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Article

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Extending the role of headquarters beyond the firm boundary: entrepreneurial alliance innovation



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Abstract

Prior research on corporate headquarters (CHQ) characteristics identifies the impact of CHQ location and composition on the innovation outcomes of internal subsidiaries. However, given that external strategic alliances with high-tech entrepreneurial firms represent a key source of innovation for the corporation, corporations must also consider how their choices of CHQ location and composition affect the innovation outcomes of these partners. In a study of 36 incumbent pharmaceutical corporations in 377 strategic alliances with 143 VC-backed biotechnology startups, we leverage detailed hand-collected data on CHQ locations and functions to estimate the effect of the CHQ on the innovation performance of the corporations' entrepreneurial alliance partners. We find that a 1000-km decrease in CHQ-partner distance leads to an increase of 28 forward citations for the alliance partner, i.e., a 1% decrease in the distance is associated with a 1.7% increase in innovation performance. We find that the co-located presence of the corporation's R&D function at the CHQ attenuates the benefit of CHQ-partner proximity, particularly for alliances structured for horizontal collaboration at the same part of the value chain. This study contributes to the literatures on both CHQ design and technology alliances.

Keywords: Corporate Headquarters, Corporate Headquarters Composition, Corporate Headquarters Design, Geographic Distance, R&D Function, Strategic Alliance, Horizontal Alliance, Vertical Alliance, Entrepreneurship, Innovation, Biotechnology, Pharmaceutical

Introduction

An extensive body of prior work documents strategic importance of the location and composition of the corporate headquarters (CHQ) for the performance of business units or subsidiaries internal to the boundaries of the corporation (Bouquet and Birkinshaw 2008; Menz et al. 2015). First, the location of the CHQ relative to internal business units or subsidiaries affects the performance of those individual units. Geographic distance affects the ability of the CHQ to monitor, manage, or collaborate with subsidiaries (Roth and O'Donnell 1996; Flores and Aguilera 2007; Slangen 2011; Baaij and Slangen 2013) and has thus been particularly highlighted in studies of multinational corporations (MNCs) (Monteiro et al. 2008; Boeh and Beamish 2011). Second, the composition of the CHQ—in terms of the business functions and leadership represented or co-located at the CHQ—also affects the performance of internal business

units. In a survey of over 600 CHQ, Collis et al. (2007) identify significant relevant heterogeneity in the functions present at the CHQ and link that heterogeneity to corporate performance, consistent with a more recent study of 105 European incumbent firms by Menz and Barnbeck (2017).

However, existing work on CHQ location and composition overlooks the potential effect of these CHQ design decisions on the performance of a corporation's alliance partners outside the traditional boundary of the corporation. A separate literature on technology commercialization underscores why corporations should care about the entrepreneurial innovation stemming from their strategic alliances. Established incumbent firms partner with entrepreneurial firms to tackle the commercialization of a new product and to combine their complementary assets with the innovation production capabilities of the entrepreneurial firm (Hitt et al. 2001; Rothaermel 2001; Gans and Stern 2003; Aggarwal and Wu 2019). The portfolio of alliance relationships with entrepreneurial partners represents a significant corporate asset for long-term innovation and performance of the incumbent firm (Ozcan and Eisenhardt 2009; Sarkar et al. 2009; Jiang et al. 2010). An established stream of work maintains that the capability to manage an alliance portfolio is an important source of sustained competitive advantage (Dyer and Singh 1998; Ireland and Vaidyanath 2002; Lavie 2006). Thus, an incumbent needs to take great care in cultivating the innovation of its partners to sustain the value of its portfolio relationships and its access to future entrepreneurial innovations (Weaver and Dickson 1998; Robson et al. 2008).

Thus, we seek to extend our understanding of the consequences of the CHQ—beyond the performance of internal units within the traditional firm boundary—to the performance of external entrepreneurial alliance partners. In particular, we study the consequences of CHQ distance and functional composition for the performance of the incumbent corporation's entrepreneurial alliance partners. Given that prior work argues that the distance and composition of the CHQ relative to internal businesses affect the value creation of those internal businesses, we argue that these same CHQ characteristics may also affect the performance of alliance partners. As the strategic apex and central unit (Chandler 1991; Menz et al. 2015) of the corporation, the CHQ occupies a core decision-making role (Campbell et al. 1995; Collis et al. 2012) in the orchestration and control of resources for the broader corporation (Deeds and Hill 1996; Birkinshaw et al. 2006; Nell and Ambos 2013). Alliance partners may fall under the purview of decisions made and resources allocated by the CHQ, making the design of the CHQ relevant to the performance of the entrepreneurial alliance partners. In turn, the capabilities of the CHQ should translate into long-term value creation and innovation among the components of the corporation (Chandler 1991; Foss 1997; Menz et al. 2015; Meyer and Benito 2016), which includes its external alliance partners.

To explore this empirically, we use alliance data from the pharmaceutical and biotechnology industry to build a startup–corporation–year panel. We manually collect detailed data on the headquarters (and subsidiaries) of the incumbent pharmaceutical corporations. In particular, we longitudinally track the location of the CHQ and several of the functions present at the CHQ over time. We exploit CHQ relocations over time as the primary source of heterogeneity in CHQ–partner distance, which enables us to account for unobservable differences in which alliances form; in a review of the CHQ literature, Kunisch et al. (2015) note that CHQ relocations tend to be frequent yet

significant decisions. We document significant heterogeneity in both the CHQ–partner distance and the presence of the R&D function at the CHQ over time within corporations, as well as across corporations. Our data structure enables us to investigate the innovation performance of entrepreneurial alliance partners while controlling for incumbents, startups, and alliance relationship-specific characteristics through control variables and multiple fixed effects. To account for potential endogeneity related to the pre-alliance performance of entrepreneurial firms (affecting the incumbent's choice of alliance partner) and pre-relocation performance of the entrepreneurial firms (affecting the decision of the corporation whether and where to relocate), we conduct several robustness tests to exclude these alternative explanations.

Our empirical results demonstrate a positive and statistically significant relationship between the CHQ–partner proximity and the partner's innovation performance. We theorize that the geographic distance between incumbent firm CHQ and its alliance partners affects collaboration between the entrepreneur and the incumbent's downstream business functions represented at the CHQ. Distance limits the efficient coordination of the incumbent's complementary assets and the entrepreneur's favorable innovation capabilities. We then study the moderating effect of the presence of the R&D function at the incumbent CHQ, finding that the R&D presence at the CHQ attenuates the benefit of CHQ–partner proximity. We argue that proximity to R&D at the CHQ reduces the autonomy needed for partner innovation, while also biasing the resource allocation decisions of the incumbent CHQ. We support these findings with an additional test on contingent effects of the alliance structure, namely the horizontal (collaboration at same level of value chain) versus vertical (specialization in upstream or downstream activities) forms of alliance, finding that horizontal alliance structures further exacerbate the attenuation of the proximity benefit to a partner when R&D is located at CHQ.

This study contributes to both the literatures on technology alliances and on CHQ. For the technology alliance literature, we identify the effect of incumbent organizational design choices for entrepreneurial alliance innovation. More broadly, we suggest that internal design choices of one firm can have performance implications for external parties. For the literature on CHQ, we draw attention to the implication of CHQ design for the performance of external partners, beyond existing work on CHQ design for the performance of the focal corporation (Trichterborn et al. 2016; Findikoglu and Lavie 2019). In turn, we offer another perspective on CHQ and the organizing of transactions across alternative governance structures, i.e., external and non-hierarchical, which help to shape the boundaries of the firm (Foss 2019).

Background and hypotheses development

We focus specifically on alliances between the larger incumbent corporations and the younger entrepreneurial firms. We refer to the entrepreneurial firm as the alliance partner or partner. We define alliances broadly as all kinds of contractual collaborative relationships among firms to develop and/or commercialize products (Shan et al. 1994; Deeds and Hill 1996). Encompassing both non-equity and equity alliances, this broad definition of alliances captures the richness of alliance forms in our pharmaceutical and biotechnology industry context, as the industry contains thousands of cooperative relationships formed under various contract types and purposes (Rothaermel and Deeds 2004). Whereas the relevant

characteristics of the CHQ—its location and functions—are at the discretion of the incumbent corporation, the relevant performance outcome is that of the entrepreneurial firm, the counterparty in an alliance. The characteristics of the alliance itself are of course a joint decision between the incumbent and the entrepreneurial partner.

Our study considers two dimensions of the design of the CHQ and one dimension of alliance design that may have an impact on alliance partners. Our primary consideration is the distance from the CHQ to the alliance partners, where distance is a function of the location of the CHQ. Then, we consider what functions are contained within the CHQ, in particular the upstream function of R&D. As we will present later in our data section, in the pharmaceutical and biotechnology context, most downstream functions, such as marketing or manufacturing, have some presence at the CHQ. However, the most relevant function for our study is the R&D function; as we will show, CHQ vary substantially in whether they contain a dedicated R&D function, with about half of the firms without an R&D function at the CHQ. Finally, we consider the form of the alliance contract, namely, whether it specifies a horizontal or vertical relationship between the incumbent and entrepreneurial partner.

Baseline: CHQ–partner distance

We start by laying out a baseline hypothesis relating CHQ–partner geographic distance with the innovation performance of the partner, consistent with prior work on geographic distances in alliances.¹ Geographic distance is a barrier to communication between the incumbent and the entrepreneur, where distance is associated with greater communication costs (Rosenzweig and Singh 1991; Stuart and Sorenson 2003), resulting in less frequent in-person visits (Giroud 2013; Bernstein et al. 2016) and less personal interaction (Lerner 1995; Chen et al. 2010). Prior work documents this effect of distance specifically in alliances (Reuer and Lahiri 2014; Van Kranenburg et al. 2014). Distance reduces both the quality and frequency of intentional collaborative communication and incidental knowledge spillovers. Closer distance of a CHQ to its alliance partners encourages inter-firm interactions involving in-person communication between executives (Allen 1977). In turn, this improved communication leads to better coordination and knowledge sharing (Kale et al. 2002). Prior work identifies the consequences of geographic distance for the incumbent corporation's innovation (Capaldo and Petruzzelli 2014; Hsiao et al. 2017) or financial performance (Lavie and Miller 2008; Zaheer and Hernandez 2011).² We now focus on the performance of the entrepreneurial alliance partner, which has not been addressed yet in the literature.

To build up to Hypothesis 1, we focus on the mechanism of managerial coordination, which we argue is the primary mechanism at play in the CHQ–partner context. There are two mechanisms—managerial coordination and scientific knowledge spillovers—that might relate CHQ–partner distance to partner innovation performance. These two mechanisms both have the same implication: CHQ–partner proximity improves the innovation performance of the partner. When we develop Hypothesis 2 below, we will

¹Empirically, we measure the geographic distance between the CHQ of the incumbent firm and the primary office of the entrepreneurial alliance partner, where we define CHQ as the office where CEO is located.

²In related work, several studies address the impact of the distance as an antecedent to alliance formation between a focal corporation and its alliance partners (Phene and Tallman 2014; Reuer and Lahiri 2014; Van Kranenburg et al. 2014).

consider the mechanism of scientific knowledge spillovers, where we will ultimately rule it out as a second-order consideration (at best) for CHQ design, relative to the primary consideration of managerial coordination.

Reduced CHQ–partner distance facilitates greater managerial coordination between the partner and the top corporate executives (e.g., CEO) towards the utilization of downstream business-oriented functions (e.g., sales, marketing) of the incumbent. Reduced distances improve inter-party communication, enhancing the efficiency of resource allocation as well as integration of joint activities (e.g., Reuer and Lahiri 2014). Incumbent firms amass extensive resources over time to support technology commercialization, both in the form of later-stage R&D capabilities and downstream complementary assets for activities such as manufacturing, marketing, and distribution (e.g., Zahra and Nielsen 2002; Lavie and Miller 2008). Entrepreneurial firms, particularly those backed by venture capital investors, serve as laboratories for risky early-stage R&D that can generate novel products (e.g., Lowe and Ziedonis 2006; Katila et al. 2008). A successful alliance requires efficient collaboration between the incumbent and its complementary assets as well as the innovation generated by the entrepreneurial partner. Thus, effective CHQ–partner coordination is critical (Menz et al. 2015). Furthermore, increased coordination of this form allows both parties to specialize. By having the incumbent specialize in the downstream functions for which it has complementary assets, the alliance allows the entrepreneurial partner to specialize in innovation, devoting more resources and attention towards generating patentable ideas. We elaborate on the benefits of specialization later in this section when we develop Hypothesis 3.

Over time, learning effects may further enhance the importance of the managerial coordination mechanism. Proximity engenders interaction with the CHQ, facilitating the learning process for the entrepreneurial partner who presumably has less past alliance experience (Anand and Khanna 2000). Experientially learning to manage alliances creates relational capital and accelerates the coordination process by lessening competitive tension and encouraging cooperative behavior (Kale et al. 2000). The accumulated knowledge not only creates value within the alliance where the experience was accumulated (Doz 1996; Arino and De La Torre 1998), but it also creates value across a portfolio of alliances (Anand and Khanna 2000). As the relational capital disseminates, the learning-to-learn process leads to a virtuous cycle that further improves the performance of the alliance (Arino and De La Torre 1998; Anand and Khanna 2000).

For these reasons, we argue that the distance of the CHQ to alliance partners is a determinant of partner innovation performance, motivating the following hypothesis:

Hypothesis 1: Proximity between the CHQ and an entrepreneurial alliance partner positively relates to the innovation performance of the alliance partner.

Heterogeneity in CHQ functions: research and development

However, not all CHQ are the same. Collis et al. (2007) and Young (1998) highlight the tremendous heterogeneity in size and structure of CHQ across firms: while some functions, such as legal or finance, nearly always exist at the CHQ, functions such as R&D vary in representation at the CHQ. Kunisch et al. (2012) and Kunisch et al. (2014) further document this heterogeneity in CHQ functional composition in more recent

large-scale surveys that demonstrate the growing importance of CHQ design. Because our study concerns innovation productivity, we now focus on the moderating effect of the R&D function at the CHQ.

By examining heterogeneity on this dimension of CHQ composition, we can separate out the effect of the two possible mechanisms that could have motivated Hypothesis 1: management coordination and scientific knowledge spillovers. Our argument so far has considered only the management coordination mechanism. Now, given empirical variation in whether the CHQ contains the R&D function, we can test whether the scientific knowledge spillovers channel drives the main benefit of proximity. First, we will argue that, in fact, the scientific knowledge spillovers channel is not a salient benefit of CHQ–partner proximity even when the R&D function is at the CHQ, in contrast to prior work on technology alliances that emphasizes the benefits of knowledge spillovers. Then, we will present two channels through which this proximity to a CHQ with an R&D function may actually hurt partner performance.

In principle, the partner could benefit from the accumulated scientific knowledge of the R&D function at the CHQ. Taking the view that innovation results from the recombination of existing knowledge, exposure to more diverse knowledge is more likely to result in novel combinations associated with impactful innovation (Fleming 2001). Prior research on strategic alliances, especially in high-tech industries, demonstrates consistent patterns of knowledge transfers among the network of participants (Chen 2004; Sammarra and Biggiero 2008), which ultimately lead to more innovation for the involved parties as knowledge accumulates (Kotabe and Swan 1995; Zollo et al. 2002).

However, in our CHQ–partner context, we argue that there is, in fact, not a substantive amount of scientific knowledge at the CHQ and that this knowledge, if it existed, would not actively circulate to the partner. The CHQ tends to contain only a limited number of scientific staff if it does contain the R&D function (Collis et al. 2007), such as the Chief Scientific Officer (CSO). Any possible knowledge transfers would need to rely on deep inter-personal knowledge sharing by many frontline scientists actually engaged in cutting-edge scientific work, whereas the R&D activity at the CHQ typically contains only a few executives. Given that the scale and scope of R&D activity at the CHQ are minimal, we argue that the location of R&D at the CHQ would not enable much interaction between scientists that would allow for the scientific knowledge spillovers to alliance partners.

While there are only limited benefits from scientific knowledge spillovers engendered by CHQ–partner proximity, we propose two channels for which the presence of the R&D function at CHQ may attenuate the benefit of proximity. First, the partner needs autonomy from the incumbent to generate innovation, but the partner's autonomy could be restricted when the R&D function is present at the CHQ and there is CHQ–partner proximity. The entrepreneurial partner needs to preserve flexibility, slack, and autonomy to continue generating exploratory innovations (Puranam et al. 2006). When organizing for innovation, the corporation must balance coordination with the preservation of the autonomy of the alliance partner (Puranam et al. 2006). To the incumbent firm, technology startup firms are attractive sources of innovation because the startup partner does not face the organizational rigidity and inertia that limit the larger established corporation (Zenger 1994; Doz 1996; Brown and Eisenhardt 1997).

However, the deeper interactions stemming from their proximity could enhance intervention by the established corporation if the R&D function is present at the CHQ because the CHQ may no longer delegate its research activities solely to its proximate partners. Hence, the strengthened intervention by the incumbent, through the R&D function at its CHQ, may hurt the existing innovation potential of the startup partner. This effect occurs as the incumbent's unfavorable atmosphere for innovation negatively affects the activity of the partner. If the R&D function is present at the CHQ, then proximity to the CHQ makes it more likely that the incumbent might intervene in the activities of the startup, limiting its slack.

Second, the presence of the R&D function at the CHQ may bias the ability of the CHQ to efficiently allocate resources that might be better used at the alliance partner as opposed to being used at the internal R&D function. As a strategic apex and central unit of the corporation (Chandler 1991; Menz et al. 2015), the CHQ acts as a control tower for corporate resources (Deeds and Hill 1996; Birkinshaw et al. 2006) and must make decisions to allocate those resources across its internal business units and external alliance partners. Given constraints on corporate resources, the alliance partners compete for access to those resources (Aggarwal 2014), putting the internal business units and the external alliance partners in an adversarial position (Goerzen 2005). Having the R&D function at the CHQ may make it more likely that the CHQ favors its internal R&D activities over external partners in its decisions to allocate corporate resources, given that the co-location of the internal R&D function draws more attention from corporate leadership. For example, Bouquet and Birkinshaw (2008) find that geographic distance moderates the attention that a CHQ pays to a particular subsidiary, and we extend this argument to corporate functions and alliance partners alike. Allocating fewer resources to the alliance partner reduces the slack available to the partner, where slack fosters experimentation (Nohria and Gulati 1996).

Due to reduced partner autonomy and biases in incumbent resource allocation, we argue that the presence of the R&D function at the CHQ attenuates the benefit of CHQ-partner proximity:

Hypothesis 2: The presence of an R&D function at the CHQ attenuates the positive relationship between CHQ-partner proximity and the innovation performance of the alliance partner.

Horizontal versus vertical alliances

We argued above that the location of an internal R&D function at CHQ has an attenuating effect on the proximity benefit otherwise expected to accrue to alliance partners. We now turn to the implications of the structure of the alliance itself to verify that the previously described predictions result from improved managerial coordination but not from knowledge spillovers. We now consider whether the structure of the alliance has implications for both the effect of distance and the moderating effect of the R&D function at the CHQ.

We characterize alliances between incumbent firms and entrepreneurial firms into two types: horizontal and vertical. In our usage, horizontal alliances are those representing a horizontal relationship between the incumbent and the entrepreneur,

where the contract specifies joint activities between parties at the same level of the value chain, such as co-development or collaboration (Hagedoorn and Schakenraad 1994; Kotabe and Swan 1995; George et al. 2001).³ In contrast, vertical alliances are those contracts where one party is designated to be responsible for an activity further upstream or downstream than the other. As Stuart et al. (2007) note, the entrepreneurial partner generally addresses upstream activities (e.g., R&D), while the incumbent generally engages in downstream activities (e.g., marketing).

We argue that the horizontal alliance form, as opposed to the vertical alliance form, further attenuates the proximity benefit to a partner when R&D is located at CHQ for two reasons. First, a horizontal alliance implies greater intervention by the incumbent into the innovation activities of the entrepreneurial partner, which hurts the ability of the entrepreneurial firm to operate autonomously. Horizontal alliances prescribe collaboration between the incumbent and the entrepreneur at a given part of the value chain. Given that the resource-constrained entrepreneurial partner necessarily operates on a comparatively limited scope of the value chain, any horizontal collaboration implies that the incumbent is collaborating on the finite part of the value chain where the entrepreneur operates. For an entrepreneur whose primary purpose is R&D towards new patentable technology, intervention by the incumbent encumbers the entrepreneur with the detrimental qualities of the incumbent's innovation capacity, namely the organizational rigidity and inertia of the incumbent corporation (Zenger 1994; Doz 1996; Brown and Eisenhardt 1997).

Second, the vertical alliance form allows the entrepreneurial partner to specialize in innovation-related activities. Vertical alliances suggest intended specialization by the parties, with coordination limited to the interface between different levels of the value chain, e.g., the incumbent coordinating on manufacturing a drug discovered by the entrepreneurial partner. In these vertical alliances, corporations can leverage the existing innovation of the startup firm in combination with the complementary assets of the corporation (Rothaermel and Deeds 2004; Lavie and Rosenkopf 2006), where the incumbent's exploitation-oriented capabilities apply to downstream activities such as manufacturing and applied late-stage research. Entrepreneurial success then depends on vertical coordination with established firms (Stuart et al. 2007).⁴

In most industries, the CHQ contains representatives from the business functions (Collis et al. 2007) and, especially in our context, the CHQ almost always contains leadership for the downstream functions that leverage the complementary assets of the incumbent. Improved coordination from CHQ-partner proximity in a vertical alliance allows the entrepreneur to leverage these downstream resources of the incumbent, enabling the entrepreneurial partner to dedicate its own limited resources towards its upstream innovation activities.

³We take a more general definition of a horizontal alliance than does prior work in strategy. Baum et al. (2000) consider horizontal alliances only between pairs of biotechnology firms and not between biotechnology and incumbent pharmaceutical firms. Oxley (1997) studies horizontal technology transfer alliances only.

⁴Rothaermel and Deeds (2004) find that horizontal relationships (exploration alliances) originally focusing on early-stage R&D transform into exploitation alliances interacting vertically as the corporation eventually tries to impose more control in the relationship to commercialize the products, rather than collaboratively developing new technology.

Baum et al. (2000) note that vertical alliances are particularly effective for enhancing innovation in high-technology industries such as biotechnology.

For these two reasons—decreased partner autonomy and decreased partner specialization—we argue that the horizontal alliance form further attenuates the benefit of CHQ–partner proximity when R&D is present at the CHQ:

Hypothesis 3: When the R&D function is present at the CHQ, the positive relationship between CHQ–partner proximity and the innovation performance of the alliance partner is further attenuated for a horizontal alliance relative to a vertical alliance form.

Empirical approach

Industry setting

To test the three hypotheses, we study strategic alliances in the pharmaceutical and biotechnology industry, which provides a rich source of data for empirical investigation. There have been frequent strategic alliances in the biotechnology industry since the early 1970s (Rothaermel and Deeds 2004). These alliances allow firms in this industry's technology-intensive environment to share their knowledge and exploit complementary assets to develop and commercialize their products (Powell et al. 1996; Baum et al. 2000).

The characteristics of the pharmaceutical and biotechnology industry align well with our research framework. In this industry, alliances facilitate upstream horizontal collaboration—for sharing cutting-edge knowledge for new product development—and vertical upstream–downstream transaction relationships—for commercializing products developed by one party using the complementary assets held by the other (Baum et al. 2000).

This setting conveniently allows for a contextually legitimate metric of performance: patenting outcomes. Patent activity in the industry plausibly represents innovation performance because biotechnology firms use patents as the primary method of appropriating value from innovation (Levin et al. 1987). Patent production in this industry is particularly strong, giving firms a strong incentive to generate patents aggressively (Deeds and Hill 1996). Prior work also shows that firms leverage shared alliance resources in the race for patents (Deeds and Hill 1996; Baum et al. 2000). While some work interprets the number of patents granted to a firm as a measure of the direct output of R&D investment (Shan et al. 1994), our main dependent variable of forward citations intends to capture the economic potential and innovative impact of the entrepreneurial partner's R&D activity.

Data and sample

We combine hand-collected CHQ data with archival data on alliances, incumbent and startup location, incumbent and startup patenting activity, and incumbent and startup firm characteristics. Our data construction starts with a set of incumbent pharmaceutical corporations for which we hand-collect CHQ characteristics over time. We match those corporations to entrepreneurial alliance partners. We build patent performance outcomes for the entrepreneurial alliance partners. For both

corporations and their partners, we collect office location data and other time-varying firm characteristics. The final data consists of startup–incumbent–year observations.

We start with 36 top publicly traded pharmaceutical corporations for which we can locate a CHQ in the United States.⁵ We manually collect data on CHQ characteristics of all 36 pharmaceutical incumbent firms over time. We define the CHQ as the office where the CEO is located. In most cases, we confirm the location of the US CHQ in each year based on information in the corporation's annual 10-K filings in the EDGAR database of the US Securities and Exchange Commission (SEC).⁶ We hand-collect data on the functional composition of the CHQ, documenting whether the CHQ contains the R&D, legal, and manufacturing functions. We also collect data from Dun & Bradstreet (D&B) on the CHQ size and spatial design. The [Appendix](#) details the manual CHQ data collection process.

Table 1 summarizes the functions, characteristics, and spatial design of CHQ of the 36 incumbents over time. Each corporation has a unique time-series for which they appear in our data, meaning that they each have a different initial year and final year in which we observe them. In panel A, about half of the CHQ have an R&D function in the initial year they appear in our data, and the percentage decreases to less than 40% in the final year they appear. In contrast to the across-firm and within-firm-over-time heterogeneity of the R&D function at CHQ, a majority of corporations have legal and manufacturing functions at the CHQ over time. Importantly, for our empirical study, panel B shows that 70% of the incumbents experience at least one CHQ relocation, providing rich time-sectional variation in CHQ–partner distance.

The underlying alliance data consists of all strategic alliances from 1985 to 2009 between these 36 pharmaceutical corporations and venture capital-backed entrepreneurial firms located in the USA. The alliance data from Deloitte Recombinant Capital (Recap) contains party names, contract start dates, contract terms, and alliance-associated technology types. The alliance contracts linking the 36 incumbent corporations and 386 startups form 1299 unique startup–incumbent dyads, where each dyad has one or more underlying alliance contracts.⁷ From these dyads, we set up the data as a startup–incumbent–year panel, where each startup–incumbent alliance relationship can last for several years and each startup–incumbent dyad has multiple observations.⁸ Because the alliance contract end dates may not be announced publicly, we assume a startup–incumbent alliance relationship lasts 5 years from the observable start year of their first alliance contract, a typical alliance duration (Stuart 2000; Lavie and Miller 2008). If a startup–incumbent renews its contract within the 5-year window of a

⁵Although some of these firms have an international headquarters, we include them if they have a United States headquarters. For example, the global healthcare company Novartis International AG is included in our data because one of its multiple global headquarters is located in the USA. We include 11 foreign-based corporations, representing 31% of our starting sample of 36 incumbent firms.

⁶For the firms whose CHQ locations are not available in the EDGAR database, we use the BoardEx database to identify the CEO of each corporation. We then identify public longitudinal profiles (e.g., LinkedIn profile) to identify where the CEO was based during her employment.

⁷In other words, on average, a corporation contracts with $1299 \div 36 = 36$ different entrepreneurial alliance partners during the whole period.

⁸There are 8505 startup–incumbent–year observations in the original Recap data, meaning that there are $8505 \div 1299 = 6.5$ years of observations for each startup–incumbent dyad, on average.

Table 1 CHQ Functions, characteristics, and spatial design. Detailed Information about the 36 CHQ in our data is provided. *R&D Function* presents whether an R&D function is present at a CHQ, and *Legal Function* indicates whether a CHQ has a legal function. *Manufacturing Function* means a CHQ contains some manufacturing activity, and *Largest* denotes that a CHQ has largest size among all its other HQ units and subsidiaries. *Acquired* represents whether another firm acquired the focal corporation. *Foreign-Based* denotes a non-US-domiciled corporation

Panel A: CHQ functions and characteristics						
Functions/characteristics	At CHQ in initial year			At CHQ in final year		
	Yes	No	% Total	Yes	No	% Total
<i>R&D Function</i>	19	17	53%	14	22	39%
<i>Legal Function</i>	32	4	89%	29	7	81%
<i>Manufacturing Function</i>	24	12	67%	34	2	94%
<i>Largest</i>	25	11	69%	21	15	58%
<i>Acquired</i>	1	35	3%	14	22	39%
<i>Foreign-Based</i>	11	25	31%	N/A	N/A	

Panel B: CHQ spatial design									
CHQ relocations			HQ units in initial year			HQ units in final year			
Count	Firms	% Total	Count	Firms	% Total	Count	Firms	% Total	
0	11	30%	1	31	86%	1	23	64%	
1	13	36%	2	4	11%	2	6	17%	
2	5	14%	3	1	3%	3	4	11%	
3	5	14%	4	0	0%	4	0	0%	
4	1	3%	5	0	0%	5	1	3%	
5	1	3%	6	0	0%	6	1	3%	
			7	0	0%	7	0	0%	
			8	0	0%	8	1	3%	

previous contract, we continue the time series for that relationship for 5 years after the renewal year.

To measure or control for innovation performance, we then link these startup partners and incumbent corporations to their patenting history. We use the Harvard Institute for Quantitative Social Science (IQSS) version of the United States Patent and Trademark Office (USPTO) patent grant data created by Li et al. (2014).⁹ Given the lack of unique and common firm identifiers, we engaged in a challenging and lengthy matching process to link incumbent and startup firm names from Recap to assignees in the patent data. We standardize firm names and fuzzy match these standardized names across datasets, based on the fuzzy matching methods by Wasi and Flaaen (2015).¹⁰ We then manually verify those matches. We end up identifying patent information for 284 startups in the Recap data, tentatively accounting for 954 startup–incumbent dyads and 3953 startup–incumbent–year observations.

To measure geographic distance between the CHQ (or corporate subsidiaries) and the startup alliance partners, we use detailed historical location data from D&B. The

⁹Li et al. (2014) provide a clean, inventor-disambiguated version of the data on patents granted by the USPTO. Their data derives from patent data that the National Bureau of Economic Research (NBER) patent database first codified.

¹⁰Wasi and Flaaen (2015) provide a Stata module to execute a fuzzy match. The fuzzy match determines a matched record if it passes a match score cutoff where a match score denotes similarity of the standardized firm names. We set the threshold at 0.95 and then manually checked the matches.

D&B data covers a large portion of firms and their business units located in the USA between 1969 and 2016. We use the same fuzzy matching method to identify the incumbent and startup firms from the Recap-IQSS data in the D&B data. From the 284 startups in the last step, this matching process results in 143 startups; we verify that the startup location data is missing at random relative to observable patent outcomes.¹¹ Each corporation has multiple offices including subsidiaries; in some cases, more than one office may be labeled as an HQ, but we identify a single CHQ in each year based on the previously described manual process. We assume the entrepreneurial alliance partners have only a single establishment, which is true for the vast majority of these startup firms; we exclude startup branch locations in our data. The D&B data provides office ZIP codes, which we convert to longitudes/latitudes and match to core-based statistical areas (CBSA) based on US Census Bureau data. The D&B data also provides longitudinal information on the office-level SIC code, size (employee count), and age. For control variables, we obtain incumbent corporation characteristics from Compustat and startup partner characteristics from Thomson ONE VentureXpert.

The final dataset used in our regression analysis consists of 1478 startup–incumbent–year observations, comprising 36 incumbent corporations and the 143 startup alliance partners forming 377 unique startup–incumbent dyads. The [Appendix](#) presents further detail about the sample construction and archival dataset merging process. Our number of dyad–year observations is similar to (Lavie and Miller 2008; Capaldo and Petruzzelli 2014) or greater than (Zaheer and Hernandez 2011; Van Kranenburg et al. 2014) those of previous studies.

Variables

Dependent variable

We measure startup partner innovation performance by the number of forward citations, *Forward Citation Count*. Compared to just using the raw count of patents granted, the number of forward citations better captures the economic importance of the innovation (Trajtenberg 1990) and better predicts firm productivity (Hall et al. 2005; Kogan et al. 2017). We define *Forward Citation Count* by the count of forward citations to the focal firm's patent applications in the focal year, where the forward citations are from US patents applied for in the 4-year window after the focal year that cites a focal firm's patent. For example, suppose a firm A applied for two patents B and C at year t . If each patent was cited 10 times and 20 times, respectively, between t and $t + 4$, then firm A's forward citation at t is counted as 30. Consistent with the conventions in the literature (e.g., Aggarwal and Hsu, 2013), limiting forward citations to a 4-year window allows comparison of innovation performance across years: earlier patents mechanically have more total forward citations than more recent patents because there is more time for the forward citations to accumulate.

¹¹To investigate potential bias from missing data, we conducted a t test comparing the forward citations of startups with available location information (143 startups) with startups with missing location information (141 startups). We find no evidence of missing data bias. We fail to reject the null hypothesis that there is no difference in innovation performance between the two groups ($t = 0.608$, $p = 0.545$).

Independent variables and moderators

The variable *Distance CHQ to Startup* measures the geodetic geographic distance between incumbent CHQ and their startup alliance partners in thousands of kilometers.¹² In the regression models, we multiple this and other distance measures by -1 to facilitate the interpretation of the point estimates as being the benefit of proximity from reduced distance. Figure 1 shows the distribution of the primary independent variable *Distance CHQ to Startup* and the control variable *Distance Subsidiary to Startup (Closest)*, which we describe in the next section. There is no significant difference in the two distributions relative to the R&D presence at CHQ.

We include two moderators to capture heterogeneity in the effect of CHQ-partner distance on partner performance. The first moderator *CHQ R&D Function* takes a value of 1 if the R&D function is present at the CHQ in a year. We assume that CHQ contains the R&D function if the CSO is primarily located at the CHQ. To get this information, we access the BoardEx database to identify the name of each firm's CSO. We track her office location using professional longitudinal profiles (e.g., LinkedIn accounts) and articles announcing her appointments from Factiva and LexisNexis.¹³

The second moderator variable *Horizontal Alliance* takes a value of 1 when an alliance contract specifies horizontal collaborative activity, as opposed to a vertical relationship where it takes a value of 0. An alliance is considered to be horizontal if it includes at least one contract term about co-development, co-marketing, co-promotion, or cross-license, as listed in the Recap data.

Control variables

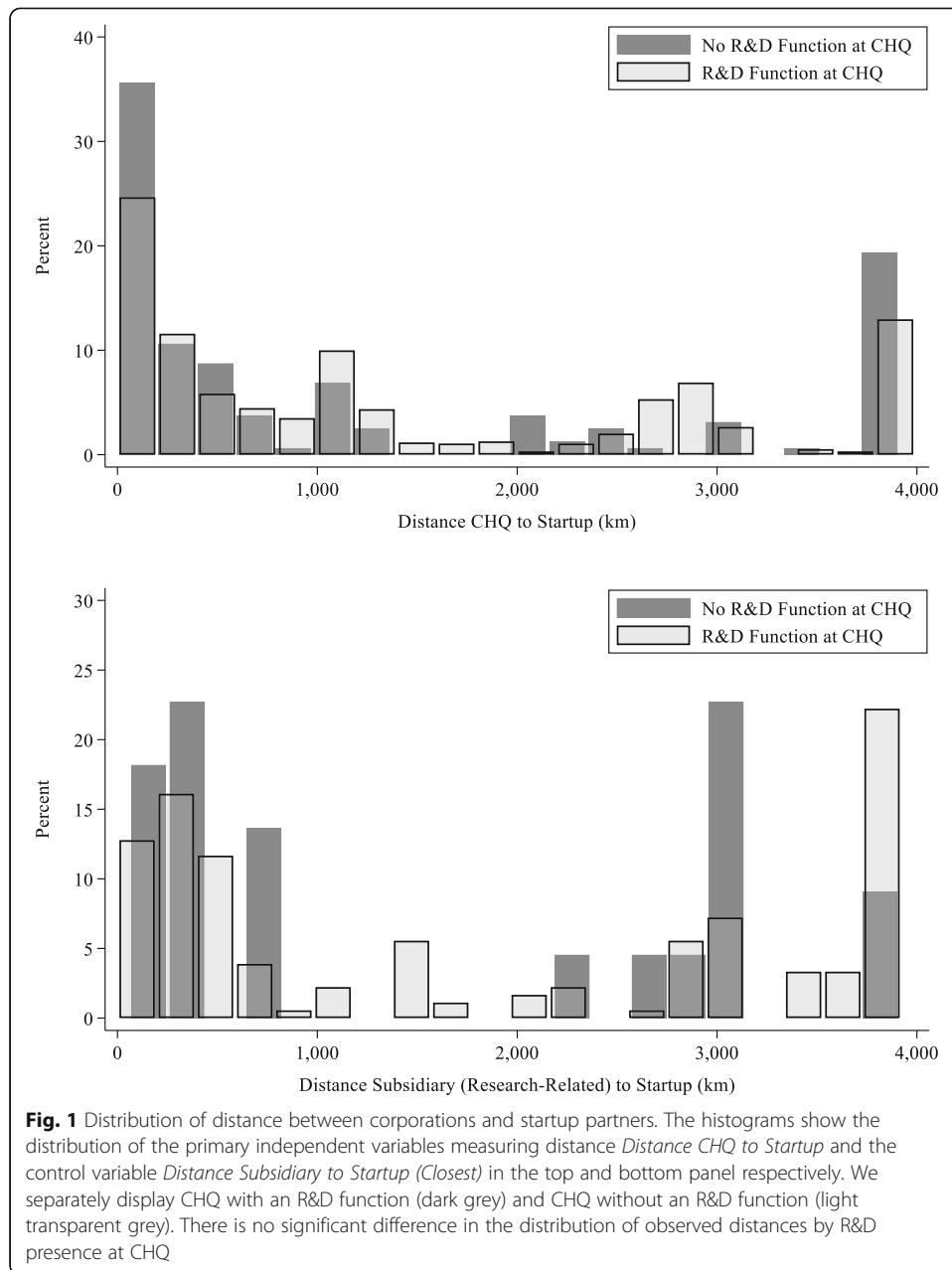
We control for a battery of time-variant incumbent corporation, startup partner, and alliance characteristics. To control for the incumbent's overall spatial design of its one or many designated US headquarters, of which only one is the CHQ, the binary variable *CHQ Consolidated* takes a value of 1 if the CHQ and all other HQ units are co-located in one city. This case accounts for 61% of the observations. We use this variable on its own and in an interaction term.

We use *Distance Subsidiary to Startup (Closest)* to control for the effect of proximity between corporate subsidiaries and their alliance partners. This variable measures the geographic distance from a startup partner to the closest research-related subsidiary location of the corporation.¹⁴ This variable assumes that an alliance partner could work with the nearest corporate subsidiary.

¹²Geodetic distance is the length of the shortest curve between two points along the surface of a mathematical model of the earth. Our calculation uses the same model of the earth as used by Google Earth/Map and GPS devices.

¹³If neither of these methods works, we visit each corporation's official website and historical websites (via the Wayback Machine) to identify location information for their R&D activity.

¹⁴Subsidiaries whose unit-level SIC is "Commercial Physical and Biological Research" (8731) are considered research-related for our purposes. On average, each incumbent had 12 subsidiary units per year, and three of them were related to research. By this definition, the maximum number of research-related subsidiaries is 32, for Amgen Inc. in 2008.



We include three control variables for alliance characteristics: exploitation versus exploration orientation with *Alliance Exploitation*; equity investment by the incumbent with *Alliance Equity and Joint Venture*; and time length with *Alliance Duration*. For *Alliance Exploitation*, we assign a value of 1 if the alliance contract contains more terms related to exploitative activities such as commercialization or manufacturing; explorative activities are those related to research or new product development (Rothaermel and Deeds 2004). We group equity alliances and joint ventures together because they provide similar ownership incentives to the incumbent. Lastly, *Alliance Duration* is the difference of the first year and the focal year of a startup–incumbent–year time series.

We control for the dispersion of subsidiaries because widely scattered incumbent units could affect resource allocation that could be associated with startup performance. *Incumbent Subsidiary Dispersion* counts the unique CBSAs from all operating corporate subsidiary locations for each incumbent in each year.¹⁵ *Incumbent Acquired* indicates whether an incumbent corporation is acquired by another corporation, taking a value of 1 in the years after the acquisition, to capture structural changes in the incumbent corporation.

We control for the spatial dispersions of the incumbent's and startup's alliance portfolios analogously by counting the unique CBSAs of all alliance affiliates in a given year, leading to the respective variables *Incumbent Portfolio Dispersion* and *Startup Portfolio Dispersion*.

To control for pre-alliance innovation performance of the incumbent and the startup, we create the 5-year lagged patent count variables *Incumbent Patent Count (Five-Year Lagged)* and *Startup Patent Count (Five-Year Lagged)*.¹⁶

We control for other incumbent and startup firm characteristics. The age variables *Incumbent Age* and *Startup Age* are relative to the founding year of the firm. Since the firm size distribution for the incumbents and the startups are very different, we control for their sizes in a slightly different way. *Incumbent Size (Logged)* is the logged total number of employees in a year, logged to normalize the right-skewed distribution. *Startup Size (Binary)* is a dichotomous variable taking a value of 1 if a startup has more than 100 employees; the distribution of startup employee count is relatively discontinuous and narrow.

We control for startup functional heterogeneity with *Startup Manufacturing*, which takes a value of 1 if the startup conducts manufacturing activities. *Startup Capital Investment (Cumulative)* is the stock venture capital investment in million dollars received by the startup up to the focal year, intended to control for startup financial resources.

Analysis

To estimate the effect of the independent variables and moderators, we exploit time-sectional heterogeneity in CHQ design and alliance form. In particular, we seek to isolate the impact of the CHQ–partner distance on startup innovation performance from all potential confounding factors: identification of the coefficient for *Distance CHQ to Startup* comes primarily from variation over time in CHQ location (i.e., CHQ relocation). We control for an extensive battery of time-variant alliance, incumbent, and startup characteristics. Pre-alliance incumbent and startup performance control for pre-alliance trends. The main regression model takes the following form for startup–incumbent dyad i , startup j , incumbent corporation k , and year t :

¹⁵We exclude non-operating subsidiaries, which are those that list zero employees. These are likely shell entities or “mailbox” locations that exist for tax or legal reasons.

¹⁶We use a 4-year window of forward citations in our research. We use the number of patents at $t-5$, because its effective period expires one year before having an alliance, to avoid any contamination from forward citations of those past patents to forward citations of the focal-year patents.

$$\begin{aligned} \text{Forward Citation Count}_{i,t} = & \alpha + \tau \text{Distance CHQ to Startup}_{i,t} + \mathbf{X}'\boldsymbol{\beta} + \mathbf{Y}'\boldsymbol{\gamma} \\ & + \mathbf{Z}'\boldsymbol{\delta} + u_i + \eta_j + \theta_{k,t} + \rho_t + \varepsilon_{i,t} \end{aligned} \quad (1)$$

where X is a vector of alliance characteristics, Y is a vector of incumbent characteristics, Z is a vector of startup characteristics, u_i is startup–incumbent fixed effects, η_j is startup location fixed effects, $\theta_{k,t}$ is incumbent CHQ location fixed effects, ρ_t is year fixed effects, and $\varepsilon_{i,t}$ is the usual error term. We use CBSA as the location unit for the startup and incumbent location fixed effects, which capture the regional clusters of the US pharmaceutical and biotechnology industry (e.g., Owen-Smith and Powell, 2004). Recall that *Distance CHQ to Startup* is multiplied by -1 in the regressions so that it represents proximity (i.e., its positive coefficient implies that CHQ–startup proximity is beneficial to startup innovation).

To estimate Eq. (1), we use a high-dimensional fixed-effects (HDFE) ordinary least squares regression model. Because we include four high-dimensional fixed effects, the HDFE regression model provides more consistent estimates than a traditional OLS fixed-effects regression model does when there is more than one high-dimensional fixed effect (Guimaraes and Portugal 2010).¹⁷ Robust standard errors are clustered at the startup–incumbent level. We weight startup–incumbent–year observations by incumbent return on assets (ROA) to account for the incumbent’s significance.¹⁸

From this baseline model that tests Hypothesis 1, we include (triple) interaction terms to estimate heterogeneity in the effect of CHQ–partner proximity with respect to CHQ composition and alliance form. The test of Hypothesis 2 includes the variables in the baseline model and two additional variables, *CHQ R&D Function* and *Distance CHQ to Startup* \times *CHQ R&D Function*. The test of Hypothesis 3 adds three further variables, *Horizontal Alliance*, *CHQ R&D Function* \times *Horizontal Alliance*, and *Distance CHQ to Startup* \times *CHQ R&D Function* \times *Horizontal Alliance*, to the set of variables used to test Hypothesis 2. While we control for observable confounding factors in Eq. (1), other unobservable factors may cause endogeneity. We consider and rule out two potential sources of endogeneity: pre-alliance bias and pre-relocation bias. To test these two potential biases, we investigate the relationship between CHQ–partner distance and *ex ante* innovation performance, presented in the endogeneity and robustness checks section of the [Appendix](#).

Results

We first present descriptive statistics before discussing the main results. Table 2 documents the summary statistics for all variables used in the main regressions and the robustness tests. Among these 1478 startup–incumbent–year observations, 34% involve a CHQ where the R&D function is present and 10% involve horizontal alliance relationships. For all the explanatory variables used in the main analysis, Table 3 presents the correlation matrix and variance inflation factors (VIF) of them; we do not observe a significant multicollinearity problem.¹⁹

¹⁷“High-dimensional” means that a fixed effect consists of many values. If a model includes dummy variables for each fixed effect, the model becomes saturated with too many covariates and loses huge degrees of freedom, as constrained by the sample size.

¹⁸Without this weighting, we still find results consistent with our main findings; this alternate analysis preserves the same coefficient signs and maintains statistical significance.

¹⁹None of the VIF measures exceed the conventional threshold of 5 indicating significant multicollinearity. In particular, the main independent variable *Distance CHQ to Startup* and the two main moderators have VIFs ranging from 1 to 2, which would be considered safe under even a stricter criteria than the conventional rule of thumb.

Table 2 Summary statistics. This table shows the summary statistics of the variables for 1478 startup–incumbent–year dyads

	Mean	SD	Min	Max
Dependent variable				
<i>Forward Citation Count</i>	36.13	88.38	0	598
Main independent variable				
<i>Distance CHQ to Startup</i>	2.10	1.69	0.00	4.35
Moderator variables				
<i>CHQ R&D Function</i>	0.34	0.47	0	1
<i>Horizontal Alliance</i>	0.10	0.29	0	1
Control variables				
<i>CHQ Consolidated</i>	0.61	0.49	0	1
<i>Distance Subsidiary to Startup (Closest)</i>	2.14	1.63	0.00	4.24
<i>Alliance Exploitation</i>	0.27	0.44	0	1
<i>Alliance Equity and Joint Venture</i>	0.16	0.37	0	1
<i>Alliance Duration</i>	3.34	1.67	1	6
<i>Incumbent Subsidiary Dispersion</i>	29.95	24.28	0	89
<i>Incumbent Portfolio Dispersion</i>	5.40	2.78	1	11
<i>Incumbent Patent Count (Five-Year Lagged)</i>	245.37	1867.06	1	29,433
<i>Incumbent Age</i>	67.99	53.45	0	160
<i>Incumbent Size (Logged)</i>	6.61	1.57	1.10	8.92
<i>Incumbent Acquired</i>	0.01	0.10	0	1
<i>Startup Portfolio Dispersion</i>	0.01	0.12	0	1
<i>Startup Patent Count (Five-Year Lagged)</i>	20.03	42.29	1	438
<i>Startup Age</i>	17.31	23.34	0	159
<i>Startup Size (Binary)</i>	0.62	0.48	0	1
<i>Startup Manufacturing</i>	0.60	0.49	0	1
<i>Startup Capital Investment (Cumulative)</i>	7.18	25.90	0.00	172.77
Robustness check independent variables				
<i>Startup Patent Count (One-Year Lagged)</i>	20.33	37.05	1	438
<i>Cumulative Startup Patent Count (One-Year Lagged)</i>	294.36	604.14	4	3070

Table 4 summarizes the three hypotheses and the empirical findings for each. Hypothesis 1 argues that the entrepreneurial partner benefits from proximity to the CHQ in general. However, Hypothesis 2 predicts that if an R&D function is present at CHQ, the partner's benefit from CHQ proximity attenuates. Hypothesis 3 predicts that this benefit attenuates even further for horizontal (as opposed to vertical) alliance forms, for CHQ with an R&D function. We find empirical support for all these predictions.

Table 5 presents the main empirical results. The first column (5.1) tests Hypothesis 1. We find that a 1000-km decrease in the CHQ–partner distance (an increase in *Distance CHQ to Startup*, which is the distance multiplied by -1) is associated with an increase of 28 forward citations to patents assigned to the entrepreneurial alliance partner ($p < 0.10$). In terms of elasticity, a 1% decrease in distance leads to a 1.7% increase in innovation performance. The elasticity is calculated by taking the ratio of the mean values of *Distance CHQ to Startup* and *Forward Citation Count* and multiplying

Table 3 Correlation matrix. The correlations among all the variables are presented. Variance inflation factors (VIF) are provided for each variable. Both the correlations and VIFs corroborate that there is no significant correlation that may cause multicollinearity

Variable	VIF	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	16	18	19	20	
1 Distance CHQ to Startup	1.20	1.000																				
2 CHQ R&D Function	1.54	-0.011	1.000																			
3 Horizontal Alliance	1.18	-0.009	0.005	1.000																		
4 CHQ Consolidated	1.34	-0.018	0.048	0.006	1.000																	
5 Distance Subsidiary to Startup (Closest)	1.28	0.275	-0.149	-0.045	-0.270	1.000																
6 Alliance Exploitation	1.09	-0.084	0.053	-0.070	-0.044	0.003	1.000															
7 Alliance Equity and Joint Venture	1.20	0.033	0.102	0.315	-0.031	-0.031	-0.062	1.000														
8 Alliance Duration	1.04	0.003	-0.027	-0.023	0.007	-0.027	0.027	0.085	1.000													
9 Incumbent Subsidiary Dispersion	3.72	-0.005	-0.227	-0.070	-0.258	0.141	0.016	-0.053	0.022	1.000												
10 Incumbent Portfolio Dispersion	1.93	0.017	-0.214	-0.049	0.127	-0.084	-0.109	-0.085	0.049	0.530	1.000											
11 Incumbent Patent Count (Five-Year Lagged)	1.06	-0.082	-0.068	-0.023	0.060	-0.018	0.042	-0.038	-0.049	-0.048	-0.061	1.000										
12 Incumbent Age	2.73	-0.012	-0.360	-0.094	-0.108	0.198	0.009	-0.069	-0.001	0.760	0.476	-0.033	1.000									
13 Incumbent Size (Logged)	1.68	-0.037	0.177	-0.013	-0.182	0.037	0.081	0.076	-0.038	0.443	0.114	-0.058	0.268	1.000								
14 Incumbent Acquired	1.09	0.001	-0.020	-0.034	-0.118	-0.035	0.069	-0.028	-0.001	-0.042	-0.147	-0.012	-0.034	-0.071	1.000							
15 Startup Portfolio Dispersion	1.05	-0.140	0.083	-0.000	0.025	-0.018	0.004	0.010	0.034	-0.056	-0.087	-0.011	-0.038	-0.015	-0.013	1.000						
16 Startup Patent Count (Five-Year Lagged)	1.54	0.063	0.058	-0.046	-0.023	0.006	0.059	-0.127	-0.052	-0.021	-0.037	-0.018	-0.078	-0.018	-0.037	-0.034	1.000					
17 Startup Age	1.55	-0.093	0.054	-0.071	0.024	0.000	0.160	-0.096	-0.006	-0.071	-0.106	0.002	-0.091	-0.019	-0.024	-0.033	0.555	1.000				
18 Startup Size (Binary)	1.13	0.085	0.016	-0.107	0.009	0.039	0.073	-0.122	-0.049	-0.031	-0.039	0.049	-0.074	-0.002	-0.027	-0.036	0.271	0.189	1.000			
19 Startup Manufacturing	1.14	0.122	0.056	0.026	0.046	0.031	0.075	-0.043	-0.012	-0.000	0.013	0.056	-0.045	-0.024	0.006	0.029	0.190	0.211	0.172	1.000		
20 Startup Capital Investment (Cumulative)	1.03	0.012	-0.039	-0.001	0.018	0.053	-0.058	0.027	-0.002	0.051	0.056	-0.016	0.037	0.011	0.018	0.004	-0.063	-0.060	-0.008	-0.091	1.000	

Table 4 Summary of hypotheses with empirical results. The three hypotheses are categorized by their related corporate characteristics. The script τ is the coefficient of the key variable defined in Eq. (1)

	Hypothesis 1	Hypothesis 2	Hypothesis 3
Corporate characteristic	CHQ location proximity (vs. distant)	CHQ function: R&D (vs. no R&D)	Alliance form: horizontal (vs. vertical)
Key variable	Distance CHQ to Startup	Distance CHQ to Startup \times CHQ R&D Function	Distance CHQ to Startup \times CHQ R&D Function \times Horizontal Alliance
Prediction	$\tau > 0$ Benefit of proximity	$\tau < 0$ Attenuated benefit of proximity	$\tau < 0$ Further attenuated benefit of proximity
Finding	$\hat{\tau} > 0$ ($p < 0.10$)	$\hat{\tau} < 0$ ($p < 0.01$)	$\hat{\tau} < 0$ ($p < 0.10$)
Support	Yes	Yes	Yes

that ratio (0.058) by the estimated coefficient of *Distance CHQ to Startup* (28.415). The second column (5.2) presents the test of Hypothesis 2, where the key variable is the interaction term *Distance CHQ to Startup* \times *CHQ R&D Function*. We confirm that the benefit of proximity attenuates if the CHQ contains the R&D function: the size of this statistically significant effect represents a decrease of about five forward citations from the benefit of proximity for partners associated with CHQ without the R&D function ($p < 0.01$). In other words, if an R&D function is present at CHQ, a 1000-km decrease in the CHQ–partner distance is associated with an increase of 23 forward citations (adding together the coefficients on *Distance CHQ to Startup* and *Distance CHQ to Startup* \times *CHQ R&D Function*). The significantly negative coefficient of *Distance Subsidiary to Startup (Closest)* also implies that proximity from research-related units of incumbents may hurt startup innovation performance.

The results in the third column (5.3) test Hypothesis 3. The negative coefficient of the triple interaction term (*Distance CHQ to Startup* \times *CHQ R&D Function* \times *Horizontal Alliance*) means that the benefits from CHQ–partner proximity further attenuates when a partner—aligned with the corporation with an R&D function at CHQ (*CHQ R&D Function*)—engages in a horizontal alliance rather than a vertical alliance with the corporation ($p < 0.10$). In this model, the startup experiences an additional decrease of eight forward citations from the benefit it would otherwise get from a 1000-km decrease in CHQ–partner distance with a CHQ with an R&D function. Figure 2 visually compares the heterogeneity in predicted performance related to *CHQ R&D Function* and *Horizontal Alliance*.

The Appendix documents several additional robustness checks and analyses to rule out endogeneity associated with pre-trends in alliance formation and CHQ relocation.

Discussion

Contributions to literature

We contribute to both the literatures on CHQ and on technology alliances. For the literature on CHQ, we extend the understanding of the consequences of CHQ design beyond the boundary of the firm to its external alliance partners. Although prior work addresses the performance consequences of the CHQ, it focuses on the impact on the corporation itself, primarily through the effects on the internal business units (and

Table 5 Main results. The main results testing the three hypotheses are provided. All the distance variables are multiplied by -1 in the regression to allow their interpretation as proximity. For example, the positive coefficients on the distance variables imply that proximity is beneficial to startup innovation performance

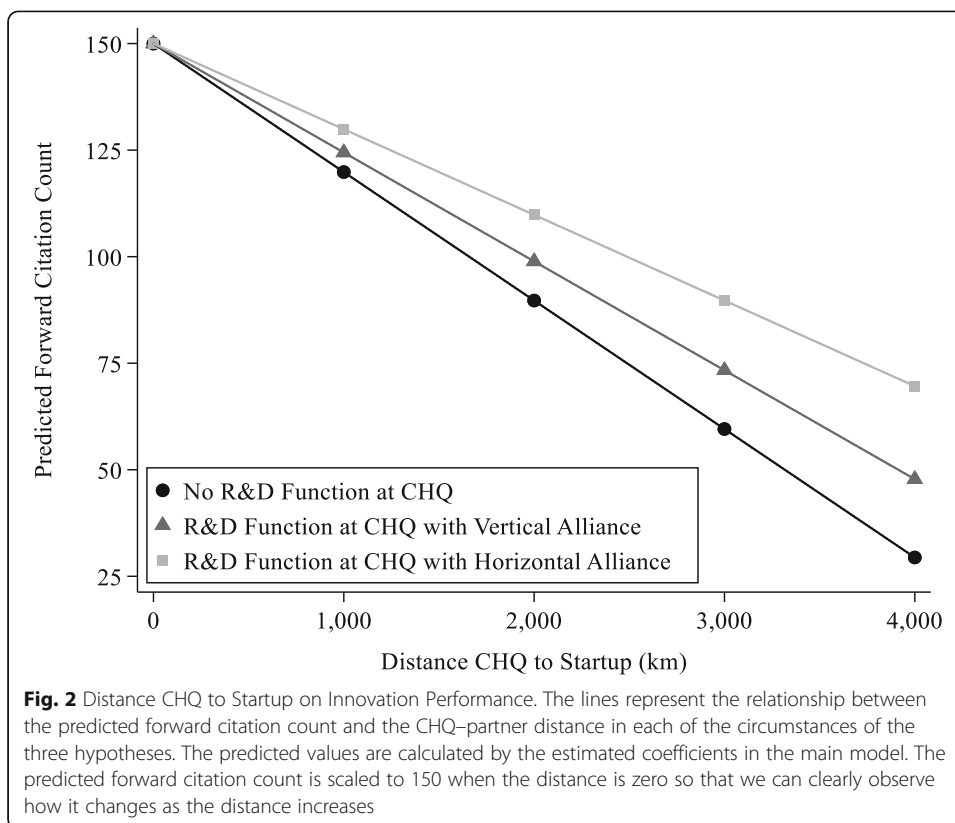
Dependent variable: <i>Forward Citation Count</i>	(5.1)	(5.2)	(5.3)
Hypothesis tested:	H1	H2	H3
<i>Distance CHQ to Startup</i>	28.415* (14.748)	27.902* (14.631)	26.108* (13.997)
<i>Distance CHQ to Startup</i> × <i>CHQ R&D Function</i>		- 4.861*** (1.812)	- 4.372** (1.859)
<i>Distance CHQ to Startup</i> × <i>CHQ R&D Function</i> × <i>Horizontal Alliance</i>			- 7.766* (4.580)
<i>Distance CHQ to Startup</i> × <i>Horizontal Alliance</i>			2.310 (5.791)
<i>Distance CHQ to Startup</i> × <i>CHQ Consolidated</i>	6.399** (3.145)	6.247** (3.127)	6.264** (3.139)
<i>Distance Subsidiary to Startup (Closest)</i>	- 6.703** (3.378)	- 6.871** (3.442)	- 6.789** (3.435)
<i>CHQ R&D Function</i>	- 7.515 (7.118)	- 8.428 (7.020)	- 8.458 (7.046)
<i>Horizontal Alliance</i>	33.073** (15.205)	33.342** (14.650)	28.249** (13.652)
<i>CHQ Consolidated</i>	14.503* (7.976)	14.898* (7.855)	14.940* (7.870)
<i>Alliance Exploitation</i>	17.841 (20.017)	19.429 (19.608)	18.658 (19.464)
<i>Alliance Equity and Joint Venture</i>	- 59.582*** (16.772)	- 58.580*** (16.357)	- 59.644*** (16.815)
<i>Alliance Duration</i>	1.456 (2.189)	1.497 (2.139)	1.613 (2.143)
Controls for incumbent characteristics	Yes	Yes	Yes
Controls for startup characteristics	Yes	Yes	Yes
Startup–incumbent fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Startup location fixed effects	Yes	Yes	Yes
Incumbent location fixed effects	Yes	Yes	Yes
Observations	1478	1478	1478
Number of startup–incumbent dyads	377	377	377
Adjusted R^2	0.750	0.752	0.752

Robust standard errors clustered at startup–incumbent level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

subsidiaries) of the firm. We extend this logic to argue that those characteristics might also affect alliance partners.

A comprehensive view of corporate strategy not only takes into account the activity inside the boundary of the corporation, but also the activity taking place in the ecosystem of arms-length affiliates engaged in long-term relationships with the corporation (Grigoriou



and Rothaermel 2017). However, in contrast to work on internal subsidiaries, the external alliance partners face a different set of CHQ design trade-offs than internal business units do. First, the more significant organization boundary that separates the alliance partner from the CHQ, than separates an internal business unit from the CHQ, makes coordination more important but also more difficult. This more severe organization barrier may also limit beneficial knowledge spillovers (Mowery et al. 1996). Second, given that the corporation does not capture all the value generated by the entrepreneurial partner’s innovation, the CHQ has different resource allocation incentives with respect to the alliance partner than to its internal business unit; the incumbent may more cautiously and skeptically allocate resources, putting the alliance partner in competition with other partners (Aggarwal 2014) and potentially with the internal business units.

For the literature on technology alliances, we suggest that the characteristics of the CHQ have salient effects on alliance performance. Prior studies document the performance consequences of alliance characteristics (e.g., Baum et al. 2000; Rothaermel and Deeds 2004), partner characteristics (e.g., Stuart 2000; Kale et al. 2002), and both together (Saxton 1997; Sampson 2007). However, this body of work overlooks the implications of CHQ design, which previously mentioned work documents as an important determinant of performance for other corporate-specific performance outcomes. Our work sheds light on the possibility of CHQ design affecting the upstream–downstream coordination (Rothaermel and Deeds 2004; Lavie and Rosenkopf 2006) within an alliance, but not necessarily the knowledge spillovers within an alliance (Mowery et al. 1996; Reuer and Lahiri 2014). Furthermore, we extend the understanding

of alliance structure, namely the horizontal versus vertical design of the alliance (e.g., Kotabe and Swan 1995; Mowery et al. 1996) to suggest that the consequences of alliance structure are contingent on CHQ design.

Managerial implications

Our findings have implications for executives of large corporations as well as for entrepreneurial founders. Before noting the specific actions they might consider, we first address the reasons why incumbent executives should take responsibility for the innovation performance of entrepreneurial alliance partners. First, an incumbent can commercialize future innovations generated by the partner (Rothaermel and Deeds 2004). Second, an incumbent directly profits from partner financial performance in equity alliances and joint ventures (Sampson 2007). Third, building a track record for facilitating partner performance engenders a corporate reputation that can lead to future success in securing new alliance partners and maintaining relationships with existing partners (Weaver and Dickson 1998; Robson et al. 2008). Thus, incumbent corporations cannot ignore the innovative performance of their alliance partners and need to consider them in their strategic decisions around CHQ characteristics.

Given those reasons, our conceptual model and empirical findings suggest that executives designing CHQ should take alliance partners into account. First, a corporation can improve partner innovation performance by locating its CHQ closer to its partners, while balancing the distance to partners with distance to its internal business units (Flores and Aguilera 2007; Slangen 2011; Baaij and Slangen 2013) and foreign subsidiaries (Roth and O'Donnell 1996; Boeh and Beamish 2011). Second, when deciding on which functions to co-locate at the CHQ, executives should cautiously evaluate whether to include the R&D function at the CHQ, given its undesirable moderating effects on the coordination between the CHQ and alliance partners.

Our findings also have implications for the entrepreneurs that make up the ecosystem of partners of the incumbent corporation. Entrepreneurs should locate closer to the CHQ of corporations they expect to partner with because doing so can drive beneficial coordination leading to their own innovation performance. And while entrepreneurs may not have sufficient discretion to select for alliances with corporations without an R&D function at the CHQ, they may want to cautiously evaluate the extent to which they might expect benefits from scientific knowledge spillovers and focus more on the biases that the CHQ might exhibit in resource allocation and coordination unfavorable to the entrepreneur.

Limitations and future research

While we manually collect extensive data on CHQ to supplement the rich archival data available on alliances, public incumbent firms, and venture capital (VC)-backed entrepreneurial firms, this data also represents the primary limitation to the work. We now outline four ways in which future scholars could extend and improve on the present findings.

First, other studies could consider a broader battery of CHQ characteristics as determinants of entrepreneurial alliances performance. While we focus on CHQ-partner distance and the presence of the R&D function at the CHQ, it is likely that other CHQ characteristics will affect partner performance through similar theoretical channels.

With respect to the incidence of functions appearing at CHQ, most legal and financial (e.g., treasury, taxation, control) functions do not vary a sufficient amount for an empirical study of this sort (Collis et al. 2007). However, there are several other functions that Collis et al. (2007) report as varying substantially across incumbent corporations—e.g., training, government relations, purchasing—that would likely have implications for alliance performance. For example, the availability of purchasing at CHQ may have implications for the ability of the less prominent alliance partner to participate in lower-cost volume purchases of scientific equipment and consumables that can increase the efficiency of the alliance partner's work.

Prior work also shows the importance of dedicated M&A or alliance management functions at the CHQ. Although we were unable to collect data on these dedicated functions in the present study, future work could assess whether these dedicated M&A or alliance functions at CHQ affect performance of entrepreneurial partners. Dyer et al. (2004) argue that corporate strategy for M&A versus alliance activity is not interchangeable, suggesting a need for dedicated (but also coordinated) functions for each at CHQ. In this vein, Trichterborn et al. (2016) show that a dedicated M&A function benefits the focal corporation's M&A performance and enhances M&A learning effects. Likewise, in a response to contradictory findings regarding the consequence of a dedicated alliance function, Findikoglu and Lavie (2019) find that a dedicated alliance function can improve alliance value creation by enabling the focal corporation to better leverage its firm-specific routines for managing alliances.

Second, further studies could address the antecedents to CHQ design as a function of a corporation's alliance strategy. In a study of MNCs, Collis et al. (2012) demonstrate that CHQ size, in terms of headcount or functions, is a function of the organization of the firm, where the size of CHQ increases with the geographic scope of the MNC. The scope of the alliance portfolio may have a similar effect on the CHQ, where the scope can vary in geography, but also in technology (Sarkar et al. 2009) or stage of the value chain (upstream or downstream) (Jiang et al. 2010). These dimensions of scope can vary not only in terms of alliance partner characteristics but also in terms of the specific alliance contracts.

Third, we only consider one dimension of distance—geographic distance—and prior work suggests other concepts of distance represent meaningful determinants of performance for collaborating firms (Vassolo et al. 2004; Hoffmann 2007). For example, extant literature has studied institutional distance (Van Kranenburg et al. 2014), cultural distance (Kogut and Singh 1988), economic distance (Tsang 2007), and composite distance index (Lavie and Miller 2008). Geographic distance may interact with other types of distance, and the results, without considering the interactions, would not necessarily fully capture these considerations. In particular, Reuer and Lahiri (2014) show that the impact of geographic distance on the formation of R&D collaborations is moderated by market relatedness and technological similarity. Thus, examining the impact of geographic distance with other dimensions of distance would expand our research scope and strengthen the results.

Fourth, further studies could implement other dimensions of innovation performance, and even financial performance, by the entrepreneurial firm. Even though forward citations capture firms' innovation performance more broadly than the raw number of patents in terms of their economic importance (Hall et al. 2005; Kogan et al. 2017), there

are scholars who assert that forward citations are still not a perfect measure of innovation performance because forward citations cannot consider variation in the importance of technologies that is not directly related to patents' creativeness (Bernstein 2015). Alternatively, Bernstein (2015) constructs "scaled citations" that weight less on patents whose citation count is affected by the upward trend of their technology class. In addition, "scaled originality" is the count of forward citations to a patent outside of its original technology field. It also weights more on diverse selection of outside industries. Beyond the impact of the patentable innovation, scholars also propose a variety of performance measures that could be generated from the patent data (Jaffe and De Rassenfosse 2017): generalizability/originality (Trajtenberg, Henderson and Jaffe 1997; Jung and Lee 2016), complexity (Fleming 2001), and inter-firm citation patterns (Jaffe et al., 1993).

Conclusion

Our findings demonstrate that CHQ characteristics have a significant impact on the performance of entrepreneurial alliance partners. We conduct an empirical study of public incumbent corporations and VC-backed entrepreneurial firms in the pharmaceutical and biotechnology industry. We find that reducing geographic distance between the CHQ and the entrepreneurial alliance partner significantly improves the innovation performance of the partner. However, the presence of the R&D function at the CHQ attenuates the benefits of the proximity. We confirm the conceptual logic behind this result by also demonstrating that horizontal alliances, as opposed to vertical alliances, further attenuate the benefits of proximity when the CHQ contains the R&D function.

Appendix

CHQ data

We manually collect data to document the heterogeneity of CHQ design over time and across corporate incumbents, in terms of spatial design, size, and, most importantly, composition of functions. With respect to CHQ function, we collect time-series data on whether the CHQ contains the R&D, legal, and manufacturing functions. We select this set of functions because of their potential relevance to innovating alliance partners in the pharmaceutical and biotechnology industry. Practically speaking, these are also the functions we could most feasibly collect.

Although Collis et al. (2007) collect precise data on a broad set of possible CHQ functions, many of those functions, e.g., taxation, treasury, and human resources, are not conceptually relevant to our research question and also unobservable to us. More importantly, they find that those functions, generally administrative-type functions, do not vary substantively across firms. So even if we were able to obtain that data, we would be limited in our ability to study those functions in our empirical study given the lack of necessary heterogeneity. In the main text, we document how we determine CHQ locations and how we define R&D presence at CHQ. We now explain how we collect the data for the R&D, legal, and manufacturing CHQ functions.

Research and development function at CHQ

We assume that CHQ performs an R&D function if the CSO is located in CHQ. We use the BoardEx database to identify the name of each firm's CSO in each

year. After that, we identify their location by searching their public longitudinal professional profile, e.g., LinkedIn accounts or articles regarding their appointments in Factiva and LexisNexis. If neither of these methods led to a result, we visit each corporation's website—and the past versions of the website through the Wayback Machine—to see whether it shows location information about their R&D units. For example, we successfully identify all R&D locations of Novartis; its R&D activity takes place in Cambridge, MA; East Hanover, NJ; Emeryville, CA; and San Diego, CA. Because Novartis's CHQ is located in East Hanover, we assume that its CHQ is co-located with an R&D function.

We provide two other examples to illustrate this process. Dr. Alan Sachs was a CSO at Thermo Fisher Scientific. We can verify that he worked in Carlsbad, CA, for Thermo Fisher Scientific. Because Thermo Fisher Scientific's CHQ was located in Waltham, MA, we conclude that its CHQ did not contain the R&D function. In fact, one of the corporation's subsidiaries was located at 5791 Van Allen Way in Carlsbad, CA, so it is likely that that location contained the leadership for the R&D function. In the case of Warner-Lambert, we could not identify the CSO of this corporation, and its official website is not available as it was acquired by Pfizer in 2000. By using the Wayback Machine, we access Warner-Lambert's 1999 homepage, and we find that its CHQ was located in Morris Plains, NJ, and this CHQ contained the R&D function.

Legal function at CHQ

A legal function may also take place at the CHQ. We identify the presence of the legal function at the CHQ by collecting data on whether the General Counsel is located at the CHQ. We use BoardEx and LinkedIn to find the names and the office locations of each corporation's General Counsel. There are comparatively many press releases regarding appointments (and resignations) of a General Counsel. For example, an article from PR Newswire in 2000 titled "Aerogen, Inc. Appoints Carol A. Gamble Vice President, General Counsel" reported that "AeroGen, Inc. ... announced the appointment of Carol A. Gamble ... Ms. Gamble was previously Senior Vice President and Chief Corporate Counsel at ALZA Corporation, a pharmaceutical company located in Palo Alto, California" In this case, Palo Alto is also the city where ALZA's CHQ was located in 2000, so we assume that the General Counsel is co-located with the CHQ. As compared to data collection for the R&D function, we could not leverage the corporation's websites because they do not include specific information regarding executive office locations.

Manufacturing function at CHQ

We collect data on the presence of the manufacturing function at the CHQ through information directly provided by one of our main data sources, D&B.

Largest HQ

This variable indicates whether the CHQ is the largest office among all headquarters and subsidiaries of a firm. We use data on number of employees at each office as reported in the D&B database.

Acquired

Acquired means an incumbent is acquired by another company. We collected this information from news articles in Factiva and LexisNexis.

Foreign-based

We identify whether a firm’s US CHQ reports to a global CHQ by identifying each corporation’s primary “nationality” through its 10-K form and official website.

Data-merging process

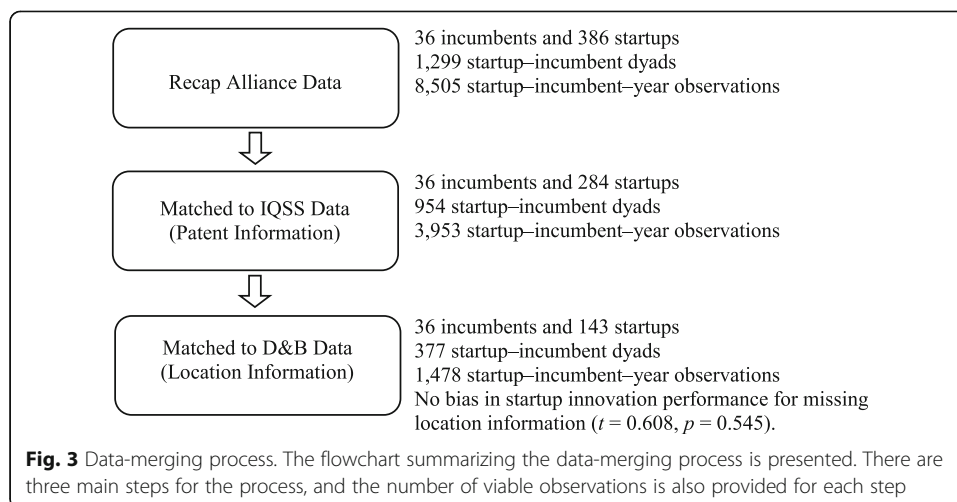
The flowchart in Figure 3 summarizes the data-merging process and the number of observations at each step. The initial 8505 startup–incumbent–year observations result in 1478 startup–incumbent–year observations. As mentioned in the main text, we conduct a *t* test to conclude the data is missing at random relative to the dependent variable, *Forward Citation Count*.

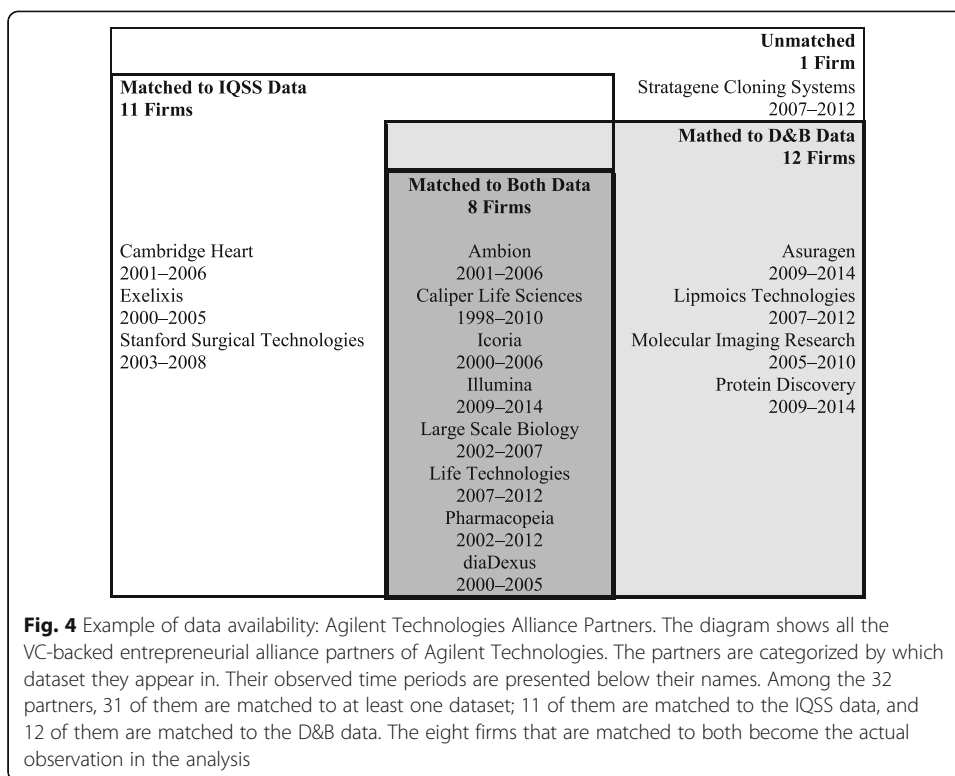
Figure 4 provides a practical example of the data availability in a diagram based on alliance partners of Agilent Technologies. We categorize the firm’s 32 alliance partners by their data availability. Of those, 31 partners match to at least one data source, i.e., IQSS or D&B. The eight partners that match to both data sources become the actual observations used in our main analysis.

Endogeneity and robustness checks

Pre-alliance bias

One could argue that incumbents disproportionately form alliances with top-performing and nearby startups. This pre-alliance bias in alliance formation would be an omitted variable that affects both the CHQ–partner distance and partner performance, leading to potential endogeneity (Wooldbridge 2016). This scenario would imply that CHQ–partner distance is just a proxy for the startup’s current performance. If so, the estimated impact of the CHQ–partner distance would represent a partial correlation between the startup’s





current performance and future innovation performance, which reduces the causal interpretation of the estimate (Angrist and Pischke 2008).

To test and rule out this counterargument, we investigate the relationship between the CHQ–partner distance and patent counts, instead of forward citation counts. We use a 1-year lagged flow variable *Startup Patent Count (One-Year Lagged)* and stock variable *Cumulative Startup Patent Count (One-Year Lagged)*. Note that forward citations at time t indeed take place between t and $t + 4$ in our framework. If an incumbent tries to find a new alliance partner at $t - 1$, it might consider the performance of startup candidate at $t - 1$ in its decision. The available information at $t - 1$ is the absolute number of patents (i.e., *Startup Patent Count (One-Year Lagged)*) or the cumulative number of patents (i.e., *Cumulative Startup Patent Count (One-Year Lagged)*), not the number of citations. Thus, we investigate whether the 1-year lagged patent counts are positively correlated with the current CHQ–partner proximity to test and rule out pre-alliance bias.

Table 6 investigates whether there is an omitted variable representing a corporation’s willingness to have an alliance relationship with top-performing and nearby startups. The existence of this omitted variable is negated by the first column (6.1). The null effect of *Startup Patent Count (One-Year Lagged)* shows that current innovation performance of startups does not lead to having closer distance with its focal firms. The result is not changed even after replacing the independent variable with the cumulative number of patents in (6.2). The third and fourth columns (6.3) and (6.4) present the results obtained from a restricted sample to investigate newly-signed contracts without assumptions on alliance duration. The new contracts may better reflect

Table 6 Pre-alliance trend analysis. The potential endogeneity problem stemming from pre-alliance trends is tested. The results show that there is no evidence that incumbent firms tend to align with nearby startup partners that outperformed before the alliance

Dependent variable: <i>Distance CHQ to Startup</i>	(6.1)	(6.2)	(6.3)	(6.4)
Sample:	Full	Full	Restricted	Restricted
<i>Startup Patent Count</i> (One-Year Lagged)	0.001 (0.002)		– 0.003 (0.003)	
<i>Cumulative Startup Patent Count</i> (One-Year Lagged)		– 0.000 (0.000)		– 0.000 (0.000)
<i>Horizontal Alliance</i>	0.162 (0.281)	0.168 (0.281)	0.718 (0.446)	0.699 (0.458)
<i>Alliance Exploitation</i>	– 0.320* (0.172)	– 0.322* (0.173)	0.003 (0.228)	0.028 (0.224)
<i>Alliance Equity and Joint Venture</i>	0.032 (0.250)	0.015 (0.250)	– 0.103 (0.429)	– 0.067 (0.430)
<i>Incumbent Subsidiary Dispersion</i>	0.002 (0.005)	0.002 (0.005)	– 0.013 (0.011)	– 0.012 (0.011)
<i>Incumbent Age</i>	– 0.002 (0.002)	– 0.003 (0.002)	– 0.013 (0.011)	– 0.010 (0.010)
<i>Incumbent Size (Logged)</i>	– 0.009 (0.100)	– 0.011 (0.100)	0.095 (0.260)	0.085 (0.255)
<i>Startup Age</i>	0.009 (0.006)	0.010 (0.007)	0.015 (0.012)	0.015 (0.013)
<i>Startup Size (Binary)</i>	0.202 (0.185)	0.223 (0.190)	– 0.128 (0.333)	– 0.127 (0.335)
<i>Startup Manufacturing</i>	– 0.231 (0.147)	– 0.228 (0.146)	– 0.029 (0.317)	– 0.050 (0.320)
<i>Startup Capital Investment (Cumulative)</i>	– 0.001 (0.002)	– 0.001 (0.002)	– 0.005 (0.007)	– 0.004 (0.007)
Incumbent fixed effects	Yes	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes	Yes
Startup location fixed effects	Yes	Yes	Yes	Yes
Incumbent location fixed effects	Yes	Yes	Yes	Yes
Observations	1401	1401	233	233
Number of startup–incumbent dyads	376	376	179	179
Adjusted R^2	0.352	0.351	0.369	0.362

Robust standard errors clustered at startup–incumbent level in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

changes in the corporation's alliance portfolio strategy. The restricted sample results do not provide any significant evidence of a pre-alliance trend.

Pre-relocation bias

Another source of endogeneity comes from CHQ relocations. Kunisch et al. (2015) find that larger and younger firms tend to relocate their CHQ more frequently, and some environmental factors such as regulations and market size can be related to CHQ

relocations. Our model directly controls for the age and size of firms (i.e., *Incumbent Age*, *Incumbent Size (Logged)*). Additionally, because we focus only on the incumbent firms in the USA, most of the major environmental differences are controlled. To capture more granular regional differences (e.g., state-level regulations), the incumbent location fixed effects are included in the model at the CBSA level.

In addition, structural motivations could facilitate relocations in the alliance context. An incumbent firm may choose to relocate its CHQ closer to (farther from) startups that show an upward (downward) trend in innovation performance. This alternative argument assumes that incumbents make strategic decisions in the middle of ongoing alliance

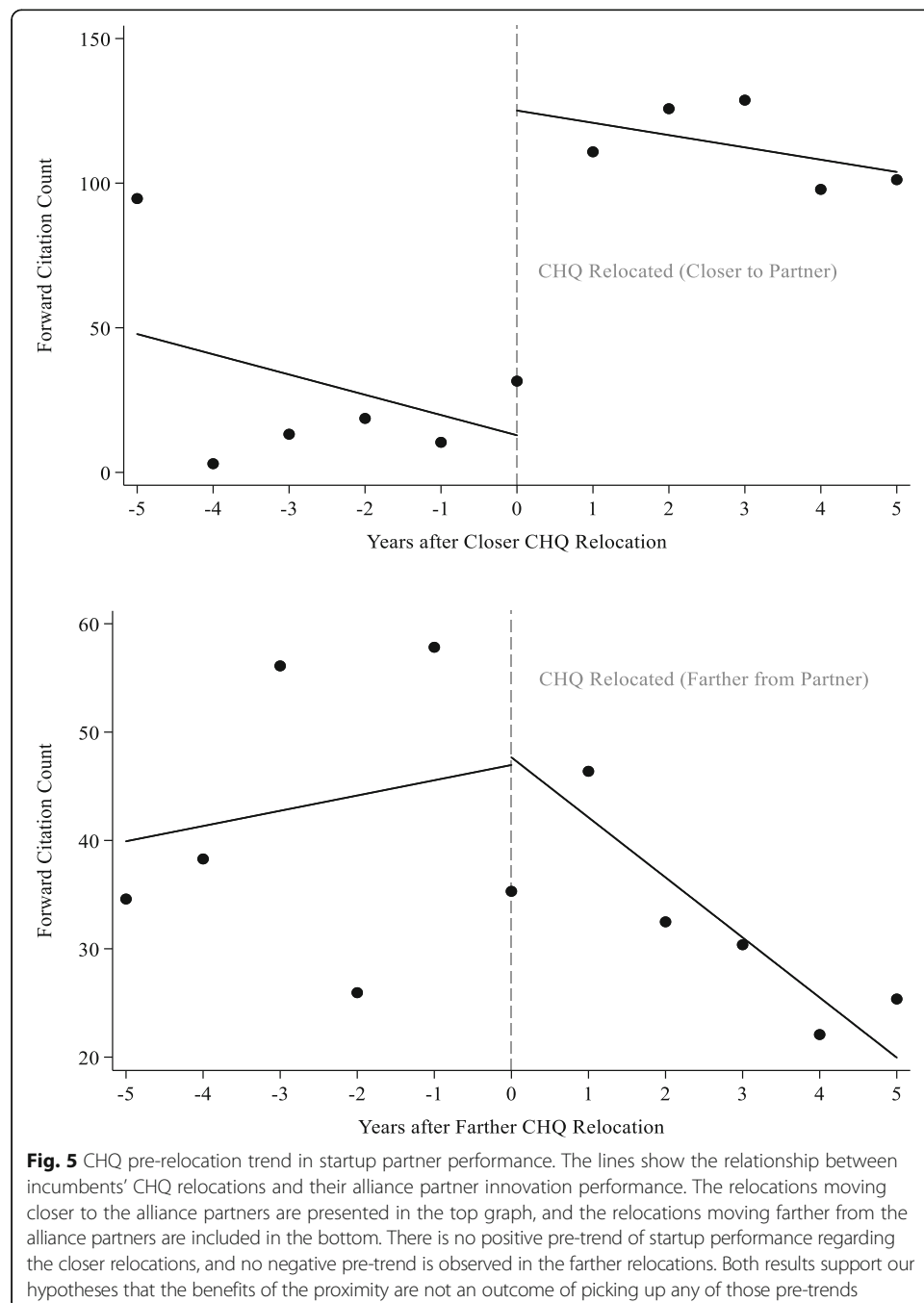


Fig. 5 CHQ pre-relocation trend in startup partner performance. The lines show the relationship between incumbents' CHQ relocations and their alliance partner innovation performance. The relocations moving closer to the alliance partners are presented in the top graph, and the relocations moving farther from the alliance partners are included in the bottom. There is no positive pre-trend of startup performance regarding the closer relocations, and no negative pre-trend is observed in the farther relocations. Both results support our hypotheses that the benefits of the proximity are not an outcome of picking up any of those pre-trends

contracts to get closer to more promising startups, which translate into CHQ relocations resulting in decreases in CHQ–partner distance and improvements in partner performance. If this counterargument holds, the estimated CHQ–partner distance effect would absorb the upward pre-trends in startup performance, rather than reflecting the startup’s benefit from CHQ–partner proximity. We investigate and rule out pre-relocation bias by examining pre-trends in startup performance prior to CHQ relocations.

Figure 5 tests the pre-relocation bias in startup performance. There is no significant upward (downward) trend in forward citations when CHQ relocates closer to (farther from) its alliance partner. Rather, we note that a startup’s innovation performance is drastically improved immediately after its allied CHQ relocates closer to the startup. On the other hand, a farther relocation of CHQ gradually worsens its partner performance after the relocation. Both these results substantiate our argument that CHQ–partner proximity improves startup innovation performance.

Even if we rule out the existence of pre-relocation trends with respect to particular startup partners, there could be pre-relocation trends at the geographic-cluster level. For instance, some CBSAs may trend upwards in their aggregate startup innovation. Incumbent firms may want to relocate their CHQ in those geographic clusters. To see whether CHQ converge towards specific CBSAs during a CHQ relocation, we track initial, intermediate, and end locations of CHQ that have ever experienced relocations. If there were cluster-level pre-relocation trends, we would expect to see evidence of CHQ convergence in these selected CBSAs.

Table 7 evaluates the possibility of cluster-level CHQ pre-relocation trends by presenting the transition matrix of incumbent CHQ locations. The rows denote the starting locations, whereas the columns represent their intermediate and end locations. For example, the component in [1,2] represents the relocation from 1 to 2. Among the 28 headquarter moves tagged by changes in ZIP codes, 19 of the cases (68%) are indeed

Table 7 CHQ relocation matrix. The potential endogeneity problem stemming from cluster-level pre-relocation trends is tested. This transition matrix summarizes all the relocations of CHQ. The rows denote the starting locations, whereas the columns represent their intermediate and end locations. For example, the component in [1, 2] represents the relocation from 1 to 2. Most of the relocations are within-CBSA, and there is no pattern that CHQ relocations converge to a certain CBSA, such as particularly promising CBSAs containing an industry cluster. The relocations documented in this analysis are only those that occur during periods where an alliance with an entrepreneurial partner exists; some CHQ relocations occur outside of the time windows in which the incumbent firm has alliances. Bold entries indicate relocations within the CBSA, e.g., from one location in Dover (DE) to another location in Dover (DE)

		1	2	3	4	5	6	7	8	9	Total
1	Philadelphia–Camden–Wilmington (PA–NJ–DE–MD)	8	1	0	0	0	0	0	1	0	10
2	New York–Newark–Jersey City (NY–NJ–PA)	0	6	0	0	0	0	1	0	1	8
3	Riverside–San Bernardino–Ontario (CA)	0	1	2	0	0	0	0	0	0	3
4	Cincinnati (OH–KY–IN)	1	0	0	1	0	0	0	0	0	2
5	Dover (DE)	1	0	0	0	1	0	0	0	0	2
6	Durham–Chapel Hill (NC)	1	0	0	0	0	1	0	0	0	2
7	Kalamazoo–Portage (MI)	0	1	0	0	0	0	0	0	0	1
8	Boston–Cambridge–Newton (MA–NH)	0	0	0	0	0	0	0	0	0	0
9	Kansas City (MO–KS)	0	0	0	0	0	0	0	0	0	0
	Total	11	9	2	1	1	1	1	1	1	28

Table 8 Main results with all coefficients. The main results testing the three hypotheses are provided with all the control variables and their estimated coefficients. All the distance variables are multiplied by -1 in the regression to allow their interpretation as proximity. Hence, the positive coefficients of the distance variables mean proximity improves innovation performance

Dependent variable: <i>Forward Citation Count</i>	(8.1)	(8.2)	(8.3)
Hypothesis tested:	H1	H2	H3
<i>Distance CHQ to Startup</i>	28.415* (14.748)	27.902* (14.631)	26.108* (13.997)
<i>Distance CHQ to Startup</i> × <i>CHQ R&D Function</i>		-4.861*** (1.812)	-4.372** (1.859)
<i>Distance CHQ to Startup</i> × <i>CHQ R&D Function</i> × <i>Horizontal Alliance</i>			-7.766* (4.580)
<i>Distance CHQ to Startup</i> × <i>Horizontal Alliance</i>			2.310 (5.791)
<i>Distance CHQ to Startup</i> × <i>CHQ Consolidated</i>	6.399** (3.145)	6.247** (3.127)	6.264** (3.139)
<i>Distance Subsidiary to Startup (Closest)</i>	-6.703** (3.378)	-6.871** (3.442)	-6.789** (3.435)
<i>CHQ R&D Function</i>	-7.515 (7.118)	-8.428 (7.020)	-8.458 (7.046)
<i>Horizontal Alliance</i>	33.073** (15.205)	33.342** (14.650)	28.249** (13.652)
<i>CHQ Consolidated</i>	14.503* (7.976)	14.898* (7.855)	14.940* (7.870)
<i>Alliance Exploitation</i>	17.841 (20.017)	19.429 (19.608)	18.658 (19.464)
<i>Alliance Equity and Joint Venture</i>	-59.582*** (16.772)	-58.580*** (16.357)	-59.644*** (16.815)
<i>Alliance Duration</i>	1.456 (2.189)	1.497 (2.139)	1.613 (2.143)
<i>Incumbent Subsidiary Dispersion</i>	-0.063 (0.289)	-0.069 (0.287)	-0.071 (0.287)
<i>Incumbent Portfolio Dispersion</i>	1.223 (1.573)	1.224 (1.525)	1.194 (1.532)
<i>Incumbent Patent Count (Five-Year Lagged)</i>	0.003 (0.006)	0.003 (0.006)	0.003 (0.006)
<i>Incumbent Age</i>	-0.303** (0.128)	-0.293** (0.126)	-0.293** (0.126)
<i>Incumbent Size (Logged)</i>	0.074 (4.710)	0.333 (4.673)	0.540 (4.682)
<i>Incumbent Acquired</i>	86.877*** (13.787)	85.270*** (13.968)	85.134*** (13.947)
<i>Startup Portfolio Dispersion</i>	-33.694 (34.282)	-33.591 (34.246)	-33.367 (34.449)
<i>Startup Patent Count (Five-Year Lagged)</i>	0.010 (0.078)	0.013 (0.077)	0.014 (0.077)
<i>Startup Age</i>	-0.418	-0.399	-0.349

Table 8 Main results with all coefficients. The main results testing the three hypotheses are provided with all the control variables and their estimated coefficients. All the distance variables are multiplied by -1 in the regression to allow their interpretation as proximity. Hence, the positive coefficients of the distance variables mean proximity improves innovation performance (Continued)

Dependent variable: <i>Forward Citation Count</i>	(8.1)	(8.2)	(8.3)
	(0.408)	(0.404)	(0.375)
<i>Startup Size (Binary)</i>	2.490	3.284	3.341
	(4.986)	(4.958)	(4.936)
<i>Startup Manufacturing</i>	42.374***	42.363***	41.955***
	(8.886)	(8.818)	(8.725)
<i>Startup Capital Investment (Cumulative)</i>	-0.040	-0.039	-0.045
	(0.029)	(0.030)	(0.030)
Startup–incumbent fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes
Startup location fixed effects	Yes	Yes	Yes
Incumbent location fixed effects	Yes	Yes	Yes
Observations	1478	1478	1478
Number of startup–incumbent dyads	377	377	377
Adjusted R^2	0.750	0.752	0.752

Robust standard errors clustered at startup–incumbent level in parentheses
 $*p < 0.10$, $**p < 0.05$, $***p < 0.01$

within-CBSA relocations, which is not relevant to convergence of CHQ locations. In addition, the other nine transitions do not show any specific patterns in CHQ relocations toward particular clusters. The three major CBSAs in the initial year, Philadelphia–Camden–Wilmington, New York–Newark–Jersey City, and Riverside–San Bernardino–Ontario, still account for most of the destinations of the intermediate and the final relocations by preserving the previous rank orders. Therefore, we can rule out potential endogeneity stemming from the pre-relocation bias towards geographic clusters.

Full main analysis

Table 8 shows the full results from our main analysis, including all estimated coefficients for control variables.

Abbreviations

CBSA: United States Census Bureau Core-Based Statistical Area; CHQ: Corporate headquarters; CSO: Chief scientific officer; D&B: Dun & Bradstreet; HDFE: High-dimensional fixed effects; IQSS: Harvard Institute for Quantitative Social Science; MNC: Multinational corporation; R&D: Research and development; Recap: Deloitte Recombinant Capital; ROA: Return on assets; SEC: United States Securities and Exchange Commission; USPTO: United States Patent and Trademark Office; VC: Venture capital

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Authors’ contributions

Both authors contributed equally. JK carried out the data assembly and statistical analysis, creating all the tables and figures. JK also had the primary responsibility for the writing in the data and empirical methods and results sections. AW wrote most of the manuscript, particularly the introduction, theory and hypotheses development, and conclusion sections. Both authors read and approved the final manuscript.

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Availability of data and materials

The data sets that support the findings of this study are available from Deloitte Recombinant Capital, Dun & Bradstreet, ThomsonONE, and Compustat. Restrictions apply to the availability of these data sets, which were used under license for the current study, and so are not publicly available. Data is however available from the authors upon reasonable request and with the permission of the above organizations. Publicly available data from Harvard IQSS was also used.

Competing interests

The authors declare that they have no competing interests.

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