOWLEDGE SPILL-IN: HOW INCUMBENT FIRMS CAN LEARN FROM NEW VENTURES

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Research summary: *We consider conditions in which incumbent firms are particularly poised to benefit from knowledge spilling in from new ventures that employ individuals previously employed by the focal incumbent firm. We distinguish between inventors who leave their incumbent employers to found spin-outs and those who become non-founding employees of existing new ventures. Using a sample of new ventures and incumbent firms in the U.S. information technology (IT) sector, we find that incumbents are more likely to benefit from patented knowledge that spills in from their spin-outs than from new ventures that employ non-founding inventors formerly employed by the respective incumbent. Any advantage that parent firms have in reaping such knowledge quickly dissipates, however, when these parents have a history of misappropriating the intellectual property of others.*

Managerial summary: *It has long been acknowledged that new ventures can acquire valuable knowledge from their larger and more established counterparts by hiring away their talented employees. We consider the possibility of a reverse flow of knowledge where established firms learn from those new ventures that have poached employees from them. We find that established information technology (IT) firms are more likely to learn and build on the technology of their spin-outs (i.e., new ventures founded by their former inventors) than from new ventures that simply employ non-founding inventors formerly employed by the respective IT firm. Any advantage that these IT firms had in reaping technical know-how from their spin-outs quickly dissipated, however, when they had a history of misappropriating the intellectual property of others.*

INTRODUCTION

With their cutting-edge expertise, new ventures are central players in the process of creative destruction, and can turn market leaders into has-beens (Christensen and Rosenbloom, 1995; Henderson and Clark, 1990). To avoid becoming obsolete, incumbent firms often need to renew their internal knowledge by tapping into state-of-the-art external knowledge, much of which is held by new ventures (Chesbrough, 2006; Dushnitsky and Lenox, 2005; Helfat, 1997). Thus, although new ventures can lead to the demise of incumbent firms, they also can be sources of revitalizing knowledge for incumbent firms that help to avert their downfall.

Incumbents can access new venture knowledge through various types of formal agreements, including strategic alliances (Ahuja, 2000),

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minority equity stakes (Wadhwa and Kotha, 2006), and acquisitions (Ahuja and Katila, 2001). Despite their potential to form these mutually beneficial agreements, incumbents and new ventures often battle over sourcing the other's knowledge at a granular level. Specifically, incumbent firms frequently lure new venture employees to secure their knowledge (Tzabbar, 2009). Likewise, new ventures can poach talented employees from incumbent firms, or these employees may leave their incumbent firms to create their own start-ups (Campbell *et al.*, 2012b; Ganco, 2013).

Losing employees to new ventures can be particularly disconcerting to incumbent firms. Not only do they suffer the loss of valuable human capital that could be used to assimilate external knowledge, but this human capital also may ultimately be deployed by new ventures to compete against the same incumbent firms from which they poached employee talent. To protect the interests of incumbents and to discourage employee mobility, certain states have laws that enforce employee non-compete agreements (Marx, Strumsky, and Fleming, 2009). In their efforts to limit how attractive their employees are to competitors, some firms establish reputations for enforcing their patents (Ganco, Ziedonis, and Agarwal, 2015). Despite these and other constraints, employees maintain substantial discretion regarding their employment trajectory, and the risk for incumbents of losing valuable employees is considerable (Coff, 1997).

Nevertheless, losing employee talent to others may not be all bad. Recent research has shown that, when employees move between firms, not only can they facilitate knowledge flow from their former employers to their new employers, but also from their new employers back to their former employers (Corredoira and Rosenkopf, 2010). One explanation for this reverse knowledge flow is that employees maintain social ties with their former colleagues and share information with them. Thus, losing employees to new ventures could potentially provide incumbents with avenues by which to attain the new venture knowledge that they need to thrive.

As noted by Agarwal, Gambardella, and Olson (2014) in their review of employee mobility and entrepreneurship, few studies have provided a nuanced understanding of how and when firms are more likely to benefit from *knowledge spill-in*, that is, a flow of knowledge from those organizations that employ their former employees. We considered conditions in which incumbent firms are particularly poised to benefit from knowledge spilling in from new ventures that employ individuals previously employed by the focal incumbent firm. To do so, we distinguished between two routes by which employees leave incumbent firms and join new ventures within the same industry. One route is to become employees of already-existing new ventures. Alternatively, individuals may take advantage of what they have learned from their prior employers by founding start-ups (Agarwal *et al.*, 2004). These new ventures, commonly referred to as *spin-outs* of their parent firms, are independent from their parents.[1]

We argue that, for two reasons, incumbent firms are generally more likely to benefit from knowledge spill-in when their former employees become entrepreneurs and start new ventures (i.e., spin-outs) as compared to when they become *non-founding* employees of existing new ventures. First, founders have greater discretion and incentive to share proprietary knowledge of their start-ups with their former colleagues. Such sharing may lead to partnering opportunities (e.g., licensing) that are particularly rewarding to highly-vested founders. These prospective partnering opportunities are likely to be especially salient when parent firms signal a proclivity for partnering with new ventures by having active corporate venture capital (CVC) programs. In comparison, non-founding employees of new ventures are typically subject to nondisclosure agreements that impede sharing information, and have relatively little to gain from doing so compared to founders. Second, because spin-out founders tend to have been high performing incumbent firm employees (Campbell *et al.*, 2012b), incumbent firms may pay greater attention to the activities of their spin-outs relative to the activities of new ventures that simply employ their former employees.

Any advantages that parent firms may have in sourcing knowledge from their spin-outs through social ties with their founders, however, are far from assured. Although spin-out founders have

[1] Spin-outs differ from internal corporate venturing, which occurs when a company spins off sections of its existing business as a separate entity, while maintaining ownership in the new business, and appoints the management team of the new business. Employee movement in such cases is not typically considered to be employee entrepreneurship or mobility events (e.g., Agarwal, Ganco, and Ziedonis, 2009; Campbell *et al.*, 2012b).

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substantial discretion to share information with their parents, they may have strong incentive *not* to share. We add nuance to our expectation that incumbent firms are more likely to benefit from knowledge spill-in from their spin-outs by taking into account the incumbent firm norms for respecting the intellectual property rights of others. Based on their time as employees, founders will possess unique insight into whether their parents respect the intellectual property rights of others. A lack of respect in this regard will be especially salient to spin-out founders, and as a result, any communication that could facilitate the flow of knowledge back to their parents will be quelled. Not only may new venture founders have much to gain in sharing with trustworthy parents, but also much to lose from sharing with untrustworthy parents. Thus, although spin-out founders have greater discretion to share information, they are particularly sensitive to the internal norms of their parents for misappropriating the knowledge of others.

We assessed the flow of patented knowledge between the years 1990 and 2006 from 370 new ventures to 41 CVC-active incumbent firms in the U.S. IT sector. We hand collected individual career histories of 680 founders of the 370 new ventures to determine which new ventures were spin-outs founded by former inventors of the respective incumbent firms. Patent inventor data also were used to determine whether any non-founding inventors moved from a sample incumbent firm to a sample new venture. Incumbent firm history of patent infringement litigation (in which the incumbent is the defendant) was used to proxy the incumbent's respect for the intellectual property rights of others.

By distinguishing between the mobility of non-founding and founding employees, we address the need to account for the destinations of departing employees when exploring the implications of employee mobility (Hancock *et al.*, 2013; Somaya, Williamson, and Lorinkova, 2008). Although the conventional view is that spin-outs harm parent firms, empirical results have been mixed (e.g., Campbell *et al.*, 2012b; Ioannou, 2014; McKendrick, Wade, and Jaffee, 2009). We provide clarity by showing that spin-out events can benefit parent firms by creating knowledge spill-in opportunities. Such opportunities, however, are likely to be unavailable to parent firms when they have norms for disrespecting the intellectual property rights of others.

EMPLOYEE MOBILITY, SPIN-OUTS, AND KNOWLEDGE SPILL-IN

Although firms may invest substantial resources toward creating knowledge, they are unable to completely control the knowledge that is embedded within individual employees who can leave their current employers at any time (Coff, 1997). As such, firms that compete in technology sectors supplement their limited expertise or reposition themselves technologically by hiring talented individuals from their competitors (Tzabbar, 2009). Poaching experienced employees from incumbent firms is particularly beneficial for small, entrepreneurial firms (Almeida, Dokko, and Rosenkopf, 2003). Doing so is thought to come at the expense of incumbent firms, however, as conventional wisdom and much of the prevailing research suggests that employee turnover hampers firm performance (e.g., Shaw, Park, and Kim, 2013). By losing key employees, valuable knowledge walks out the door and into the arms of competitors (Campbell *et al.*, 2012b).

Employees who are restless and in search of other opportunities do not always jump from one firm to merely become an employee of another. These individuals may take advantage of what they have learned from their prior employers by striking out on their own and founding start-ups within the same industry (Agarwal *et al.*, 2004; Franco and Filson, 2006; Klepper, 2001). These new ventures are commonly referred to as spin-outs from their respective parent firms, and are "spawned with a silver spoon" because they inherit technical and commercial knowledge from their parents (Chatterji, 2009: 202). Just as losing employees to competing firms can be detrimental to incumbent firms, spawning spin-outs also comes at a price to parent firms due to the loss of knowledge from parent to progeny, undermining parent firm competitiveness.

Thus, at first blush, incumbent firms appear to have little to gain from losing talented employees either to other firms or to entrepreneurial pursuits. Corredoira and Rosenkopf (2010) showed, however, that employee mobility can result in bi-directional knowledge flow. Not only can knowledge spill *over* from employees' prior employers to their new employers, but it also can spill *back in* to employees' prior employers from their new employers through the social relationships that are maintained between mobile employees and their former colleagues. When coworkers pursue common organizational goals, their frequent

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interactions generate a sense of camaraderie and social capital (Nahapiet and Ghoshal, 1998). When individuals leave their current firms to work for other firms, these relationships may remain intact; what was internal social capital between coworkers is essentially converted to informal social ties between prior employers of mobile employees and their new employers.

Just as losing employees to existing firms may not be all bad, having employees leave to start new ventures may not be solely detrimental to their parent firms. Producing spin-outs is thought to potentially enhance parent firm performance by allowing parent firms to subsequently refocus their resources and to get back to their core (Ioannou, 2014). McKendrick *et al.* (2009) found that incumbent firms that spawned *technologically successful* spin-outs outperformed those incumbents that had no spin-outs and those whose spin-outs were less successful. They argued that the spawning of successful spin-outs forces parent firms to alter their routines and capabilities to improve their performance.

McKendrick *et al.*'s (2009) finding that the relationship between spin-out activity and improved parent firm performance depended on the technological success of the spin-out firms, however, suggests a more direct influence of spin-out activity on their parents than simply encouraging parents to adjust routines and capabilities. In theory, spin-outs also create knowledge spill-in opportunities for their parent firms (Agarwal, Audretsch, and Sarkar, 2007). When mobile employees start their own ventures, social relationships between these founders and their former colleagues at the parent firms are often sustained, creating communication channels between spin-outs and parent firms. Due to these communication channels, parent firms have greater opportunity, vis-à-vis other incumbent firms, to learn from these new ventures. Thus, instead of leading to the creative destruction of their parents, spin-outs have the potential to contribute to creative *construction* in terms of aiding their parents to survive (Agarwal *et al.*, 2007).

HYPOTHESIS DEVELOPMENT

Spill-in via spin-outs versus non-founding employee mobility

Although both founders and employees of new ventures generally have an appreciation for autonomy, control, and risk-taking, they differ in how strongly they prefer these attributes (Roach and Sauermann, 2015). Founders typically maintain large shareholdings in their start-ups and possess the authority to influence their strategic direction (Dobrev and Barnett, 2005). Although the performance of non-founding employees is critical to new venture success, these employees have substantially less input into the strategic direction of the ventures for which they work. These differences in authority between founders and their employees are consistent with the relative risk that they bear. New venture employees shoulder some risk by leaving the security of their previous positions to join new ventures. Founders, however, invest unparalleled time, capital, and reputation into their start-ups. Nonetheless, if their ventures are successful, founders are rewarded handsomely in terms of both wealth and status. All else equal, new venture founders have more at stake in the success of their ventures than do non-founding employees.

New ventures generally do not have all the resources necessary to commercialize their own innovation (Teece, 1992), but may be able to access what they lack by collaborating with incumbent firms (Rothaermel and Deeds, 2004). Collaborative opportunities with incumbent firms that have actively invested in new ventures in the recent past will be particularly salient to founders. Having active CVC programs signals to new ventures that incumbent firms are interested in collaborating and potentially providing new ventures the capital and complementary assets they need to survive (Katila, Rosenberger, and Eisenhardt, 2008; Park and Steensma, 2012).

It is often challenging, however, for new ventures to initiate such partnerships because they have little collaborative history from which to establish themselves as reliable partners (Ahuja, Polidoro, and Mitchell, 2009). Founders can overcome this deficit by exploring collaborative opportunities through their personal networks (Hallen, 2008). Due to the authority of the founders and to what is at stake for them, they are more likely than non-founding employees to exploit any social capital that they have for the success of their new ventures. Founders have both the discretion and incentive to share information regarding their ventures' innovative activities with others in their network when they anticipate that doing so may lead to outcomes beneficial to their new ventures and themselves. By using their social ties to their former colleagues and

DOI: 10.1002/smj

sharing such information, founders can potentially secure valuable partnerships and licensing revenue streams if their parent firms were to commercialize products based on the proprietary knowledge of these new ventures.

Although non-founding employees also have a stake in the success of their new venture employers, it is substantially smaller than that of founders. As such, there may be relatively little incentive for them to exploit their social ties by sharing proprietary information with former colleagues, even if doing so were to lead to favorable commercial relationships for their new venture employers. Moreover, non-founding employees are often required to sign nondisclosure agreements as part of their employment, restricting them from disclosing trade secrets or confidential information. Non-founding employees are not typically expected to secure external resources for their employers or to explore partnering opportunities for which they need to divulge sensitive information. Although these nondisclosure agreements may be difficult to enforce, they offer a credible threat and can lead to legal and emotional costs to those employees who disregard them (Campbell, Coff, and Kryscynski, 2012a). Thus, even if new venture employees have social ties that connect them to incumbent firms, their limited incentive to use these ties for knowledge sharing and the legal perils of doing so will hamper the flow of knowledge through such conduits.

Knowledge flow from new ventures to incumbent firms depends on the willingness not only of the source to reveal, but also of the recipient to search. Due to their bounded cognition, incumbent firms tend to target a limited number of sources when searching for external knowledge (Nelson and Winter, 1982; Simon, 1972). Where incumbent firms search depends on the saliency of potential knowledge sources (Ocasio, 1997). Having colleagues leave to join new ventures are salient events for those employees who remain with incumbent firms. Because their former colleagues who start new ventures tend to be highly capable individuals (Campbell *et al.*, 2012b; Ganco, 2013), their forming spin-outs is particularly salient to their parent firms; these parents will pay inordinate attention to their spin-outs as compared to new ventures that simply employ their former employees (i.e., non-founding employees).

In sum, founders have greater discretion and potentially greater incentive to use their social ties as information conduits with their former colleagues at previous CVC-active employers than do non-founding employees of new ventures. Incumbent firms are also likely to pay greater attention to the activities of their spin-outs than they are to unrelated new ventures. As a result, CVC-active incumbent firms will benefit to a greater extent from knowledge that spills in from their spin-outs (i.e., new ventures founded by former employees of the incumbent) than from new ventures that employ non-founding employees previously employed by these incumbent firms.

Hypothesis 1: Knowledge will more likely flow to CVC-active incumbent firms from new ventures founded by former employees of the incumbent firm than will knowledge from new ventures that employ non-founding individuals who were previously employed by the incumbent firm.

The influence of incumbent firm history of misappropriating intellectual property

Any advantage that CVC-active incumbent firms may have in learning from their spin-outs due to founder social ties, however, is predicated on spin-out founders' anticipating that their start-ups will benefit from their sharing information with their former colleagues. Although founders have substantial discretion to reveal information through their social ties, they also would have much at stake if sensitive information were to end up in the wrong hands. Because knowledge is a key strategic asset for most technology-based new ventures, founders of these ventures are inherently concerned with these assets' leaking to larger established firms. Such firms are typically equipped with complementary assets that allow them to misappropriate the knowledge of others, if so inclined, by profiting from it commercially without providing fair compensation (Dushnitsky and Shaver, 2009; Katila *et al.*, 2008). Therefore, they will tend to avoid sharing information about their innovative activities with incumbents whom they believe are inclined to misappropriate knowledge.

It can be difficult to discern, however, whether incumbents have such inclinations, as firms may try to keep word of their questionable behavior from spreading or discredit the source (Mishina, Block, and Mannor, 2012). Nonetheless, during their time as employees, founders of spin-outs are likely to become highly cognizant of their parent firms'

DOI: 10.1002/smj

inclinations for misappropriating knowledge. They may have directly observed a lack of respect for the intellectual property rights of others or perceived company norms that tolerate such behavior.

Moreover, after their departure, founders may stay informed of their parent firm's behavior through their interactions with former colleagues who remain with the parent firm. Information gathered through these social interactions tends to be rich and fine-grained (Uzzi, 1997). Any negative information that is attained tends to be particularly vivid and influential in creating impressions of an individual or organization than is positive information (Baumeister *et al.*, 2001; Fein, 1996; Fiske, 1980). One evolutionary explanation for this bias is that paying greater attention to potentially bad outcomes enhances survival. Negative information on familiar entities is particularly salient because one can readily envision how these familiar entities of questionable character could threaten one's self or firm (Ebbesen, Kjos, and Konečni, 1976).

How inclined parent firms are to misappropriate the knowledge of others may have little influence on whether they pay disproportionate attention to the activities of their spin-outs relative to those of unrelated new ventures. Such inclinations, however, are likely to influence the willingness of spin-out founders to share proprietary information with their former colleagues. If parent firms have a negligible history of misappropriating the proprietary knowledge of others, founders of their spin-outs will feel relatively comfortable in sharing their innovative activities with their former colleagues who have remained with the parent firms. They may voluntarily divulge important information to their former colleagues in the hopes that CVC-active parent firms will build on their proprietary knowledge, possibly leading to licensing revenues and other collaborative opportunities. Due to the combination of social relationships and a sense of security held by spin-out founders toward their parents in such cases, knowledge will more likely flow to incumbent firms from their spin-outs than from comparable new ventures that are not their progeny.

If incumbent firms are inclined to misappropriate the knowledge of others, however, founders of their spin-outs will be more mindful of such inclinations, based on their experiences as employees, than will founders of new ventures unrelated to these respective incumbents firms. In such cases, spin-out founders will be particularly guarded in any communication with their parent firms. They are likely to sever their relationships with former colleagues or limit their conversations to strictly superficial aspects of their operations for fear that their knowledge will be appropriated without fair compensation. Due to the sense of insecurity held by spin-outs toward their parents in such cases, any advantage that parent firms may have in terms of knowledge that spills in from their spin-outs will be suppressed.[2]

Hypothesis 2: The greater a CVC-active incumbent firm's history of misappropriating the knowledge of others, the weaker the positive relationship between a new venture's being a spin-out of the incumbent firm and the likelihood of knowledge's spilling in to the incumbent from the new venture.

METHODOLOGY

Sample and data

We tested our hypotheses by tracking the flow of patented knowledge from 370 new ventures to 41 incumbent firms in the information technology (IT) sector across the years 1990–2006. The IT sector provided a useful setting for our study because employee mobility and spin-out formation frequently occur (Agarwal *et al.*, 2004). Firms in this sector also engage in frequent, systematic patenting activities (Hall, Jaffe, and Trajtenberg, 2001) that support the use of patent citations as a proxy of knowledge flow. Specifically, we sampled firms in the following industry subsectors: (1) computer hardware (SIC 357), (2) communications equipment (SIC 366), (3) electronic components (SIC 367), and (4) telecommunications (SIC 481-484, 489).[3]

[2] Employees who have been poached from incumbent firms and become non-founding employees of new ventures also may be cognizant of their former employers' norms for respecting the intellectual property rights of others through their prior work experiences or from their former colleagues. Because they have relatively little discretion to share knowledge with their former employers, however, their norms are likely to have little influence on whether knowledge flows through the social ties between non-founding new venture employees and their former incumbent firm employers. Thus, we do not hypothesize a similar moderating influence for the mobility of non-founding employees. We do, however, test for such an effect as part of our post hoc analyses.

[3] Similar to other studies using the IT sector as a context (e.g., Corredoira and Rosenkopf, 2010; Yang, Phelps, and Steensma, 2010), we excluded firms in the software industry (SIC code 737).

DOI: 10.1002/smj

Using the Thomson One VentureXpert database, we identified all U.S.-based ventures that (1) operated in the industry subsectors listed above, (2) were founded between 1990 and 2002, and (3) had received at least one round of financing. We focused on investor-backed ventures because they tend to possess viable technology, making them feasible sources of patented knowledge for incumbent firms in general (Katila *et al.*, 2008). Because we relied on patent citations to measure knowledge flow, any possibility of observing knowledge flow from a new venture to an incumbent firm was predicated on the new venture's having patented knowledge. Thus, consistent with other studies that have used patent citations to measure knowledge flow (e.g., Agarwal *et al.*, 2009; Corredoira and Rosenkopf, 2010), each new venture in our sample had to have been granted at least one U.S. patent. Our final sample consisted of 370 new ventures that met these criteria.

To construct an appropriate sample of incumbent firms, we limited our sample to U.S.-based public companies that belonged to the subsectors described above and to those that had shown some proclivity for collaborating with new ventures through investment relationships. A primary reason for incumbent firms to invest in new ventures is to have a window into new technologies developed by these ventures (Wadhwa and Kotha, 2006). First, we used VentureXpert to compile a list of incumbent firms at the fund level that made at least one investment during the study period of 1990–2006.[4] Using this list of corporate funds, we conducted an extensive search by fund name on Google and in various online databases, such as Lexis-Nexis and Factiva, to identify the firms' corporate parent. In addition to obtaining data from VentureXpert, we collected patent data from the U.S. Patent and Trademark Office and patent citation data from the National Bureau of Economic Research patent database (Hall *et al.*, 2001). We relied on the Securities Data Corporation Platinum Alliances database and Harvard Dataverse (U.S. patent inventor database) (Lai *et al.*, 2013) to develop some of our control variables.

We analyzed patterns of patent citations to examine knowledge flow from new ventures to incumbent firms. Prior research has used backward patent citations (i.e., prior art citations) as a measure of knowledge flow (e.g., Rosenkopf and Almeida, 2003; Singh and Agrawal, 2011). Both applicant firms and patent examiners contribute prior art citations during the patent application process. One drawback of using patent citations to measure knowledge flow is that firms and their inventors may intentionally omit relevant prior art citations in their patent applications in the hopes of attaining broadly scoped patents (Steensma, Chari, and Heidl, 2015). To address this concern, we assessed the robustness of our original results through post hoc analyses, for which we relied only on examiner-added citations.

The unit of analysis is the incumbent—new venture patent (i.e., those patents at risk of being cited) dyad by year. Our dependent variable is whether the focal knowledge of a focal new venture (as encapsulated in a patent) flows to a focal incumbent firm (as indicated by a citation). We chose this relatively granular research design because it allowed us to control for extensive heterogeneity in the characteristics of the patented knowledge at risk of flowing including its relevance to a focal incumbent firm, patent age, and patent quality. Specifically, for a given year t, we created dyads between incumbent firms and new venture patents that were applied for (and subsequently granted) up until $t - 1$ and not previously cited by the focal incumbent firm. When the dyad's incumbent firm cited a new venture patent in a given year, thereafter, that dyad was removed from the risk set. When the incumbent of a focal dyad acquired a new venture, the incumbent–new venture patent dyad observations associated with those firms were subsequently removed. Our final data set included 168,020 unique incumbent firm-new venture patent dyads and was an unbalanced panel with 695,151 dyad-year observations.

Dependent variable

Knowledge flow is a binary variable that indicates whether any of the focal incumbent firm's patents applied for in the observation year t (and subsequently granted) has cited the focal new venture patent. If so, this variable was coded as 1, and 0 otherwise.

The role of patents in the software sector is substantially different from their role in the manufacturing sector. Specifically, software patents do not diffuse information about the patented technology in the same fashion as they do in the manufacturing sector (Hall and MacGarvie, 2010). Instead, these patents are used by their patent holders more strategically to signal capability to providers of funding and for bartering during cross-licensing negotiations.

[4] We excluded non-manufacturing companies that pursued venture capital investments as a means of portfolio diversification (Dushnitsky and Lenox, 2005).

DOI: 10.1002/smj

Independent variables

Outward inventor mobility-founder

We modeled whether the focal new venture was founded by an inventor previously employed by the focal incumbent firm (i.e., the new venture is a spin-out of the incumbent firm), using a dummy variable. Because the knowledge flow of interest was patented intellectual property, we limited our focus to founders of our sample new ventures who also were inventors, as determined by their biographic information. To identify a spin-out relationship between new ventures and incumbent firms in our sample, we collected data on the prior employment of these founders by conducting a rigorous online search, using various sources including company websites, *Businessweek* executives' profiles and biography database, and professional networking websites, such as LinkedIn (Winston-Smith and Shah, 2013). Based on their employment history, we established whether these founders had been employed by any of the sample incumbent firms prior to the founding of their new ventures. This dummy variable was coded as 1 if a founder of the dyad's new venture had been previously employed by the dyad's incumbent firm, and 0 otherwise. If multiple founders had started a new venture, we considered all of their employment histories, and if any of the founders from the dyad's new venture had worked for the dyad's incumbent firm, we considered the dyad to have had a spin-out relationship. Of the 370 new ventures in our sample, 132 had spun out from an incumbent firm from our sample of 41 incumbents.

Outward inventor mobility-employee

We used multiple steps to determine whether the focal incumbent firm had previously employed any non-founding inventors at the focal new venture (Corredoira and Rosenkopf, 2010). First, we relied on the U.S. patent inventor database developed by Lai *et al.* (2013) to identify all inventors associated with the patents of each new venture that were applied for (and subsequently granted) up until the focal year. We then collected the patenting history of these inventors to determine whether any of their prior patents was assigned to any incumbent firms in our sample. This is an indication that the inventor had been previously employed at the incumbent firm. We coded this variable as 1 if at least one non-founder inventor moved from the focal incumbent to the focal new venture in the five years prior to the observation year, and 0 otherwise. We manually cross-checked inventor names to ensure that *outward inventor mobility-employee* for a focal new venture was not erroneously coded with a 1 as a result of the patenting activity of a founder who was previously employed by the focal incumbent firm. Of the 14,267 incumbent firm-new venture dyads represented in our sample, 323 experienced inventor mobility from the focal incumbent firm to the focal new venture for which the inventor was a non-founding employee.

History of misappropriation

We measured an incumbent firm's history of misappropriating the intellectual property of others by using a five-year window, including the observation year, to compute a cumulative count of unique patent infringement lawsuits that involved the incumbent as a defendant. We used Public Access to Court Electronic Records, a web-based service that allows online access to court dockets, to collect the data. Because this variable is highly skewed, we used a log transformation. Higher values indicate a greater history of possible knowledge misappropriation.

We controlled for a host of other factors that may influence the propensity for knowledge to flow from a new venture to an incumbent firm. These factors fall into four categories: (1) incumbent–new venture dyad, (2) incumbent firm, (3) new venture, and (4) patent.

Incumbent–new venture dyad control variables

Inward inventor mobility

Knowledge may flow from new ventures to incumbents when incumbent firms hire inventors previously employed by new ventures (Palomeras and Melero, 2010). We measured the incidence of at least one inventor's moving from the focal new venture to the focal incumbent firm (i.e., *Inward inventor mobility*) with the same method used for *Outward inventor mobility-employee*. We first identified all inventors of the focal incumbent firm's patents that were applied for in the five years prior to the observation year. We then collected the patenting history of these inventors to determine whether any of their prior patents were assigned to the focal new venture. If so, this indicates an inventor's

DOI: 10.1002/smj

movement from the new venture to the incumbent firm. The time of mobility was assumed to be the year prior to the application year of the incumbent firm's first patent for which the mobile inventor was listed as the inventor (Corredoira and Rosenkopf, 2010). We coded this variable as 1 if at least one mobility event had taken place in the five years prior to the year of observation, and 0 otherwise.

Same subsector

Knowledge flow is more likely to occur between firms that operate within the same subsector. Based on the four-digit SIC code, we coded this variable as 1 if an incumbent and a new venture belonged to the same subsector, and 0 otherwise.

Technology distance

Technological similarity is an important determinant of interfirm knowledge flow (Rosenkopf and Almeida, 2003). In keeping with prior research (Jaffe, 1986), we measured this variable by computing an *n*-dimensional Euclidean distance between the technology profiles of the focal incumbent firm and those of the focal new venture, using their patents and their primary International Patent Classification (IPC) codes with a five-year historical window, including the focal year.

Geographic distance

Geographically proximate firms are more likely to learn from each other (Rosenkopf and Almeida, 2003). Using a formula based on ZIP codes (Sorenson and Stuart, 2001), we measured this variable in miles between the focal new venture and focal incumbent.

Investment relationship

Interorganizational relationships influence knowledge flow between firms (Rosenkopf and Almeida, 2003). Corporate venture capital investment is often the first interorganizational relationship between young start-ups and incumbents (Katila *et al.*, 2008). We examined the presence or absence of the *Investment relationship* between the incumbent and new venture in the observation year, using a binary variable. We assumed that the effect of an investment relationship would be salient for five years.

Alliance relationship

Although investment relationships are typically the first ties formed by technology-based ventures (Hallen, 2008; Katila *et al.*, 2008), we also controlled for any other alliance between the incumbent and the new venture in a dyad using a binary variable. We assumed that the effect of an investment relationship would be salient for five years.

Patent relevance to incumbent

The relevance of the knowledge that underlies a focal new venture patent to the focal incumbent firm is likely to influence whether the focal incumbent firm builds on this knowledge and cites the patent in its own patents. To account for the heterogeneity in patent relevance to the focal incumbent firm, we controlled for whether the focal new venture patent at risk of being cited by the focal incumbent firm had backward citations to any focal incumbent firm's patents. A patent's backward citation to an incumbent firm's patents suggests that the patent builds on the knowledge of the incumbent firm to some extent. We took several steps to create this variable (Yang *et al.*, 2010). First, we identified all patents assigned to the focal incumbent firm that were applied for, and subsequently, granted in the 10 years prior to the observation year (i.e., $t - 1$ to $t - 10$). We then determined whether the focal new venture patent at risk of being cited by the focal incumbent firm in the observation year had cited any of the incumbent firm's patents identified in the first step. If so, this variable was coded as 1, and 0 otherwise. For example, if new venture Patent A had cited a patent applied for between 1990 and 1999, and subsequently, granted to Incumbent Firm B, the *Patent relevance to incumbent* for the Incumbent Firm B-New Venture Patent A dyad would be coded as 1 for the observation year 2000. Thus, this dummy variable controlled for how relevant the focal patent (and its underlying knowledge) may be to the focal incumbent firm.

Incumbent firm control variables

Incumbent patents

We controlled for the technological capabilities of incumbent firms using the natural log of the count of patents obtained within a five-year rolling window, including the observation year.

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Incumbent alliance experience

An incumbent firm's ability to learn external knowledge may be correlated with its access to different sources of external knowledge through alliance activity (Tzabbar, Aharonson, and Amburgey, 2013). We computed the natural log of the count of alliances that an incumbent firm formed during each five-year rolling window, including the observation year.

Incumbent firm size

We measured the size of the incumbent firm, using the natural log of total assets adjusted for inflation.

Incumbent firm dummies

We included *Incumbent firm dummies* to control for remaining time-invariant unobserved heterogeneity across incumbents that may influence their motivation and capabilities to learn.

New venture control variables

New venture age

To the extent that age of the venture may influence knowledge outflow, we controlled for *New venture age* based on its year of foundation.

Founder prior entrepreneurial experience

Having experienced and relatively savvy founders may influence knowledge flow from new ventures to incumbent firms. Using a dummy variable, we controlled for whether the founder(s) of the focal new venture had any venture-founding experience in the IT sector prior to founding the focal venture.

New venture patent control variables

New venture patent age

We controlled for the age of intellectual property that underlies the focal patent as measured by the difference between the observation year and the patent application year.

New venture patent quality

The quality of a patent may influence its propensity for being cited. We constructed this variable by computing the natural log of the number of times that the focal patent had been cited by other patents using a five-year window based on a grant year.

ANALYSIS AND RESULTS

Because the dependent variable is binary, we used logistic regression. Table 1 provides descriptive and correlation statistics for the sample and indicates low levels of correlation among the variables. The base rate of *Knowledge flow* across all incumbent–new venture patent dyad by year observations is 0.003.[5]

In a data set that consists of dyads, the presence of the same firm (or patent) in multiple dyads for the same year leads to interdependence. Thus, the assumption of independent observations may be a concern. To address this issue, we included an auto-regression control variable defined for the *ij*th dyad as the mean of the dependent variable across all dyads that included either an incumbent firm *i* or a new venture patent *j* in the current year *t*, excluding the *ij*th dyad (Lincoln, 1984; Stuart, 1998). In addition to incumbent firm dummy variables and other new venture patent-level controls, the auto-regression variable accounted for additional unobserved heterogeneity, as it captured within-year nodal (incumbent firm, new venture patent) effects not otherwise included in our models. Thus, the coefficients of the explanatory variables were cleansed of the propensities of the dyad to experience knowledge flow for a given year.

Table 2 provides the results of our logit analysis. Year dummies were included to control for heterogeneity across different time periods. Because our data structure consists of non-nested clusters of incumbent–new venture patent dyads, we clustered the standard errors by both incumbent firm and new venture (Cameron, Gelbach, and Miller, 2011; Petersen, 2009).[6]

[5] The low base rate of knowledge flow is due to our research design, in which we compare the incumbent–new venture patent dyads that experience patent citation relative to all dyads that could have experienced the citation link over time.

[6] Which method and level to use for clustering standard errors depends on the structure of the data as this determines the source of correlation among the residuals (Petersen, 2009). When clusters are nested (e.g., individual within household within state), clustering error terms at the highest level of aggregation (e.g., state) is recommended. For non-nested designs such as ours, however, multiway clustering is recommended (Cameron *et al.*, 2011).

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Table 1. Descriptive statistics and correlations

	Variables	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	Knowledge flow to incumbent	0	0.06	1																		
2	Outward inventor mobility-founder	0.02	0.13	0.02	1																	
3	Outward inventor mobility-employee	0.05	0.21	0.03	0.18	1																
4	History of misappropriation (Ln)	2.13	1.05	0.02	0.06	0.14	1															
5	Same subsector	0.06	0.24	0.03	0.07	0.03	−0.06	1														
6	Technology distance	0.6	0.22	−0.03	−0.08	−0.16	−0.35	−0.12	1													
7	Geographic distance (Ln)	5.75	3.54	−0.01	−0.06	−0.03	0.08	−0.14	−0.01	1												
8	Investment relationship	0.01	0.11	0.02	0.03	0.07	0.06	0.09	−0.05	−0.06	1											
9	Alliance relationship	0	0.04	0	0	0.03	0.03	0	−0.02	0.02	0.15	1										
10	Inventor mobility from new ventures	0.01	0.11	0.01	0.07	0.15	0.03	0.08	−0.09	−0.08	0.11	0.01	1									
11	Patent relevance to incumbent	0.07	0.26	0.04	0.11	0.17	0.17	0.07	−0.15	0.02	0.04	0.01	0.05	1								
12	New venture age	6.14	2.38	−0.02	0.01	0.06	0.07	0	−0.15	−0.02	0	0.03	0.06	0	1							
13	Founder's prior industry experience	0.79	0.41	0	0.06	0.02	0	0	−0.03	0.03	0.01	0.01	0	0.03	0.01	1						
14	Founder's prior entrepreneurial experience	0.41	0.49	0.01	0.02	0.01	−0.02	−0.03	−0.01	0	0.03	0.02	0.01	−0.01	0.04	0.36	1					
15	New venture patent age	3.16	1.95	−0.02	0	−0.01	0.08	0	−0.07	0.01	0.01	0.01	0.04	0	0.5	−0.03	0	1				
16	New venture patent quality (Ln)	−0.08	2.97	0.05	−0.01	0	−0.08	−0.02	0.02	0.03	0.01	0.01	0.02	0	0.02	0.04	0.11	0.23	1			
17	Incumbent patents (Ln)	6.08	2.66	0.05	0.1	0.17	0.53	0.13	−0.64	0.01	0.07	0.01	0.07	0.22	−0.02	0	0	−0.03	0.02	1		
18	Incumbent alliance experience (Ln)	1.7	3.29	0.04	0.1	0.14	0.07	0.1	−0.17	−0.2	0.06	0	0.06	0.19	−0.01	0	0	−0.02	0.01	0.4	1	
19	Incumbent size (Ln)	9.57	1.38	0.03	0.09	0.18	0.44	−0.07	−0.03	0.06	0.06	0.02	0.02	0.16	0.03	0	−0.01	0.03	−0.03	0.17	0.21	1

N = 695,151.

Table 2. The likelihood of knowledge flow from new venture to incumbent

	Model 1	Model 2	Model 3 robustness check	Model 4 small subsample	Model 5 large subsample
Hypothesized relationships					
Outward inventor mobility-founder	0.29	1.77	3.10	2.60	−0.51
	(0.20)	(0.76)	(0.39)	(0.46)	(1.08)
Outward inventor mobility-employee	0.03	0.05	0.16	0.10	0.06
	(0.10)	(0.09)	(0.14)	(0.42)	(0.07)
Outward inventor mobility-founder		−0.57	−1.03	−0.96	0.25
X History of misappropriation		(0.26)	(0.17)	(0.22)	(0.35)
Control variables					
History of misappropriation	−0.57	−0.55	0.01	−0.66	−0.51
	(0.09)	(0.09)	(0.23)	(0.20)	(0.15)
Same subsector	1.04	1.05	0.91	1.19	0.74
	(0.26)	(0.26)	(0.28)	(0.27)	(0.17)
Technology distance	−1.41	−1.39	−1.40	−3.71	−0.30
	(0.70)	(0.69)	(0.63)	(1.22)	(0.49)
Geographic distance	−0.03	−0.03	−0.02	−0.03	−0.03
	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
Investment relationship	0.26	0.26	0.33	−0.06	0.33
	(0.10)	(0.10)	(0.08)	(0.45)	(0.18)
Alliance relationship	0.83	0.81	0.52	–	0.73
	(0.21)	(0.21)	(0.30)		(0.17)
Inventor mobility from new venture to incumbent	0.25	0.23	−0.04	−0.05	0.17
	(0.27)	(0.27)	(0.23)	(0.46)	(0.06)
Patent relevance to incumbent	0.46	0.45	0.44	0.58	0.41
	(0.11)	(0.10)	(0.12)	(0.22)	(0.10)
New venture age	−0.07	−0.07	−0.08	−0.09	−0.06
	(0.03)	(0.03)	(0.04)	(0.05)	(0.03)
Founder prior entrepreneurial experience	0.02	0.03	0.08	−0.19	0.09
	(0.13)	(0.13)	(0.13)	(0.20)	(0.11)
New venture patent age	−0.08	−0.08	−0.14	−0.11	−0.08
	(0.03)	(0.03)	(0.04)	(0.06)	(0.03)
New venture patent quality	0.58	0.58	0.57	0.60	0.58
	(0.04)	(0.04)	(0.03)	(0.08)	(0.03)
Incumbent patents	0.52	0.51	0.44	0.47	0.68
	(0.13)	(0.13)	(0.19)	(0.23)	(0.25)
Incumbent alliance experience	0.02	0.02	0.56	0.10	−0.03
	(0.05)	(0.05)	(0.25)	(0.07)	(0.05)
Incumbent size	0.02	0.02	−0.16	−0.04	0.03
	(0.11)	(0.11)	(0.14)	(0.30)	(0.20)
Autocorrelation control	24.71	24.40	−28.94	49.91	16.23
	(7.81)	(7.96)	(17.61)	(16.14)	(5.38)
Intercept	−10.75	−10.77	−9.73	−8.34	−24.03
	(1.43)	(1.44)	(1.87)	(1.82)	(2.21)
Incumbent firm dummies	Yes	Yes	Yes	Yes	Yes
Year dummies	Yes	Yes	Yes	Yes	Yes
Number of observations	695,151	695,151	350,286	343,193	336,698
Log likelihood	−11779.7	−11772.1	−6137.2	−3309.4	−8359.1
AIC	23585.4	23572.3	12296.5	6648.8	16742.3

Robust standard errors are in parentheses. Standard errors are clustered on both incumbent firm and new venture.

In Model 1, we have *Outward inventor mobility-founder* and *Outward inventor mobility-employee* in addition to all control variables. In Model 2, we add the interaction term for *Outward inventor mobility-founder* X *History of misappropriation.*[7]

Hypothesis 1 predicts that, in general, knowledge will more likely flow to a CVC-active incumbent firm from its spin-outs (i.e., new ventures founded by former inventors of the incumbent firm) than

[7] For the sake of comprehensiveness, in a post hoc analysis, we explored a model that includes the interaction term for *Outward inventor mobility-employee X History of misappropriation*. We found that the interaction term was not significant and that its inclusion had no substantive influence on the pattern of our results.

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from new ventures that employ non-founding inventors previously employed by the incumbent firm. The coefficient associated with *Outward inventor mobility-founder* ($\beta = 0.29$, $p = 0.14$) in Model 1 is nine times larger than the coefficient associated with *Outward inventor mobility-employee* ($\beta = 0.03$, $p = 0.74$). Although the individual main effects of *Outward inventor mobility-founder* and *Outward inventor mobility-employee* are not statistically significant, the result from the Wald test indicates that there is a significant, substantial difference between the two coefficients ($x^2 = 4.98$, $p = 0.03$), providing some support for Hypothesis 1.

In Hypothesis 2, we predict that the greater a CVC-active incumbent firm's history of misappropriating the knowledge of others, the weaker the positive relationship between a new venture's being a spin-out of the incumbent firm and the likelihood of knowledge's spilling in to the incumbent from the new venture. In Model 2, the coefficient on the interaction term, *Outward inventor mobility-founder* X *History of misappropriation*, is negative and significant ($\beta = -0.57$, $p = 0.03$). In nonlinear models such as ours, hypothesis testing should not rely solely on coefficient significance; subsequent analysis is needed to examine the sign and statistical significance of the true interaction effect, that is, the marginal effect of the moderator variable on the relationship between the independent and dependent variables (Hoetker, 2007). For our model, the *z*-statistic for the true interaction effect of *Outward inventor mobility-founder* X *History of misappropriation* computed at variable means is -3.15 ($p = 0.002$). We calculated the marginal effects of *Outward inventor mobility-founder* at various levels of the variable *History of misappropriation* while holding *Outward inventor mobility-employee* at 0 and all other variables at their means. Figure 1 provides the pattern of our results.

At one standard deviation below the sample mean for *History of misappropriation*, the marginal effect associated with the change of the *Outward inventor mobility-founder* dummy variable from 0 to 1 on the likelihood of *Knowledge flow* to incumbent firms is eight times greater than when *History of misappropriation* is at one standard deviation above the sample mean. As a further indication of effect size, when *History of misappropriation* is one standard deviation below the mean, the marginal effect of *Outward inventor mobility–founder* is 2.67 times greater than the sample base rate of *Knowledge flow*. In contrast, when *History of misappropriation* is one standard deviation above the mean, the marginal effect of *Outward inventor mobility-founder* is only 33 percent of the sample base rate of *Knowledge flow*. Overall, we find support for Hypothesis 2: The focal incumbent firm's history of misappropriating intellectual property of others weakens the positive effect of parent–spin-out relationship on the likelihood of knowledge flow to the incumbent.

Several control variables in our model are influential in a manner that is consistent with prior research. Incumbent firms are more likely to build on the intellectual property of new ventures that operate within the same industry subsector ($p = 0.00$) and when they are in proximal technological or geographical space ($p = 0.04$ and $p = 0.04$, respectively). As indicated by the significance of *Patent relevance to incumbent*, an incumbent firm is also more likely to build on knowledge of a new venture when the new venture has previously built on knowledge created by the incumbent ($p = 0.00$).

Post hoc analyses and tests of robustness

Corredoira and Rosenkopf (2010) found evidence of reverse knowledge flow from inventor mobility between firms, but did not distinguish whether these mobile inventors became founders of spin-outs or non-founding employees. We replicated their work by creating a dummy variable that also disregarded this distinction and re-analyzed our model. Consistent with their findings, the coefficient for this variable was positive ($\beta = 0.18$, $p = 0.07$).[8] Nevertheless, our full analysis indicates that this general effect is driven primarily by inventors who founded their own start-ups and depends on the incumbent firm's history of misappropriating intellectual property.

We tested the robustness of our full model in multiple ways. Firms and their inventors may selectively and strategically disclose prior art in their patent applications in the hopes of attaining broadly scoped patents (Steensma *et al.*, 2015). We assessed the robustness of our original results by conducting post hoc analyses for which we relied solely on examiner-added citations as indication of knowledge flow. Because the distinction between examiner- and applicant-added citations became available only in 2001, our sample was significantly reduced. Nonetheless, as seen in Table 2, Model 3,

[8] Results available on request.

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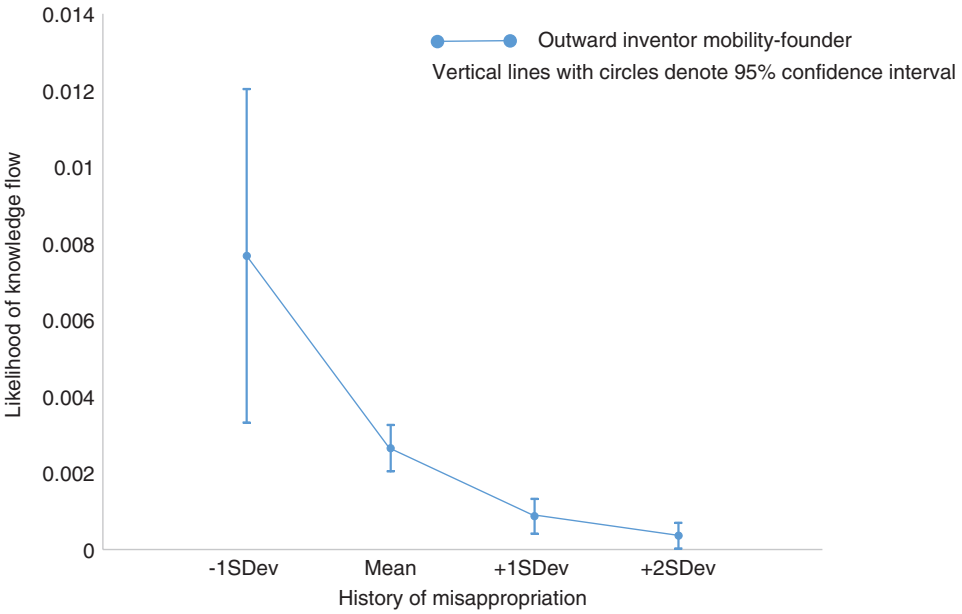

Figure 1. Marginal effects of outward inventor mobility-founder on the likelihood of knowledge flow to incumbent firms from new ventures

the pattern of these results is consistent with and somewhat stronger than our original results.

Incumbent firms that have active corporate venture capital (CVC) programs tend to be relatively large. By sampling CVC-active incumbent firms, our sample may be constrained in terms of incumbent firm size, limiting the generalizability of our results. We tested the premise that our results are a function of our sampling relatively large incumbent firms by splitting our sample based on incumbent firm size (small versus large, based on assets) and re-analyzing our empirical model.[9] If our results are applicable only to relatively large incumbent firms, we should either (1) observe no difference in the models across the two groups (due to constrained variance between the groups in terms of incumbent firm size), or (2) observe our pattern of results only for the subsample that includes relatively large incumbents. As seen in Table 2, Models 4 and 5, we find from this analysis that our pattern of results is driven primarily by observations associated with the *smaller* incumbent firms in our sample. Figure 2 depicts the marginal effects based on the small incumbent subsample, which shows a similar pattern as in Figure 1 based on the full sample.

Thus, our results do not appear to be a function of our incumbent firm sample's being composed of relatively large firms. The results from these split samples are consistent with and provide additional support for our theoretical story. It stands to reason that social ties between spin-out founders and individuals from parent firms will have greater efficacy if the parent firm is relatively small. All else equal, the contributions that individual employees make to smaller employers are greater than those made to larger ones (Zenger and Hesterly, 1997). Thus, employees of smaller parent firms have greater influence within their firms and will have greater discretion to deploy knowledge that they acquire from former colleagues, including spin-out founders. In contrast, the effects of such social ties and subsequent knowledge flow will be much more diluted when parent firms are particularly large.

By using the first citation that a focal incumbent firm makes to a focal new venture patent as the basis of our dependent variable, we assume that a firm "learns" knowledge once and that this initial learning is best indicated by the initial citation. Any subsequent citations of the same patent indicate the reuse of knowledge that the firm had previously possessed. As an alternative analysis, we collapsed the patent-level dyads into 14,267 new venture–incumbent firm dyads (as opposed to new venture *patent*–incumbent firm dyads) and tested our model, using a citation *count* dependent

[9] We thank our anonymous reviewers for suggesting this test.

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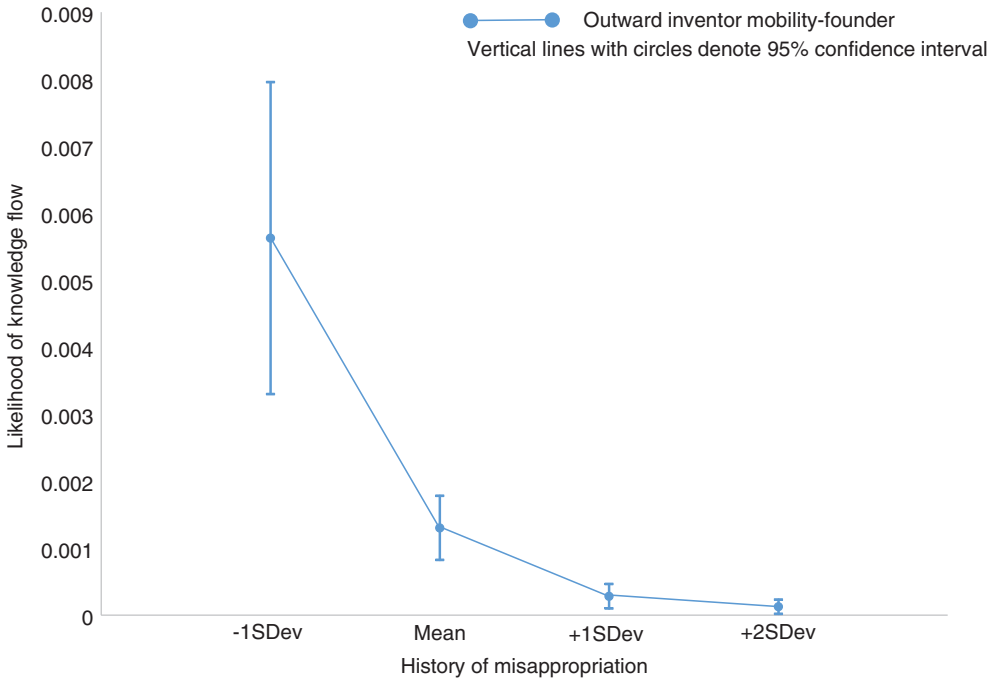

Figure 2. Marginal effects of outward inventor mobility-founder on the likelihood of knowledge flow to incumbent firms from new ventures (small incumbent firm sample)

variable, that is, the number of times the focal incumbent firm cited patents developed by the focal new venture. Because the distribution of this dependent variable indicated overdispersion and excess zeros, we estimated a zero-inflated negative binomial regression model (ZINB) with fixed effects on the incumbent firm.[10] These results were consistent with those of our original analysis.

Our original results are based on a five-year time window to calculate *History of misappropriation*. These results remain robust when three-year and seven-year windows are used. Finally, in our original analyses, we included network auto-regression controls to address concerns over the independence of observations (Lincoln, 1984; Stuart, 1998).[11] An alternative method to address this concern is to weight observations to account for the overrepresentation of a firm (or a patent) in a given year (Gulati, 1995). We ran additional regressions using this approach.[12] These results were consistent with our original results.

DISCUSSION

Mobile employees can become non-founding employees at existing new ventures. Alternatively,

[10] In the ZINB model, we predict zeros, that is, the probability of whether citations occur between two firms, using logistic regression based on same subsector, technological distance, and geographical distance between incumbent firms and new ventures. New ventures that operate in a different industry or in a space that is technologically or geographically distant from incumbent firms are unlikely to receive citations, independent of our theorized mechanisms for spill-in. In the negative binomial model estimated simultaneously with the logistic regression, we model the count of citations based on *Outward inventor mobility-founder*, *Outward inventor mobility-employee*, *History of misappropriation*, and the interaction between *Outward inventor mobility-founder* and *History of misappropriation*. Because we collapse the incumbent–new venture patent dyad level data to incumbent–new venture dyad level, we control for the number of new venture patents at risk of being cited for each year in this robustness check. All other firm- and dyad-level control variables were also included.

[11] The results are essentially the same with and without the autocorrelation control. This inconsequential autocorrelation control can be attributed to a comprehensive set of control variables, incumbent firm dummies, and clustering standard errors on both new ventures and incumbents.

[12] Specifically, when either an incumbent or a new venture patent experienced k knowledge flow events in a given year, each observation that involved that incumbent (or a patent) was given a weight of $1/k$ in the estimation. When both the incumbent and patent of a dyad experienced knowledge flow events multiple times, the weights for each were averaged.

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they can found their own new ventures within the same industry, creating spin-outs from their incumbent firm employers. Our analyses suggest that any advantage of incumbent firms in securing knowledge from their spin-outs quickly dissipates when these incumbents have a history of misappropriating the intellectual property of others as founders are highly vigilant of their proprietary knowledge's flowing to opportunistic incumbents. Our interviews with spin-out founders bore out their sensitivity to threats of infringement, even when patents protected their intellectual property.[13] In summarizing his perspective, one spin-out founder stated: " … certainly more for larger firms, infringement is a business decision, meaning that if people think they can get away with it and the price for getting caught is smaller than the benefit of doing so, infringement will be done. I've seen it happen because small companies don't have resources, and banking on patent litigation is a very expensive thing."

In contrast, when parent firms have little history of misappropriating the intellectual property of others, founders who have spun out new ventures from them are willing to take advantage of their relationships with the parent firms and to share information about their start-up's activities in the hopes of developing collaborative opportunities. For example, one of the spin-out founders whom we interviewed stated: "I approached them. I know [parent name], as a reputable company, doesn't deliberately steal patents. They act professionally. I wasn't worried about talking to them. … There are some companies that I would be concerned about, but [parent firm] isn't one of them. Companies that I do have concerns about their business ethics, I wouldn't want to partner with them. I wouldn't work with them." His comments are consistent with the findings from our analysis: When parent firms respect the intellectual property rights of others, they are more likely to benefit from knowledge that spills in from their spin-outs through founder social ties.

Limitations and future research

The limitations of our study as well as our findings provide direction for future research. With frequent employee mobility events and spin-out formation, the U.S. IT sector provided a useful context for testing our hypotheses. However, our single industry sample limits the generalizability of our findings. Additional research in other settings would help to validate our findings and to identify possible contextual nuances. Our sample of new ventures was constrained to those that were backed by U.S. investors. Due to the challenge of identifying the full population of new ventures, sampling only VC-backed new ventures is a common practice when studying new venture behaviors (e.g., Katila *et al.*, 2008). Nonetheless, our doing so limits the generalizability of our results. Due in part to data availability, the scope of our analysis was limited to the flow of patented knowledge. Research that considers the flow of other types of knowledge not protected by patents would be valuable.

Employees may leave their incumbent firm employers for various reasons, including frustration over their current employers' strategic directions or lack of capabilities, to seek a better employment opportunity or to strike out on their own. We were unable to account for the rich variety of reasons why employees in our sample left their current positions, and the terms under which they did so. Regardless of their reasons, mobile employees are likely to maintain some social ties with their former colleagues. Research on how the reasons for leaving influence the effects of employee mobility on subsequent knowledge spill-in would be worthwhile.

Consistent with prior research (Agarwal *et al.*, 2004; Franco and Filson, 2006), we define spin-outs to be new ventures founded by individuals who were previous employees of existing firms in the same industry. Due to data limitations, we were unable to account for the time that had elapsed between employees' departure from their respective incumbent firms and the founding of their new ventures. Social ties between founders and personnel at their parent firms will likely weaken as the time between departure and founding increases. Understanding the robustness of social ties between former colleagues over time may be valuable.

Contributions

Despite these limitations, our study responds to the appeal of Agarwal *et al.* (2014) for deeper insight in regard to when knowledge spill-in is likely to occur. Our work also complements that of Corredoira and Rosenkopf (2010), who found

[13] To enrich our empirical results, we secured interviews which spanned 20–25 minutes with 20 inventors who became spin-out founders.

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evidence of knowledge spill-in, but did not distinguish between the effects of employees' becoming new venture founders and employees' leaving to become non-founding employees of new ventures. We find that any benefit that incumbent firms reap from knowledge spill-in is attributable primarily to their employees' leaving to become founders. Previous research has shown how highly capable individuals are more likely to create spin-outs than to join existing firms when they exit (Campbell *et al.*, 2012b; Ganco, 2013). Although losing these employees to their entrepreneurial pursuits may come at a short-term cost to incumbent firms (Campbell *et al.*, 2012b), the spin-outs that they create are potential sources of renewing technology in the longer term. Having a history of misappropriating intellectual property, however, impedes this potential. Our analysis suggests that firms that have such history not only suffer from the departure of capable employees when they spawn spin-outs, but also forfeit any advantage that they may have for knowledge flow that originates from their spin-outs. Understanding these dynamics may be useful for incumbent firm managers as they consider the conditions under which employees exit their firms and the long-term costs of disrespecting the intellectual property rights of others.

As acknowledged by Corredoira and Rosenkopf (2010), one alternative to the social ties explanation of knowledge spill-in is that previous employers of mobile employees monitor the activities of the destination firms of these inventors more closely than those of other firms in the industry. In essence, employee mobility events may be particularly salient and draw disproportionate attention of those left behind (Corredoira and Rosenkopf, 2010). As such, knowledge spill-in from spin-outs may occur regardless of any social ties or communication. We do not directly measure social interaction or monitoring/attentiveness. However, our finding that a history of misappropriating the intellectual property of others dampens the likelihood of knowledge flow to incumbent firms from their spin-outs suggests that social interaction between mobile employees and those left behind is an essential mechanism for knowledge spill-in to occur. If parent firm attentiveness is the primary driver of knowledge spill-in, any history of misappropriating intellectual property would have little influence on whether parent firms are more likely to draw on the intellectual property of their spin-outs than on the intellectual property of comparable new ventures that are not their progeny. Further research that distinguishes these two mechanisms and when each mechanism is more influential would be valuable.

Our analyses complement the research of Yang *et al.* (2010), who found that knowledge-originating firms are uniquely advantaged in learning from those firms that originally learned from them. Together, our studies suggest that, although firms risk losing the knowledge that they generate, there is the potential for reverse knowledge flow. As some have argued, spin-outs come at the expense of incumbent firms (e.g., Campbell *et al.*, 2012b). Nonetheless, Agarwal *et al.* (2007) developed the theoretical notion of creative construction, whereby parent firms benefit from the innovative activities of their spin-outs. We extend this notion by empirically testing how spin-outs lead to spill-in and when it is more likely to occur. We note that spin-out events need not be solely detrimental to parent firms. An understanding of such reciprocal knowledge flow may help incumbent firm managers appreciate spin-outs as a useful source of external knowledge that can enhance their firms' competitiveness.

One extension of our work would be to consider further the characteristics of the knowledge that spills in from spin-outs. Employees who develop relatively complex knowledge while at incumbent firms are particularly inclined to create spin-outs (Ganco, 2013). Although complex knowledge does not easily diffuse to other firms (Sorenson, Rivkin, and Fleming, 2006), parent firms, as the original source of knowledge that spin-out founders use to create their spin-outs, may be uniquely positioned to overcome these challenges of securing particularly complex knowledge when it is developed by their spin-outs.

Our findings have policy implications as well. Although spin-outs can contribute to regional growth and development, some states, to protect the interests of incumbent firms, employ such legal devices as employee non-compete agreements to prevent employee mobility and their entrepreneurial activities (e.g., Marx *et al.*, 2009). Recent studies, however, have raised questions about the efficacy of the law (Franco and Mitchell, 2008). For example, Samila and Sorenson (2011) found that non-compete agreements are a significant impediment to entrepreneurship and employment growth in regional economies. Our results provide a cautionary note about the enforcement of such legal devices. Not only may these devices directly stifle valuable entrepreneurial activities, but they

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also impede positive externalities, whereby parent firms benefit from knowledge spill-in from their spin-outs.

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