

The Impact of Partner Organizational Structure on Innovation: An Examination of Startups' Knowledge Access in Corporate Venture Capital Relationships.

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ABSTRACT

Inter-organizational partnerships can spur innovation, but their value may be diminished by frictions in knowledge flows between firms. We consider how the knowledge accessible via partnerships may be impacted by a partner's organizational structure. We focus on how a partner's structure trades-off localized autonomy for its managers, which facilitates timelier decision-making, and unified control, which facilitates integration. By shaping this balance, centralization of decision-rights within the partner organization shapes access to its knowledge. Centralized structures generate wide-ranging internal knowledge pathways that enable access to a greater breadth of a partner's knowledge. However, the reduced managerial autonomy afforded by centralization makes decision-making more cumbersome, which constricts the rate of access to a partner's knowledge. We find evidence of this trade-off in the context of corporate venture capital relationships between incumbents and startups in the pharmaceutical industry. An increase in the diversity of knowledge possessed by the incumbent or in that required by the startup enhance the value of a greater breadth of access. Whereas the degree to which the startup can leverage social ties (affinity) or hierarchical fiat (authority) alleviate the costs of a reduced access rate. Each of these makes centralization of the incumbent organization more valuable to the startup.

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INTRODUCTION

Inter-organizational partnerships can serve as pipes that provide firms access to distinctive sources of knowledge, which is critical for innovation (Podolny, 2001; Lifshitz-Assaf, 2018). However, knowledge flows within such partnerships are also prone to frictions, which may narrow the breadth of knowledge accessible or slow the rate of knowledge access (Hughes and Weiss, 2007; Gulati, Sytch, and Mehrotra, 2008). As such frictions can substantially limit the innovation-related value of partnerships, understanding their origins is critical (Ghosh and Rosenkopf, 2014).

Scholars have suggested that some of this friction in inter-organizational knowledge flows may originate within the complex intra-organizational structures in which the managers shaping the knowledge flows operate (Simon, 1991; Gulati, Lavie, and Madhavan, 2011; Puranam, 2018). An organization's structure determines where its knowledge is located, the pathways along which knowledge flows internally, as well as the incentives of its employees to acquire, use and share knowledge (Argyres, Rios, and Silverman, 2020; Lee, 2022). Several studies have demonstrated that organizations' innovation outcomes are closely linked to their structures (Argyres and Silverman, 2004; Ter Wal et al., 2020; Eklund, 2022), which also impacts the value they are able to derive from external partnerships (Arora, Belenzon, and Rios, 2014; Sytch, Wohlgezogen, and Zajac, 2018; Eklund and Kapoor, 2022). However, the knowledge firms seek to access via partnerships is embedded within their partners' organizations rather than their own, and the impact of their partners' structures in shaping their access to this knowledge remains an open question.

In examining this question, we focus on the level of autonomy managers within the partner organization have with regards to resource orchestration decisions (Jensen and Meckling, 1992; Burton, Obel, and DeSanctis, 2011; Dattée et al., 2022). The balance between localized autonomy and unified control is a fundamental choice in organization design and it profoundly influences the way an organization accesses and deploys knowledge (Puranam, Singh, and Zollo, 2006; Dattée et al., 2022; Eklund, 2022). Prior studies have identified a range of structural elements that can shape the autonomy-control balance (e.g., Child, 1973; Damanpour, 1991; Damanpour and Aravind, 2012). One key element that has received significant scholarly attention and that forms

the focus of this paper is centralization (e.g., Mansfield, 1973; Burton, Obel, and DeSanctis, 2011; Joseph, Klingebiel, and Wilson, 2016)¹. This is a fundamental structural choice that all organizations face, which determines the extent to which decision-making authority is concentrated within the head or “center” of the organization (Garicano and Rossi-Hansberg, 2004; 2006). On the one hand, decentralization enhances autonomy and facilitates greater localized managerial discretion, thereby enabling responsiveness and more streamlined decision-making (Blau and Schoenherr, 1971; Burton, Obel, and DeSanctis, 2011). On the other hand, centralization lowers autonomy but provides greater unified control of the organization’s decision making, which helps facilitate internal knowledge sharing and reduced competition between different parts of the organization (Hounshell and Smith, 1989; Karim and Kaul, 2015).

Through greater unified control, centralized structures enable the generation of more extensive and tightly-knit knowledge networks within organizations (Argyres, Rios, and Silverman, 2020). We expect this extensive network of internal knowledge pathways to enable an external partner to access a greater *breadth* of this organization’s knowledge base as there are more paths through which knowledge can be accessed. However, in more centralized structures, decisions are made further away from where resources are located, and typically must account for more wide-ranging intra-organizational interdependencies. This can lead to slower, more complex decision processes around knowledge sharing in partnerships, constricting the *rate* of flow of knowledge (Argote, Turner, and Fichman, 1989; Pahnke, Katila, and Eisenhardt, 2015). Therefore, partner centralization is associated with a trade-off between two forms of friction in knowledge access. A partner’s organization being more centralized will enhance the *breadth* of its knowledge base that can be accessed but this will also, on average, constrict the *rate* of knowledge access.

Given this theorized trade-off, it follows that the partner structure most beneficial to a firm’s innovation efforts will depend on the relative value of breadth versus rate of knowledge

¹ Knowledge access may also be impacted by the other elements of organizational structure that shape the autonomy-control balance such as formalization and task differentiation via mechanisms analogous to the ones we describe here, see discussion on page 38.

access to that firm. Contingencies that accentuate the benefits of accessing a greater breadth of a partner's knowledge or diminish the costs of accessing knowledge at a reduced rate, should make partner centralization more effective at providing the focal firm with the knowledge it requires to innovate effectively. We theorize that the value of an enhanced breadth of access should be greater when (a) the diversity of knowledge possessed by the partner, or (b) the diversity of knowledge required by the focal firm are greater, thus making partner centralization more valuable. With regards to the rate of access, extant research highlights two important antidotes to impeded knowledge flows between organizations: (a) informal social ties, i.e., *affinity* (Smith-Doerr and Powell, 2010) and (b) formal hierarchical fiat, i.e., *authority* (Williamson, 1979; Kownatzki et al., 2013). The degree to which the focal firm can leverage each of these in its favor should in turn alleviate the negative impact of partner centralization on the rate of knowledge access.

We examine these ideas empirically in the context of entrepreneurial firms' innovation focused relationships with incumbent firms arising from corporate venture capital (CVC) investments in the life sciences (Katila, Rosenberger, and Eisenhardt, 2008; Pahnke, Katila, and Eisenhardt, 2015). We draw on changes to the structure of the R&D units of the incumbent firms in these relationships to examine how startups' access to incumbent firms' knowledge changes corresponding with these R&D structures shifting from centralized to decentralized or vice-versa. We find that the access to a greater breadth of the incumbent's knowledge base facilitated by centralized structures is more valuable to the startup when (a) the incumbent has a greater diversity of knowledge available, and when (b) the startup's innovation efforts require a wider variety of expertise. The constricted rate of knowledge flow arising from centralized structures can in turn be alleviated by (a) startups' primary sponsors in the incumbent firm (i.e., CVC managers) having greater *affinity* with other parts of their organization through prior experience working in operational roles or (b) startups being proximate to the *authority* of incumbents' senior executives based at the incumbent firms' corporate headquarters. These findings offer support to the theorized tension between breadth and rate of knowledge access arising from a partner's organizational structure. In doing so, this study helps to further bridge the literatures on *inter-organizational* and

intra-organizational drivers of knowledge flows and innovation.

THEORY

Innovation is a critical determinant of firm performance, and knowledge is the key resource that fuels it (Schumpeter, 1934). Extensive bodies of scholarship have been dedicated to investigating how firms can obtain valuable knowledge, and how they can translate it effectively into innovation (e.g., Fleming, 2001; Fleming and Sorenson, 2004; Chesbrough, 2006). A key insight from this research is that even if two firms possess similar knowledge resources, the innovations they develop could be very different because of differences in the ways they aggregate and recombine this knowledge internally. A fundamental determinant of these differences is the organizational structure within which each firm's knowledge is embedded (Simon, 1947; Burton, Obel, and DeSanctis, 2011). Organizational structure refers to the solution an organization employs to the fundamental problems of organizing, namely the division of labor and the integration of effort (March and Simon, 1958; Lawrence and Lorsch, 1967; Burton, Obel, and DeSanctis, 2011; Puranam, Alexy, and Reitzig, 2014). Broadly, an organization's structure encompasses the choices made along four dimensions: task division, task allocation, provision of incentives, and provision of information (Galbraith, 1973; Puranam, Alexy, and Reitzig, 2014). These choices can have a significant impact on the way an organization's knowledge is stored, shared internally, and applied towards innovation (Denrell, Fang, and Winter, 2003; Eklund, 2022). A range of studies have demonstrated how an organization's innovation outcomes may be impacted by structural features such as hierarchy (Gavetti, 2005; Csaszar, 2013; Lee, 2022), task differentiation (Dougherty, 1992; Burton and Obel, 2004), and the incentives of employees (Lerner and Wulf, 2007; Manso, 2011). The fundamental mechanisms underlying these findings relate to the impact of different elements of structure on the way organizations can mobilize knowledge.

However, firms' innovation outcomes are also heavily influenced by their ability to leverage knowledge that exists beyond their boundaries, most commonly via partnerships with other organizations (Powell, Koput, and Smith-Doerr, 1996; Chesbrough, 2006; Lifshitz-Assaf, 2018). These partnerships have widely been characterized as pipes through which firms can draw

from the knowledge of partner organizations (Podolny, 2001; Powell et al., 2005). A substantial literature has emerged investigating what types of knowledge-focused partnerships are most valuable to which types of firms and under what conditions (Owen-Smith and Powell, 2004; Phelps, Heidl, and Wadhwa, 2012; Lumineau and Oliveira, 2018). This literature has also highlighted that the knowledge flows in inter-firm partnerships are prone to frictions, which can restrict a firm's access to its partner's knowledge in significant ways (Ghosh and Rosenkopf, 2014). For instance, the knowledge that is valuable may be dispersed across different parts of the partner organization, leading to variation in the accessibility of different types of knowledge (Kale, Dyer, and Singh, 2002; Helfat and Campo-Rembado, 2010). Kale, Dyer, and Singh (2002:40) quote an alliance manager as saying,

“We have a difficult time supporting our alliance initiatives, because many times the various resources and skills needed to support a particular alliance are located in different functions around the company.”

As a result, firms' access to their partners' knowledge resources may be narrower than anticipated, i.e., such frictions, whose origins lie in a partner's internal structure, can limit the *breadth of access* a firm has to its partner's corpus of valuable knowledge. Existing research on partnerships has largely abstracted away from this form of variation, implicitly assuming that the locus of the partnership coincides with the locus of any salient knowledge within the partner organization i.e., that the partnership “pipe” has a homogenous ability to access any part of the partner's knowledge base that is relevant (Puranam, 2018).

Similarly, frictions can also restrict the *rate of access* to knowledge in partnerships. We know from a wide range of studies that the transmission of knowledge, even within organizational boundaries can be slow (Szulanski, 1996; Hansen and Haas, 2001). Some studies have highlighted the importance of mechanisms that can accelerate knowledge flows in partnerships (Uzzi, 1997; Dyer and Nobeoka, 2000). Others have also suggested that impediments to the rate of knowledge access arising from organizational structure may limit the value of a partnership. For instance, Pahnke, Katila, and Eisenhardt (2015:9), quote a manager describing the reason for a partnership failing to create value as arising not from the unavailability of valuable knowledge, but the rate at

which this was shared,

“Slow as molasses: resources need to get approved, technical decisions involve modifications in contracts . . . they can’t get anything done. And their hierarchy—it’s just a pain.”

Yet, as Ghosh and Rosenkopf (2014:623) highlight of the literature on inter-organizational partnerships, *“an implicit assumption of largely unrestricted knowledge flow underlies much of this work”*. Relaxing these assumptions around frictionless knowledge flow clarifies the importance of the internal structures of the partnering organizations as a potential source of variance in the knowledge driven value firms can derive from their external partnerships (Ghosh and Rosenkopf, 2014; Puranam, 2018). Some recent studies have highlighted the links between the knowledge-acquisition impact of external partnerships and the knowledge-deployment impact of internal organizational structure. For instance, Arora, Belenzon, and Rios (2014) show that firms’ internal R&D structures impact their pursuit of external targets for knowledge-focused acquisitions. Firms with more centralized structures make smaller acquisitions than those with decentralized structures and integrate the acquired companies more closely. Sytch, Wohlgezogen, and Zajac (2018) show that firms with matrix-type organizational structures are on average likely to seek out partnerships of greater functional complexity, and to use equity-based governance structures for these partnerships. However, they also find that firms with these complex organizational structures are penalized in terms of stock market performance for entering partnerships that are themselves considered more complex.

These studies demonstrate how an organization’s own internal structure may impact its choices in relation to external partnerships, as well as the value it derives from those partnerships. However, there has been little scholarly attention focused on understanding how the structure of the partner organization may shape frictions in firms’ access to their partners’ knowledge, and in unpacking how such frictions may impact the different dimensions of knowledge flow. Partnerships are often intended to serve as a channel to access the knowledge embedded within the partner’s organization (Podolny, 2001; Owen-Smith and Powell, 2004). Given an organization’s structure impacts how its knowledge is distributed, and the incentives of its

employees to share such knowledge, a partner's structure could have a meaningful impact on the knowledge flows that arise in a partnership. This is important to understand as firms are increasingly relying on partnerships to support their innovation activities, yet without careful consideration of their partners' structures and associated knowledge accessibility these partnerships may fail to deliver their anticipated value.

Organizational Structure and the Balance between Central Control and Local Autonomy

We center our study of this question on a foundational characteristic of the partner's organizational design, the degree of autonomy it affords to its constituents (Thompson, 1967; Galbraith, 1977). Structural choices made with regards to autonomy promote or restrict managerial discretion in resource orchestration decisions (Pennings, 1976; Bloom, Sadun, and Van Reenen, 2012). On the one hand, higher levels of autonomy provide greater managerial discretion. This can enable an organization to be more responsive, and to leverage specialized local information in making decisions. On the other hand, structuring the organization with lower levels of localized autonomy and greater levels of unified control, can provide important benefits like economies of scale and scope, and the integration of knowledge or other resources across the organization (Astley and Zajac, 1991; Raisch and Birkinshaw, 2008; Dattée et al., 2022). The balance between localized autonomy and unified control may be shaped by various elements of an organization's structure, both formal and informal (Child, 1973; Damanpour, 1991; Puranam, Singh, and Zollo, 2006; Damanpour and Aravind, 2012; Dattée et al., 2022).

A core structural choice that organizations need to make in this respect pertains to their degree of centralization (Hage and Aiken, 1967; Sah and Stiglitz, 1986; Argyres and Silverman, 2004). The degree to which an organization is centralized, and the implications thereof, have been the subject of research across a wide range of disciplines including management (Sengul and Gimeno, 2013), economics (Aghion and Tirole, 1997), sociology (Gould, 1996) and political science (Chhibber and Kollman, 1998). The conceptual foundation common to these literatures is that centralization reflects where decisions are made within an organization. More centralized organizations are ones where formal decision-rights are retained closer to the "center" of the

organization (Pfeffer and Lammerding, 1981; Cummings, 1995), and by corollary decentralization reflects “the extent to which problems are solved at lower levels” (Garicano and Rossi-Hansberg, 2004:197). Hence, centralization directly impacts the autonomy-control trade-off by determining the degree to which the formal authority to make decisions is diffused throughout the organization. We anticipate that the breadth and rate of a firm’s access to its partner’s knowledge will be systematically impacted by the degree to which the partner’s organization is centralized.

While the focus of our theory is specifically on the formal structural element of centralization, we expect other elements of organizational structure that shape the autonomy-control balance may also systematically impact the breadth and rate of knowledge access via analogous mechanisms to the ones we describe here². Also, the mechanisms by which we expect formal structure to influence firms’ external relationships involve its widely documented role in shaping informal structures and networks within an organization (e.g., Gulati and Puranam, 2009). We therefore conceptualize formal structure as setting the “boundaries” that contour informal interactions within organizations and will highlight the relevant informal mechanisms in our theorization (McEvily, Soda, and Tortoriello, 2014:314).

Setting: Startup – Incumbent Corporate VC Partnerships in the Life Sciences

We ground our theorization in a specific setting, partnerships between entrepreneurial ventures in the life sciences and their corporate investors, typically large pharmaceutical firms (Glaser and Strauss, 1967; Barley, 1990). We utilize this setting for two primary reasons. First, we can focus our theorization and empirical analysis on how variation in the structure of the incumbent impacts a startup’s performance as startups’ structures will be relatively simple and homogeneous (DeSantola and Gulati, 2017; Burton et al., 2019). Second, the principal aim of these partnerships for the startup is to gain critical knowledge from the incumbent to further their innovation goals, making the antecedents of these knowledge flows particularly salient. While the core of the empirical analysis in this study is quantitative, we also carried out 72 interviews with managers

² See discussion on page 38

from startups in the life sciences, as well as from the R&D and CVC divisions of incumbent pharmaceutical firms to develop an understanding of the mechanisms that operate in this setting. We draw on information gained from these interviews to help illustrate our theoretical arguments (Pontikes and Barnett, 2017; Sytch and Kim, 2021). While focusing on this setting enables us to be more precise in the mechanisms through which a partner's structure can impact the access to its knowledge by a focal firm it does place boundary conditions on our findings such as at least one partner having a complex structure. We discuss these boundary conditions in more detail in the discussion section of the paper.

Corporate venture capital, the practice of startups receiving equity investment from incumbent firms, has become the most prominent form of collaborative partnering between these two types of firms in recent times (Dushnitsky, 2012; Drover et al., 2017). For incumbent firms, relationships with startups are principally a mechanism for learning, intended to serve as a window into the emerging technologies being pioneered by startups (Dushnitsky and Lenox, 2005; Dushnitsky, 2012; Lerner, 2013). Hence, at the point of investment the basic technology of the startup is typically well defined and, in industries where this is important, protected by patents. The primary focus for startups on entering these partnerships is to access the knowledge and associated resources of the investing incumbent firm which will help them to translate these basic technologies into products or applications. We will characterize this outcome as the development of *realized inventions*, i.e., prototype applications that can potentially be commercialized (Iansiti and West, 1997; Kapoor and Furr, 2015; Kapoor and Klueter, 2015). This is a critical innovation milestone for startups as it can serve as an important signal of quality to potential investors and acquirers (Hsu and Ziedonis, 2013).

While startups at the discovery stage may have considerable knowledge of the basic science underlying their technology, transforming this into a realized invention requires expertise in many other areas.³ These can range from clinical issues such as which therapeutic indication to target

³ In the United States, prior to commencing phase 1 of trials on a drug candidate, the company must obtain Investigational New Drug (IND) approval for it from the Food and Drug Administration (FDA)

and in what type of patient, how human cells will respond, interaction effects with other treatments, what formulation to employ, and a wide range of other issues on which startups rarely have expertise readily available (Petrova, 2014; Barge-Gil and López, 2015). By contrast, incumbent firms typically possess a great deal of this expertise, and extensive experience dealing with the challenges associated with this stage of the innovation process. The R&D organizations of these firms have primary responsibility for their drug pipelines. This includes the scientific work of invention/discovery of the basic technology, but also the subsequent work of transforming that technology into a validated product which involves expertise on a wide range of different areas: formulation, dosage, toxicology, regulatory precedent, manufacturing etc. These types of expertise comprise a key part of the “D” of R&D in this industry, and expertise on these areas is typically located within the R&D organization (Barge-Gil and López, 2015).

Access to the Incumbent’s Knowledge: Why Breadth and Rate of Access Matter

Effectively accessing the knowledge and associated resources from an incumbent firm can be difficult. Startups’ need for a wide *breadth* of the incumbent’s expertise during development arises for two reasons. First, at this very early stage, most molecules (i.e., technologies) have a range of potential therapeutic applications. Identifying which one is the most promising is often challenging for the startup as it can require domain expertise on those specific therapeutic areas.

As one pharmaceutical R&D executive highlighted:

“I have a number of indications I might want to go after with this molecule, certain molecules can be used in lots of different ways.”

An entrepreneur described these challenges as:

“Figuring out what tumors to go after, and what to combine with was really hard... I found that was the most valuable thing they (the incumbent firm) could contribute. Access to people who had expertise we didn't have.”

Typically, the expertise needed to investigate these different application areas comes from different parts of the incumbent firm. One entrepreneur stated:

“...in one instance where you're delivering these nanoparticles to cells you've got this concern about immunogenicity and things so you might want to be talking to the immunology group, but at the same time, the cargo that you're carrying is acting on a

target in the cytoplasm that's implicated in cancer and in each of those instances you're talking to somebody either in a rare disease group or you're talking to somebody in the oncology group, and so you know you may have three or four different conversations with three or four different teams inside one of these big pharma firms”

Second, achieving the benchmarks of safety and efficacy to receive regulatory approval to commence human clinical trials (i.e., phase 1) on a drug can be hugely challenging because it requires expertise on many domains. A significant advantage of having an incumbent firm as an investor is that it can serve as a one stop shop for most of this expertise. However, the value to startups in this regard comes not from sustained engagements with a small group of people over a long period, but more focused short-term engagement with a wider range of experts. For instance, expertise on toxicology is likely to come from a different source to expertise on drug formulation, and startups are likely to need access to both. This varied expertise is typically widely scattered across the R&D organization, which can make locating it difficult for the startup. To further illustrate these challenges, we summarize a case study in Figure 1 which we elaborate on in Online Appendix A. The subject of the case study, a startup named Galera Therapeutics, was CVC funded by Novartis and had a core technology which it sought to apply in a variety of therapeutic areas.

----- INSERT FIGURE 1 HERE -----

In addition, the *rate* at which the knowledge is accessible can also be a concern for startups. Leveraging an incumbent firm’s knowledge and associated resources requires the support of internal stakeholders who exercise control over those resources. These individuals are typically not directly incentivized to support startups and the internal champions of the startup may not have sufficient decision-making authority or have suitable relationships to make such individuals provide this support (Dushnitsky and Shapira, 2010; Lerner, 2013). Decisions on providing access to suitable knowledge and resources can often require the approval of multiple stakeholders, especially when there are greater interdependencies (Levinthal, 1997; Raveendran, Silvestri, and Gulati, 2020). Thus, the startup often has to navigate substantial organizational complexity, as Pahnke, Katila, and Eisenhardt (2015:604) highlight: “*Helpful resources exist within corporations, but dispersed authority, complex and slow organizational processes, and internal conflicts...*

complicate ventures' access to these resources". This was also a challenge that came up repeatedly in our interviews. As one entrepreneur commented:

"...we always say you know, a pharmaceutical conference room is where good ideas go to die."

Another entrepreneur expressed a similar sentiment:

"(The) problem is partly risk averse culture, partly multiple layers of management. (There is) always somebody to say no... (you) can spend a whole career in pharma saying no, there is no opportunity cost."

Thus, the value startups can derive from these relationships is impacted both by the *breadth* of the incumbent firm's knowledge base to which they have access as well as the *rate* at which this knowledge is accessible to them.

The Impact of Centralization on Breadth versus Rate of Knowledge Access

In considering how an incumbent's organizational structure affects the breadth and rate of knowledge access for a startup, we will focus on the design element of whether the incumbent firm's R&D organization is centralized or decentralized (DeSanctis, Glass, and Ensing, 2002). We distinguish between centralized and decentralized R&D units based on the allocation of decision rights (Jensen and Meckling, 1992). Managers leading a centralized R&D unit have decision rights across the complete portfolio of firms' inventions and hierarchical authority over the parts of the organization working on these inventions with, for example, the ability to readily shift resources between different R&D projects. In contrast, in decentralized R&D units managers only have decision rights for the relevant sub-portfolio of inventions and hierarchical authority over those parts of the organization creating and developing those inventions and can shift resources between projects within their sub-portfolios but not across different units (Burton, Obel, and DeSanctis, 2011). Thus, in a centralized R&D unit reporting to the firm's head of R&D, issues are considered, and decisions made at a cross-organizational level. In contrast, with decentralized R&D units, issues are considered, and decisions made at the individual sub-portfolio level to the exclusion of

considerations of other R&D activities.⁴ We will focus on centralized R&D structures and describe their advantages and disadvantages for startups in comparison to decentralized R&D structures.

Centralized structures tend to embody greater integration of an organization's disparate knowledge resources (Zhang, Baden-Fuller, and Mangematin, 2007; Argyres, Rios, and Silverman, 2020). Research has documented how centralized structures incentivize managers within them to engage in greater knowledge sharing, and to pursue projects whose benefits accrue to the overall firm rather than just their unit or division (Kay, 1988; Hounshell and Smith, 1989; Zhang, Baden-Fuller, and Mangematin, 2007). Competition between managers from different parts of the firm is lower in centralized structures meaning that they are more likely to be collaborative (Karim and Kaul, 2015). As a result, having a centralized structure leads to more extensive interconnections in the organization's internal networks. Argyres, Rios, and Silverman (2020) demonstrate this empirically, showing that firms with centralized R&D have more densely interconnected inventor co-authorship as well as citation networks.

Our fieldwork also helped to ground this expectation. The stated purpose of centralization in incumbent firms' R&D organizations was often explicitly to facilitate internal knowledge sharing (see table 2). For startups, these interconnections in the partner organization make it easier to locate the knowledge and resources that may be valuable to them. While the knowledge search process for the startup is partly goal-driven, it may also have an element of serendipity in that by engaging with the different parts of the incumbent firm, the startup may identify solutions or innovation opportunities via a process more akin to the 'garbage can' model of Cohen, March, and Olsen (1972). A more integrated structure makes this more likely to occur since managers within the incumbent firm are more aware of the existence of expertise that may be relevant to the startup in other areas of the firm. The entrepreneurs we interviewed who had engaged with these incumbent firms' centralized structures frequently commented on the breadth of the resources they

⁴Centralized and decentralized R&D represent two ideal types. Firms may combine some features of centralized structures into a decentralized R&D unit or vice versa. As in prior research, we focus on the dichotomous classification (while empirically controlling for other design features) as this allows us to more clearly discern the principal mechanism underlying the relationships of interest.

were potentially able to access as an impressive feature of these relationships, using phrases such as “*very deep organization*” or highlighting the “*intellectual scale*” of the incumbent firms. One such entrepreneur reflecting on their engagement with the incumbent firm’s centralized R&D organization highlighted the value of the dense internal networks saying,

“(They) have contacts all over the place. They typically know people... and connect you to them, they have strong relationships that you could take advantage of, and that was freely offered to us.”

However, more decentralized structures are characterized by higher levels of autonomy with decision rights being more widely dispersed to different parts of the organization (Wiedner and Mantere, 2019). As a result, these structures promote responsiveness and streamlined decision making (Blau 1972, Raveendran et al. 2020). Centralized structures, in contrast are associated with greater bureaucracy and more cumbersome decision processes (Blau and Schoenherr, 1971; Argote, Turner, and Fichman, 1989). This can impede startups’ rate of access to valuable resources for two reasons. First, by definition, in centralized structures decision making authority is more centrally concentrated, typically at a higher level in the organization (Burton, Obel, and DeSanctis, 2011; Garicano and Wu, 2012). This need to push decisions up the organization is likely to slow down decision-making and make it more complex since it now involves a greater number of actors. In its simplest form it would involve the actor who is directly responsible for the resource in question, and the actor who has the authority to make decisions regarding the sharing of the resource. For a startup, accessing the resource now means getting the buy-in of both actors.

Second, centralized structures tend to be more integrated than decentralized structures, which tend to be more modular (Lawrence and Lorsch, 1967). In other words, decentralized structures typically have limited dependencies across different units, whereas in centralized structures hierarchical authority is the tool that is employed to manage those interdependencies which tend to be greater (Baldwin, 2007). This means that the breadth of concerned parties to any decision grows, and a prospective decision concerning one part of the organization is more likely to draw protest from another part whose activities may be perceived to be impacted in some way (Blau 1972, Raveendran et al. 2020). Hence for startups, centralized structures on average mean

having to obtain the buy-in of a wider range of stakeholders within the incumbent firm, both vertically and horizontally, than in decentralized structures. Interviews with pharmaceutical executives highlighted these limitations of centralized structures:

“Centralized structures often may have a lack of clarity of roles and who is responsible for what, so decision-making can be tough.”

The CEO of a startup dealing with an incumbent firm with a centralized structure commented:

“Partly because of the layers of organization that they have and the kind of centralized management which means that they can’t get out of their own way... and there is always somebody that is going to suggest something.... Its extraordinary, the level to which you have to jump through hoops to get things done...”

Thus, although centralization may provide more pathways through which knowledge can flow, the flow of knowledge through these pathways can become constricted by the additional complexity of decision-making. Hence, centralization of a partner’s organizational structure will facilitate access to a greater *breadth* of this organization’s corpus of knowledge, but concomitantly also impedes the *rate* at which this knowledge can be accessed. This is the fundamental tension we will seek to empirically examine in this paper. Whether a firm will benefit more from its partner having a more centralized or decentralized structure will depend on the extent to which the knowledge value of the partnership relies on the breadth versus the rate of knowledge access. We focus our hypotheses on factors that can shift the balance in this trade-off with respect to partner structure. Specifically, what factors can enhance the value of having access to a greater breadth of the partner’s knowledge or alleviate the costs of having a lower rate of access to the partner’s knowledge. Identifying these factors allows us to develop specific theoretical predictions of conditions that should make partner centralization more valuable which we can test empirically.

It should be noted that we ground our theorization in a setting where the knowledge being accessed is embedded within relatively large, bureaucratic organizations. While research suggests that similar challenges are likely to operate in a range of other organizations (e.g., Shane, 2000; Baker and Nelson, 2005; Aggarwal, Hsu, and Wu, 2020), the mechanisms may be dampened if both partners are small, for instance a partnership between two startups. Furthermore, countervailing forces to the mechanisms we describe here may arise in certain situations if startups

have access to a high degree of hierarchical authority (e.g., the CVC managers is a member of the C-suite). While these are rare in our setting, they represent boundary conditions to our theory.

Factors Enhancing the Value of Breadth of Access

The greater integration brought about by centralized structures in the incumbent firm can enable a startup to potentially tap into a wider swath of the incumbent firm's knowledge base. If that knowledge base is more diverse, spanning a broader array of domains, the additional pathways through which knowledge can reach the startup become even more valuable as a more diverse (and non-redundant) array of knowledge becomes accessible (Pfeffer and Sutton, 1999; Tortoriello and Krackhardt, 2010). In addition, a major underlying driver of the benefit of centralized structures arises from managers within them being more cognizant of expertise that exists in other parts of the firm and having relationships with the sources of that expertise. Again, this greater interconnectedness is likely to become even more valuable when the firm's knowledge base is more diverse as the expertise in the different parts of this organization is likely to be more distinct.

Also, less overlap in knowledge may diminish internal knowledge sharing, making the existence of knowledge silos in the firm more likely (Zahra and George, 2002). A decentralized structure with disconnected autonomous units would exacerbate these divisions. Startups would then be less likely to locate valuable expertise, whether they were seeking something specific or indeed via the more network driven serendipitous process of knowledge matching we described previously. Together these arguments suggest:

H1: The relationship between R&D centralization of the corporate investor and the number of realized inventions startups develop is more positive as the diversity of the corporate investor's technological expertise increases.

The degree to which accessing a wider swath of the incumbent's expertise will be valuable to the startup will also depend on the startup's own knowledge needs. Some startups may be focused on a very narrow knowledge domain in which to translate their technologies into realized inventions, whereas other startups may span a broader range of domains. The expertise needed to progress along each of these different technological domains is however likely to be distinct and

located in different parts of the incumbent firm. For instance, targeting a molecule towards gastrointestinal tumors will draw on distinct expertise to targeting it towards brain or upper-respiratory tumors. Thus, startups with technologies focusing on a wider range of application areas are likely to benefit more from having access to a wider array of expertise. If this is the case, the marginal benefits of having pathways to a wider array of the incumbent firm's R&D organization because of it having a centralized R&D structure will also be greater:

H2: The relationship between R&D centralization of the corporate investor and the number of realized inventions startups develop is more positive as the diversity of the startup's knowledge needs increases.

Factors Counteracting the Impeded Rate of Access

The theorized limitations to the rate of knowledge access from partners with centralized structures have to do with the complex decision processes that arise from the more integrated structures. Existing research has broadly highlighted two forms of solutions to these constraints, *affinity* i.e., the “role of informal networks as an antidote to formal organization practices and structures” (Smith-Doerr and Powell, 2010:479), and *authority* i.e., the use of formal hierarchical fiat to override competing interests and accelerate decision-making (Williamson, 1979; Kownatzki et al., 2013). We consider the role of each of these in easing the constrictions to the rate of knowledge access when partners have centralized structures, starting with *affinity*.

Incumbent firms typically have a specific group of employees tasked with making and managing their venture capital investments. These individuals are the primary points of contact between the startup and incumbent firm, and they play a critical role in shepherding startups through these firms by advocating for them internally and helping them access resources (Dushnitsky and Shapira, 2010; Lerner, 2013). A substantial body of research highlights the role of boundary spanners, the individuals who serve as the interface between an organization and its environment, in facilitating information exchange between firms (e.g., Adams, 1976; Aldrich and Herker, 1977). This literature highlights that such individuals become particularly important in shaping outcomes in relationships where the exchanges that need to occur between firms are more uncertain, i.e., undefinable, *ex-ante*. Various studies have pointed to boundary spanners' positions

within their own organization as being a crucial determinant of their effectiveness at facilitating access to resources, highlighting for instance their internal connectedness (e.g., Tushman and Scanlan, 1981), functional background (e.g., Clark, Smith, and Oliver, 2003), and tenure within the organization (e.g., Perrone, Zaheer, and McEvily, 2003).

We draw on these precedents in examining the role of incumbent firms' CVC managers, who serve as boundary spanners for these firms in their relationships with startups. Monetary incentives to support startups' activities being rare within the R&D organization, CVC managers need to rely on informal mechanisms to facilitate startups' access to resources. These individuals are rarely part of the senior management of the organization (for instance, members of the C-suite or management board), hence they typically cannot drive resource access for startups purely via fiat (Strebulaev and Wang, 2021). Consequently, the ability of CVC managers to persuade their R&D colleagues to share relevant knowledge with the startup will be contingent to a significant degree on their own social capital within the incumbent firm. This aspect of CVC managers' influence was highlighted by an entrepreneur we interviewed:

“...You work with your investor representative (i.e., CVC manager) to help you navigate the larger organization and based on the cultural impact that they have had, those [incumbent firm] resources are willing to dedicate some time to you...but there is nothing from an incentives perspective compelling them to do so.”

Prior work on boundary-spanners has highlighted the importance of these individuals' connections within their own company as being a critical determinant of their ability to effectively carry out their roles (e.g., Perrone, Zaheer, and McEvily, 2003). A critical distinction in this respect is between managers who have prior experience working within the firm in operational roles, and those that were externally hired specifically to work in the CVC division. Managers with prior experience working within the company in operational roles are likely to have developed more social capital within the incumbent firm (Burt, 2005). They are also likely to have a better understanding of the decision-making processes that characterize the incumbent firm and potential ways to circumvent or accelerate them (e.g., Kelly, Medina, and Cameron, 2014; Lungeanu and Zajac, 2019). This experience should therefore enhance a CVC manager's ability to ease the

impediments to the rate of knowledge flow startups face in centralized structures. Hence, we argue:

H3: The relationship between R&D centralization of the corporate investor and the number of realized inventions startups develop is more positive if more of the corporate investor's VC managers have prior experience working in the firm in operational (i.e., non-CVC) roles.

Finally, we consider the role of formal *authority* in easing constraints to the rate of knowledge access in partnerships. Hierarchical fiat is an important tool to precipitate organizational action (Williamson, 1979; Kownatzki et al., 2013). On average, decision making is likely to be accelerated in the presence of an impetus created by hierarchical authority than if this is absent. Centralized organizational structures, by definition, are characterized by more concentrated authority. More control in these structures is likely to be localized at the firm's headquarters than in decentralized structures where authority is more widely dispersed (e.g., Van de Ven et al., 2012). The value of geographic proximity to the authority situated at an organization's corporate headquarters has been widely discussed in prior work. Research has highlighted how proximity to headquarters can facilitate greater attention from those with authority (Bouquet and Birkinshaw, 2008; Giroud, 2013) and in turn how this attention can enhance outcomes such as survival (Kalnins and Lafontaine, 2013), investment (Kim, Cunningham, and Joseph, 2022), and innovation (Bernstein, Giroud, and Townsend, 2016).

We argue that the deployment of this authority in the startup's favor is likely to lead, on average, to a quicker resolution of disagreement, and therefore to an easing of the constrictions to the knowledge flow rate. A vast body of research across the social sciences demonstrates the value of propinquity for access and relationship building (Festinger, Schachter, and Back, 1950; Jaffe, Trajtenberg, and Henderson, 1993; Cai and Szeidl, 2018). A startup is likely to be better able to get the attention of managers at the incumbent firm's headquarters if it is near them (Kim, Cunningham, and Joseph, 2022). Such attention should then enable startups to leverage that authority to ease constrictions to resource access that exist in centralized structures. Prior work on CVC relationships has also documented this mechanism. Alvarez-Garrido and Dushnitsky (2016) describe a startup's CEO attributing the value his company derived from their CVC partnership

being in substantial part driven by his company's offices being located within a "five-minute walk" from the incumbent firm's corporate headquarters which eased constraints to resources access.

As we previously highlighted, to access a valuable resource in centralized structures startups typically must obtain the assent of a range of organizational stakeholders. Our argument here is that, having a more senior manager use their authority to advocate for the startup should, on average, help the startup obtain this access faster than it would without that support. The comparison here is between a startup navigating a centralized structure having access to headquarters versus not having that form of access. On the margin, the ability to draw on hierarchical fiat to help clear organizational logjams should provide faster knowledge access for the startup. In contrast, for incumbents that have more decentralized structures where authority lies lower down the organization, the marginal benefits of being located closer to a firm's headquarters will be lower. Thus:

H4: The relationship between R&D centralization of the corporate investor and the number of realized inventions startups develop is more positive if the startup is geographically collocated with the corporate investor's headquarters.

Figure 2 summarizes our theorized relationships.

----- INSERT FIGURE 2 HERE -----

METHODS

Research Context and Sample

The context for this study is the US life sciences industry between 1995 and 2012. This was a period of significant expansion of corporate venture capital investments by large pharmaceutical companies in biotechnology startups. We start the data collection from 1995 since access to structural data from companies' annual reports is more challenging to obtain prior to that period. We obtain venture capital data from *Venture Xpert*, which Kaplan and Lerner (2016) report has the widest coverage of funding events of any commercially available venture capital database. With its well-defined industry-wide milestones, the progression of drug candidates through clinical trials provides a means with which to compare firms' development outcomes. We obtain such

development data from the *Pharmaprojects* database (e.g., Chandy et al., 2006; Kapoor and Klueter, 2015). We also employ patent data obtained from the European Patent Office (EPO) Worldwide Patent Statistical (*PatStat*) database and USPTO's *Patentsview* database. We hand-collect incumbents' organizational structural data from company 10-K, 20-F, DEF14A SEC filings and annual reports. We provide more detail on this process below.

We start with a sample of 49 incumbent firms. The sample is based on annual prescription drug sales as defined by the *Pharmaceutical Executive* magazine's Top 50 Pharmaceutical companies in 2004-6, i.e. at the mid-point of the sample period (e.g., Klueter, Monteiro, and Dunlap, 2017).⁵ In this period 64 separate firms appeared in the Top 50 in one or more years. The 15 firms over that period that are excluded are either private firms or did not provide sufficient information in their public filings. These firms were in the lower half (26-50 ranking in terms of pharmaceutical sales) in one or more of the three years in the 2004-6 period. Using the mid-point of the sample enables the examination of firms that have at least 10 years of history within the sample timeframe. 33 out of the 49 sample firms are still in the top 50 pharmaceutical firms in 2015, 13 firms had been acquired by other firms and 3 firms had divested their pharmaceutical businesses. Data on these now defunct firms for many of our variables (CVC managers for instance) proved to be difficult to obtain over time as required for our analyses, hence these firms were also excluded from the sample. We then used *Venture Xpert* to identify the CVC investments made by these 33 incumbent firms in startups based in the United States over the study period. We found that 18 of these firms had made at least one CVC investment, with a total of 398 startups having received investments from these firms over this period. These were the basis for the dyads that make up our final sample.

This primary archival analysis is supplemented with 43 interviews with executives in strategy and R&D roles from all the sample incumbent firms. The interviews were semi-structured

⁵ The top 20 pharmaceutical firms by R&D spend represented 60% of industry R&D spend and the top 20 pharmaceutical firms by prescription sales represented 64% of industry sales in 2015.

and lasted between 30 and 90 minutes. The focus of these interviews was to evaluate the validity of the organizational structure measures, to discuss how these firms manage their external relationships and to evaluate the mechanisms which can facilitate or hinder the flow of resources between incumbents and startups in CVC partnerships. In addition, we conducted an additional 29 interviews with startup focused industry informants that included founders/ managers of startups that had received venture capital from incumbents, as well as the employees of incumbents responsible for making and managing these investments (i.e., CVC managers), and independent (i.e., non-corporate) VC investors who co-invested with corporate investors. These interviews focus on the types of exchanges that could arise between incumbent firms' and startups' personnel post-investment, the organizational antecedents of these, and how they can influence the startups' innovation decisions. These interviews were conducted to help us ground our theory and understand our empirical observations using archival data. They were not meant to represent a rigorous qualitative research exercise (e.g., Eisenhardt, 1989).

However, the distinctive features of this setting may also limit the extent to which our findings can generalize to other forms of inter-firm partnerships. Broadly, the salience of the mechanisms we outline in this study will depend on the extent to which ongoing resource mobilization challenges within partnering organizations are likely to influence the outcomes of the partnership. While these challenges are prominent in our setting, they can be significant in a wide range of other innovation-focused partnership types as well. We examine the issue of generalizability in detail in the discussion section and outline some boundary conditions to the applicability of the mechanisms we theorize here.

Empirical Design and Estimation

The unit of analysis for this study is the incumbent firm – startup dyad. We develop a panel dataset that examines each incumbent firm – startup dyad on an annual basis between 1995 and 2012. The first year for each dyad is the year the relationship is formed, i.e., the year the corporate VC investment is made. We then track this dyad every subsequent year until the startup either exits, i.e., is acquired or lists its shares on the public markets, or ceases to exist (Kaplan and Lerner,

2016). Since our data on startup dissolution is likely to be incomplete, we assume a startup has ceased operations if it does not exit or raise new capital for three years continuously.

Leveraging Changes to R&D Structure

To identify our effects of interest, we rely on re-organizations within the incumbent firms that lead to them shifting from a centralized to decentralized R&D structure or vice versa. We examine how the outcomes for startups change corresponding to these structural changes in the incumbent firms, relative to dyads where there was no such structural change over the same period. Focusing on shifts in structure rather than comparing dyads where structures remained stable over time offers us the considerable advantage of reducing the threat of unobserved heterogeneity between different incumbent firms being the driver of the relationships we observe. Furthermore, as we describe below, these structural shifts in the R&D organizations were not driven by considerations relating to the firm's CVC relationships with startups.

We identified the shifts based on changes in the composition of the top management team in which an R&D role changed, either expanding from one role to multiple or vice-versa i.e., centralized R&D to decentralized R&D and the reverse. We then validated these changes through a detailed investigation of the relevant incumbent firms' annual reports, press releases and the internet archive (*web.archive.org*) to ensure that the R&D structure did indeed change, confirm the directionality of the change (i.e., centralized to decentralized etc.) and identify the rationale for the change. We also discussed a sub-sample of these structural changes with our interview informants (more detail below).

In the study period 10 of the 18 incumbent firms undergo one or more restructuring of their R&D units and, as a result, 19.1 % of the dyads in our sample experience a change in an incumbent's R&D structure over the period of the sample. These 10 incumbent firms underwent 18 R&D restructuring events, nine of which were from centralized to decentralized R&D and nine involved a transition from a decentralized to centralized R&D units. Table 1 provides the full list of the 18 structural changes. These changes in R&D structure occur for a variety of reasons such as mergers and acquisitions, the departure of key R&D personnel or a desire to emphasize focus

on specific categories of products.

There are a few instances where incumbent firms undergo multiple structural changes in relatively short spaces of time, which raises the question of what real impact they may have had. Given the rationales for these changes, and based on our interviews, we do not believe any of these changes were necessarily anticipated as being temporary. However, we also verified that these back-and-forth changes are not fundamental to our findings by checking their robustness to dropping all dyads where there are multiple changes, i.e., where the incumbent firm undergoes more than one structural change (see robustness checks section).

----- INSERT TABLES 1 AND 2 HERE -----

In Table 2, we also summarize the findings from more detailed qualitative investigations into the impact of these structural changes for six of these events, with a focus on our mechanisms of interest. These six changes are evenly spread out over the sample period, with the first in 2000 and the last in 2012, three of them are shifts from decentralized to centralized structures and three are the opposite. Broadly, we find that centralization is associated with the capture of internal knowledge synergies, and decentralization with providing autonomy and facilitating nimbler decision making. A key rationale for centralizing R&D units was to facilitate internal knowledge sharing as highlighted by the following statement on Merck's 2004 website:

“The sharing of ideas across scientific disciplines enables MRL [Merck Research Laboratories] to continue to build on our tradition of innovation. We encourage our scientists to collaborate with peers...”

In contrast, decentralization of R&D was associated with a greater clarity as to who makes decisions. The following statement from Pfizer following decentralization in 2007 illustrates this:

“Creating... distinct, but complementary, research organizations... will provide sharper focus, less bureaucracy, and clearer accountability...”

Effect of R&D Shifts on CVC Activity

We did not find explicit reference to CVC investments as a driver or indeed a concern in relation to any of the R&D re-organization events. This could in part be because CVC investments generally represent a very small proportion of incumbent firms' innovation activities. For example,

Novartis had an annual R&D budget of approximately \$9 B in 2020 and spends approximately \$30 M per year on CVC investments, thus CVC represents less than 1% of their R&D budget.⁶ Thus, other elements of R&D are more likely to shape the structure of this unit as opposed to CVC investments. Furthermore, the making and managing of CVC investments in the large pharmaceutical companies that make up our sample is typically led by the managers in a separate division of the company that exists specifically for this purpose (e.g., Pfizer Venture Investments, Novartis Venture Funds, ‘SR One’ – Glaxo Smithkline’s CVC division etc..). These divisions operate independently of the firm’s R&D organization, and the CVC managers have no direct or indirect reporting relationships with managers in the R&D divisions. We were able to directly verify this with our informants from firms responsible for around two-thirds of the investments in our sample. We also examined whether these firms’ CVC activities were altered in conjunction with the changes to R&D structure and found no systematic changes in volume or type of investments, or in the personnel within these divisions (more details on this after the main results).

Our empirical design examines how changes in incumbents’ R&D structures influence the startups who have received CVC investment from these firms. As we are drawing on changes in structure over time, we have the significant advantage of being able to employ dyad level fixed effects in all our estimates. Thus, our analyses account for any unobserved aspects of the incumbent firm – startup relationship that remain constant over time (e.g., inherent quality). These fixed effects also help account for factors such as the investment objectives (strategic vs financial etc.) which are unlikely to change over time for a particular investment. Further, for each re-organization event, our effects are estimated based only on dyads that were formed prior to the re-organization occurring. Given our design, akin to much of the existing research on alliances, our findings should be interpreted as local average treatment effects conditional on these relationships being formed between the firms (Gulati, 1999; Reuer and Devarakonda, 2016). All our models are estimated with OLS regressions unless noted otherwise.

⁶ Based on Novartis 2020 Annual report and Crunchbase data

Measures

Dependent variable. To characterize an entrepreneurial firm's output of realized inventions, we use the count of the number of new drugs belonging to it that enter phase 1 of clinical trials. To enter clinical trials in the US, a prototype drug needs to receive FDA Investigational New Drug (IND) approval, which can be challenging. Moving drug candidates from pre-clinical to phase 1 clinical trials represents a major milestone for a startup as it represents the first time the drug is tested on human subjects. Getting a drug candidate into clinical trials serves as a signal of validation for the technology. This signal can be vitally important to startups as it can help them enhance their valuation, obtain additional funding, license the drug candidate for joint development or undertake a liquidity event such as an Initial Public Offering.

It should be noted that achieving the phase 1 milestone does not guarantee ultimate commercialization of the relevant drug candidate. For this to be possible, drug candidates need to have cleared all three phases of clinical trials and this typically takes many years after entering phase 1 (Petrova, 2014). Furthermore, often by the time the drug reaches the latter stage of trials (unlike at phase 1), the level of investment required means that startups typically share ownership of these candidates with other firms, or often have ceded decision rights altogether (Cunningham, Ederer, and Ma, 2021). We use the log of one plus the number of new drugs that enter phase 1 clinical trials for the entrepreneurial firm in the 3 years after the focal year to capture *New Clinical Drug Candidates*.

Independent variables. R&D Centralization: This is a dichotomous variable that is set to zero if a firm has a decentralized R&D unit and one if they have a centralized R&D unit. We follow a four-step process to develop this variable similar to that used in other studies (Sytych, Wohlgezogen, and Zajac, 2018). First, using top management team (TMT) data available from company 10-K/20-F/DEF 14A SEC filings and Annual Reports, we identified the senior executives of each incumbent firm in our sample for each sample year. TMT data has been used extensively within the strategic management literature to develop high-level organizational structural measures (e.g., Guadalupe, Li, and Wulf, 2014; Girod and Whittington, 2015; Albert,

2018; Sytch, Wohlgezogen, and Zajac, 2018). This enables us to develop a database of 6,967 executives and executive team roles for the sample of incumbent firms over the period 1995-2015.

Second, we coded all the roles of the managers in this database using the categorization developed by Guadalupe, Li, and Wulf (2014). Further, we identified all the roles pertaining to R&D through careful review of the management roles in each organization. For diversified firms which operate beyond pharmaceuticals, we focused on R&D units that pertain to pharmaceuticals and excluded R&D units dedicated to areas such as consumer products. Using this approach, the variable *R&D Centralization* is defined as a binary variable set to 0 if there are multiple R&D groups reporting to separate heads within the TMT covering different pharmaceutical domains or to leads of business units and 1 if the firm has a single integrated pharmaceutical R&D group.

Third, we further validated the *R&D Centralization* measure through a careful review of organizational descriptions from companies' filings (e.g., CEO's letter to shareholders) and publicly available press releases. This also enabled us to identify 18 specific restructuring events within 10 sample incumbent firms illustrated in Table 1. Using publicly available documents, we also examine the context around each of these 18 restructuring events to identify the rationale for the structural changes and how the structural changes could impact the two mechanisms we outline in our theory development. Finally, we interviewed managers from all the incumbent firms in our sample to validate the measure of centralization we employed in this study.

The construct we are seeking to empirically capture with this measure relates to the scope of discretion of managers making resource distribution decisions i.e., in the centralized case it is across the entire R&D organization and in the decentralized case it is within the relevant R&D sub-unit. Thus, our definition of centralization is based fundamentally on where authority lies within the organization. A related but distinct construct is disaggregation – the degree to which an organization is separated out into distinctive non-overlapping units in its task structure (Daft and Lewin, 1993; Podolny and Page, 1998). These two features of organizations – centralization and aggregation are often correlated but not perfectly so. For instance, organizations may sometimes facilitate greater centralization, i.e., increasing managerial span of control, via disaggregation, i.e.,

breaking up into more sub-units to enable easier monitoring and coordination (e.g., Zenger and Hesterly, 1997). In the case of R&D in our empirical setting, decentralization tends to be strongly correlated with disaggregation as each disaggregated unit has significant freedom to make its own decisions independent of the other R&D units without having to refer to some form of centralized authority. This is consistent with our proposed theoretical mechanisms which are grounded in the distribution or concentration of authority, and these will be the focus of our hypothesis tests.

Therapeutic Diversity Incumbent: To evaluate the diversity of knowledge in the incumbent firm, we develop a measure of the diversification of its drug development portfolio across therapeutic classes (e.g., Rothaermel and Deeds, 2004; Macher and Boerner, 2006; Macher and Boerner, 2012). The *Pharmaprojects* database classifies drugs into one or more of 18 classes based on its therapeutic application. To create this measure, we estimate the sum of the squared proportions of drug candidates in each therapeutic class in the incumbent firm's overall clinical development portfolio. This Herfindahl measure is then subtracted from 1 to develop a measure that is higher when the diversity of a drug development portfolio is higher.

Therapeutic Diversity Startup: This is measured in an analogous manner to *Therapeutic Diversity Incumbent* but using the therapeutic classes of drug candidates in the startups' development portfolios at the pre-clinical stage. Hence, this measure captures the breadth of the application areas to which startups are attempting to direct their technologies, with a higher value indicating that a startup's pre-clinical portfolio is spread over a wider range of therapeutic areas. As described in the preceding section, most startups explore more than one therapeutic area at the preclinical stage, with their efforts becoming more focused as they proceed into clinical testing.

Insider CVC Managers: To examine how effectively startups can navigate the complex decision-making environment within their incumbent partners, we focus on the senior managers within the CVC divisions of incumbent firms. We theorized that CVC managers with prior experience working in the incumbent firm in operational roles (i.e., insiders) will have developed stronger informal relationships and a better understanding of the decision processes within their firms that they can employ to accelerate resource flows towards the startup. We obtained

information on the identities of these managers from the *Greyhouse* and *Galante Venture Capital directories*, as well as from archived company web pages (*archive.org*). We then collected information on their career histories from *linkedin.com* and *archive.org*. We classified the CVC managers as ‘insiders’ if they had at least 3 years of prior experience within the incumbent firm in non-CVC roles. Then, for each incumbent firm-year, we counted the number of insiders in the CVC divisions of the incumbent firm. We verify the robustness of our results to using other lengths of time (e.g., 1 year, 5 years) to classify CVC managers as insiders, as well as tighter restrictions on the nature of their prior experience in the incumbent firm (e.g., only R&D).

HQ Colocation: We define this variable to be equal to 1, if the startup’s and the incumbent firm’s headquarters are located in the same 2 digit zip code, which roughly encompasses metropolitan areas in the US, and has been extensively used in prior research to measure geographic collocation (Yue, Rao, and Ingram, 2013; Funk, 2014). We obtain information on the incumbent firm’s headquarters from their annual reports, and those of startups from *Venture Xpert*.

The theoretical mechanism we are focusing on pertains to startups leveraging formal authority to help accelerate access to the incumbent firm’s knowledge. In firms with centralized R&D, such authority generally lies in a firm’s corporate headquarters rather than their R&D locations. The senior leadership of the R&D organization in these structures are typically based at the corporate headquarters (e.g., Pfizer in NYC, Eli Lilly in Indianapolis). We expect access to this authority to be valuable to the startup in alleviating impediments to knowledge access. In contrast, for firms with decentralized R&D, senior managers are generally located in the relevant R&D or subsidiary location (e.g., Roche at R&D sites in New Jersey, Arizona, and California). The incumbent firms in our sample all have several R&D sites located across many countries, and in most cases multiple R&D sites within the US, with the firms’ R&D expertise consequently being spread out over those locations. We control for startups’ collocation with the incumbent firms’ R&D sites in all models. However, given the theoretical focus on hierarchical authority, we focus on HQ collocation to test our hypothesis.

Control Variables. We control for a wide range of variables relating to the entrepreneurial

and incumbent firm. These variables, along with a description of how they are measured, and the rationale for their inclusion are shown in Table 3. We also include dyad fixed effects, and year fixed effects in all our estimates.

----- INSERT TABLE 3 HERE -----

RESULTS

Main Results

The summary statistics for the data that we used to test our hypotheses are shown in Table 4. In the raw data, the correlation between *R&D Centralization* and *New Clinical Drug Candidates* is positive and significant ($p=0.00$). On average, startups progress 0.13 drug candidates into phase 1 clinical trials when the incumbent has a centralized R&D unit and 0.07 drug candidates when the incumbent has decentralized R&D units (difference is significant: $p=0.00$, $t=3.2$).

Figure 3 illustrates that the raw data is in line with all four hypotheses as illustrated by the positive values of the difference in differences of *New Clinical Drug Candidates* between incumbent firms with centralized and decentralized R&D units above and below the median values of each of the moderators. Centralization of R&D has the largest positive impact on *New Clinical Drug Candidates* when startups have above the median value of *Therapeutic Diversity Startup*.

----- INSERT TABLE 4 AND FIGURE 3 HERE -----

Table 5 shows the results from our main regression analyses testing all four hypotheses. The results from model 1 contain none of the interaction terms. Given the inclusion of dyad level fixed effects in all models, the coefficient associated with *R&D Centralization* gives us the estimate of the effect of a change in structure on the outcome variable. This model suggests that centralized R&D in the incumbent firm (as compared to decentralized R&D) is associated with the entrepreneurial firm progressing more drug candidates into phase 1 clinical trials as illustrated by the positive coefficient for *R&D Centralization* ($p<0.01$) in Model 1. The effect size is such that 0.10 more drug candidates (0.30 standard deviations) move into phase 1 trials within startup firms in the following three years when the incumbent firms have centralized R&D units as compared to decentralized R&D units. We also observe that startups with more diverse knowledge bases and

incumbent firms with lower prior performance are associated with startups progressing more drug candidates into phase 1 clinical trials. Interestingly, we also observe that incumbent firms with fewer CVC managers with startup experience tend to be associated with the startup having more realized inventions. It appears that in relation to this outcome, CVC managers' experience within the incumbent firm counts for more than prior startup experience.

Focusing on our four Hypotheses, Model 2 in Table 5 provides support for Hypothesis 1 in that *Therapeutic Diversity Incumbent* positively moderates the *R&D Centralization – New Clinical Drug Candidates* relationship. Figure 4 shows this relationship graphically. Similarly, *Therapeutic Diversity Startup* (Model 3, figure 5), *Insider CVC Managers* (Model 4, figure 6) and *HQ Colocation* (Model 5, figure 7) positively moderate this relationship providing support for Hypotheses 2, 3 and 4. The fully saturated Model 6 provides support for all four hypotheses at the 95 % confidence level or above.

----- INSERT TABLE 5 AND FIGURES 4-7 HERE -----

Figure 8 illustrates the effect sizes associated with each of these hypotheses (Model 6). Interestingly, for all four hypotheses, bottom decile values of the moderators are associated with higher values of realized inventions (*New Clinical Drug Candidates*) for firms with decentralized R&D units as compared to those with centralized R&D units, i.e., decentralized structures may be more beneficial to startups under these conditions. With respect to our theoretical arguments, this means that under these conditions the benefits of greater rate of knowledge access for more decentralized structures outweigh the costs of a reduced breadth of access. This suggests that when incumbent firms have R&D units with less knowledge diversity or startups have less of a need for diverse knowledge, they do not suffer significantly from the reduced inter-connectedness associated with decentralized R&D. Further, in the absence of mechanisms such as insider CVC managers and colocation with the incumbent firm's HQ to help startups mitigate knowledge flow constrictions associated with centralized structures, startups may benefit less from partner centralization. Under these conditions, the more streamlined decision processes associated with decentralized structures and a greater rate of knowledge access are more valuable for startups.

The largest moderator impact is associated with increasing *Therapeutic Diversity Incumbent* from the lowest decile (0.63) to the highest decile (0.88) which translates to an increase in the difference in *New Clinical Drug Candidates* between firms with centralized and decentralized R&D units of 0.645 (or 0.906 drug candidates). The smallest impact is for *HQ Colocation*, moving from firms whose HQ's are not collocated with the startup to those whose HQs are collocated, we observe an increase in the difference in *New Clinical Drug Candidates* between firms with centralized and decentralized R&D units of 0.058 (or 0.060 drug candidates).

----- INSERT FIGURE 8 HERE -----

We also undertook eighteen additional tests to examine the robustness of our findings to employing alternative approaches to the measurement of each of our dependent and independent variables, alternative estimation methods including the use of non-linear models, the use of split samples rather than interaction terms and sub-sample analyses. Table 6 summarizes these tests and the key results from them. A detailed description of each of these tests and tables showing results from them are provided in Online Appendix B.

----- INSERT TABLE 6 HERE -----

Additional Analyses

Examining alternative explanations

We also undertake seven analyses to examine alternative explanations for our results to those outlined in our theoretical development. Table 7 summarizes each of these tests listing the alternative explanation we are considering, the test we carried out, and the test's finding. We examine alternative explanations based on how CVC activity is managed, R&D personnel's attitude to CVC startups, systematic differences in the "quality" of the drugs startups enter into trials when incumbents have centralized vs decentralized R&D, the role of competition between the incumbent and the startup, the impact of R&D structure on startups' likelihood of exit via IPO or acquisition, alliance formation between the two firms post investment, concurrent (but unrelated) occurrence of R&D centralization and the advancement of inventions, and heterogeneity between dyads which experience structural changes and those that do not. Detailed

descriptions of each of these tests are provided in Online Appendix C.

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Supplemental analyses of mechanisms

We undertake two further analyses to further probe the mechanisms through which an incumbent firm's R&D structure may be influencing startups' realized inventions. First, we probe the timing of our effects to examine the interplay between informal and formal structure. As highlighted, we view formal structure as being enacted, in part, via the informal norms and networks that persist within the organization (McEvily, Soda, and Tortoriello, 2014). Research shows that the informal structures of an organization such as the network of ties between managers can be sticky, and that a change in informal structures can lag a change in formal structures (Nickerson and Zenger, 2002; Gulati and Puranam, 2009). In our context for instance, even if there is a switch from decentralized to centralized R&D, it will take time for the connectedness benefits of R&D centralization to emerge as initially the new centralized R&D unit may be still quite siloed along the lines of the former R&D decentralized units. At the same time, the processes and norms that characterize decision making are also unlikely to be altered immediately.

To examine the temporal variation in the magnitude of the effects pertaining to startups' realized inventions, we create dummy variables to indicate the first two years following the change in structure, and another to indicate the subsequent two years (i.e., third and fourth) following the change. We then interact the R&D centralization indicator with each of these. The interaction effects in each case should tell us the extent to which the treatment effect we observe is altered in the period in question. The results are shown in Table 8. We observe that the baseline positive effect is substantially depressed in the initial two years following centralization of R&D and depressed to a much smaller extent in the following two years. This is precisely in line with what we would expect given our mechanisms are closely related to the informal structures within the organization, which will lag the change in formal structures. Network formation in centralized structures take time, meaning the breadth related benefits are unlikely to be realized immediately. We should note that it is also plausible that the downsides of centralized structures relating to

organizational complexity and overlapping decision authority may be especially pronounced in the years immediately following a structural change. Over time, as managers settle into the new structure, they develop an understanding of how to make decisions in more efficient ways thereby increasing the rate of access of knowledge.

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Second, we also examine the impact of an incumbent firm's R&D structure on a startups' patenting output. The focus of this study is on a specific innovation related outcome that is of proven importance to startups in these relationships, advancing drug candidates into the first phase of clinical trials. However, another commonly used measure of innovation outcomes is patenting. The two outcome variables, patenting and advancing drugs into clinical development, relate to two distinct phases of the innovation process (Garud, Tuertscher, and Van de Ven, 2013). Patents characterize the earliest stage of invention, and are primarily driven by deep scientific knowledge in a relatively narrow domain, whereas the advancement of drug candidates requires bringing together expertise on a wider range of areas such as formulation, toxicology, regulatory norms, as well as a degree of scientific expertise (Iansiti and West, 1997; Kapoor and Klueter, 2015).

To examine the impact of the structural changes on patenting, we repeat each of our analyses using a logged count of the number of patents produced in the three years following the focal year by the startup (plus one) as our outcome variable, *New Patents* (Table 9). From Model 1, we do not observe a significant direct relationship between a change in the R&D structure and a startups' patenting outcomes. Table 9 also shows estimates of our interactions of interest. In three of the four cases, we do not find these to bear a statistically significant relationship with the outcome either. The exception is the case of CVC managers who are insiders which has a positive relationship with the startup's patenting when the incumbent firm has a centralized R&D structure.

Overall, incumbents' R&D structures appear to have a weaker impact on the patenting of startups. This is consistent with our findings from interviews with CVC managers and startups that we outlined in our theory. At the point of investment startups typically have their foundational IP in place and the focus of these partnerships for both sides is less on invention but more on

advancing technology into a commercial application. Furthermore, the mechanisms we outline here that relate to the formal organizational structure of the incumbent firm are less likely to be salient in shaping the knowledge exchanges supporting the early stages of technology formation.

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DISCUSSION

Summary of Results

For partnerships to enable innovation, firms need to access resources such as knowledge and expertise embedded within their partner organizations. Research has demonstrated that such resource flows can be impeded by frictions and highlighted the importance of understanding the origins of these frictions (Ghosh and Rosenkopf, 2014). We investigate an important source of such frictions in the knowledge flows associated with partnerships that originate in the partners' organizational structures - the level of discretion managers within the partner organization have over resource orchestration decisions (Dattée et al., 2022). While this can be impacted by a range of structural choices, we focus our attention primarily on centralization, the extent to which decisions are made closer to the head or "center" of the organization (Pfeffer and Lammerding, 1981; Garicano, 2000). We highlight a critical tension in relation to the centralization of a partner's organizational structure. Centralized structures promote connectedness within the partner organization thereby enabling access to a greater *breadth* of a partner's knowledge (Hounshell and Smith, 1989; Karim and Kaul, 2015). However, such centralized structures are also characterized by more complex decision processes which can constrict the *rate* of access to the partner's knowledge (Burton, Obel, and DeSanctis, 2011).

We develop hypotheses that allow us to probe this fundamental tension by identifying factors that would theoretically shift the balance and make partner centralization more valuable, via their impact on the *breadth* and *rate* of knowledge access. We ground these hypotheses in entrepreneurial firms' innovation focused relationships with incumbents arising from corporate venture capital investment. We find that access to a greater breadth of the incumbent's knowledge base facilitated by centralized structures is more valuable when the incumbent has a greater

diversity of knowledge available, and when the startup's innovation efforts require a wider variety of expertise. The constricted rate of knowledge flows arising from centralized structures can in turn be alleviated by the incumbent firm having managers with prior experience in operational roles working with startups using their informal intra-firm networks to help push knowledge to startups, or startups being collocated with the headquarters (HQ) of the incumbent firm which enables them to leverage the formal authority of senior executives to pull knowledge towards themselves.

Contributions

This study helps bridge the literatures on organizational structure and inter-organizational partnerships. Doing so enables us to make several contributions. First, we illustrate an important trade-off managers face associated with their external partnerships. This has important implications for questions relating to partner choice in inter-organizational relationships. Existing theories have principally focused on the complementarity of the partner's resources as well as their formal and informal incentives to share resources. However, these assessments are typically made at the organizational level with an implicit assumption of alignment between these macro-level factors and the internal structure of the firm. For instance, resource-based perspectives when applied to the study of inter-firm partnerships generally assume the locus of the partnership coincides with the locus of any relevant resources within the firm (March, 1962; Barney and Felin, 2013). Our findings suggest that a partner's internal structure should be a consideration as well. Structure can generate heterogeneity in the degree to which different resources in the partner organization are accessible, as well as in the rate at which they are accessible. Hence, considering how effectively the partner's structure maps to the objectives of the partnership is important. For instance, if the partnership is seeking to explore a new technological domain in which a wide range of resources would be valuable to the endeavor, our results suggest that all else equal, seeking a partner with a more centralized structure would be beneficial. This study paves the way for future research to further consider the implications of organization structure from a partnership perspective, which our findings suggest may be a productive avenue for scholars of inter-

organizational collaboration.

Second, this study also speaks to the organization design literature by highlighting important mechanisms through which organization design can shape firms' innovation outcomes through its impact on knowledge flows. Our theory illustrates how managers can adjust the formal structure of their organizations to systematically shape the informal processes and networks within organizations which in turn shape inter-firm knowledge flows (Powell et al., 2005; McEvily, Soda, and Tortoriello, 2014; Sytch, Wohlgezogen, and Zajac, 2018). The findings also highlight that firms may optimize access to a greater breadth of their organizations' knowledge bases or the rate at which this knowledge can be accessed but there is an inherent trade-off between the two (e.g., Puranam, 2018). The design of the organization is therefore likely to be a key link between the objectives of a partnership and its actual performance.

Third, research on inter-organizational networks has historically been focused on tie structure. This study adds to the emerging body of work focused on node characteristics by highlighting the systematic impact of the internal structure of nodes on frictions in the knowledge flows occurring within networks (e.g., Barden and Mitchell, 2007; Kleinbaum and Stuart, 2014; Lumineau and Oliveira, 2018). Consider one network primarily made up of centralized nodes and contrast this to another made of decentralized ones. Our findings would indicate that the knowledge circulating within these networks will be substantially different. While one network (centralized nodes) will feature a greater variety of knowledge, the other (decentralized) is likely to feature more timely flows of focused knowledge. Being embedded in one versus the other is therefore likely to have materially different implications. We hope that future research will delve further into this question to consider how the distribution of structural characteristics of the nodes in inter-organizational networks relate to the types of resource flows that arise within it.

Fourth, speaking to the innovation literature, parametrizing knowledge flows in terms of breadth and rate of access and considering them simultaneously allows us to describe an important trade-off related to partner structure. Existing research on how partnerships impact innovation typically theorizes about knowledge flow as a unidimensional construct. Our findings suggest that

to understand the value creation that can arise from inter-firm collaboration, managers need to explicitly consider both questions: what are the available pathways to access the relevant knowledge and resources (i.e., through how many pipes can knowledge flow?) and how easily can the knowledge and resources be obtained from the relevant holder (i.e., how constricted is the flow through these pipes?). Unpacking these dimensions of knowledge flow can provide greater insight into how structure can shape firms' innovation outcomes both when conducted in isolation and in partnership with other firms. For example, different types of innovation may require different flow characteristics with some relying on timely knowledge flows and others on access to a diversity of knowledge.

Finally, our findings also contribute to the growing literature on the impact of Corporate VC on startup performance. Recent work suggests that startups' outcomes are contingent on effective access to the incumbent's resources which is dependent on navigating the complex organizations within which resources are embedded (Pahnke, Katila, and Eisenhardt, 2015; Alvarez-Garrido and Dushnitsky, 2016; Balachandran, 2018; 2023). We add to this research by examining how startups' access to resources is related to the organizational structures of incumbent firms, and by identifying conditions under which different types of structures are most valuable. For entrepreneurs, these findings suggest that undertaking a practical assessment of the structure of their corporate investors and the associated difficulties in locating and accessing the resources they require in a timely manner could help them avoid unproductive partnerships.

Generalizability and Boundary Conditions

We consider the generalizability of our findings along three dimensions: other facets of organizational structure, other forms of partnership, and other industries.

Our focus in our theorization and empirical analyses is on partner centralization and its role in shaping the balance between localized autonomy and unified control within the organization. There are a range of other facets of organizational structure that can impact the level of discretion of managers. We expect the basic tension we theorize relating to managerial autonomy to manifest itself in relation to these other structural elements as well. As an illustration, we consider this in

relation to formalization. Formalization refers to the use of “codified rules, policies, and procedures to shape behavior, guide actions, and govern social positions and role relationships between individuals” within organizations (Child, 1973; Gibson, Dunlop, and Cordery, 2019). Formalization is associated with standardized policies and processes as well as a “common language” within the organization that help ensure the different parts of the organization move in concert (Mintzberg, 1980; Adler and Borys, 1996; Lin and Germain, 2003). However, a high level of formalization can also limit flexibility, and restrict the potential for emergent processes to address issues that arise locally within the organization (Juillerat, 2010). Hence, the level of formalization in a partner organization could theoretically be the source of a tension analogous to the one we outline in this study for centralization. A highly formalized partner organization with its uniformity of processes and greater degree of integration may ease access to a wider swath of the partner’s resources. However, the limited discretion available locally within these structures may impede responsiveness and thus limit the rate of access (Baum and Wally, 2003; Eisenhardt, Furr, and Bingham, 2010). While we expect the specific theoretical mechanisms we outline in this study to apply to those facets of organizational structure that impact autonomy, the broader approach we describe here could also be extended to consider how innovation within partnerships may be shaped by other elements of partner structure that we know to impact knowledge mobilization such as the “flatness” of a partner’s hierarchy (e.g., Lee, 2022).

Our hypotheses and empirical findings are focused on partnerships arising from corporate venture capital, which is the predominant form of cooperative engagement between established and entrepreneurial firms (Dushnitsky, 2012). However, it also has several unique features that distinguish it from some other forms of alliances and inter-firm partnerships. This raises the important question of whether and when our findings generalize to other forms of partnership. Broadly, the salience of the theoretical tension we outline in this paper will depend on the extent to which ongoing resource mobilization challenges within partnering organizations influence the outcomes of the partnership. We outline three boundary conditions that are likely to shape the relevance of these resource mobilization challenges, and in turn the salience of the mechanisms

we outline in this paper. First, how precisely the resource commitments of each side are defined ex-ante. The distinction here is between partnerships where the resource commitments from each side are precisely articulated at the commencement of the partnership, and those where these commitments are left more ‘open-ended’. This is a characteristic of our setting – while there is an understanding on both sides that the investor will employ its resources to support the startup, the precise nature of that resource access is not defined ex-ante. This may also be true of a range of other partnership types, especially those of an exploratory intent (Lavie and Rosenkopf, 2006).

Second, the size of the partnering organizations is a relevant boundary condition. If the partnering organizations are both small, the role of organizational structure in shaping resource mobilization for partnerships is likely to be more limited. In this case, internal bureaucratic hurdles to resource mobilization for the partnership (that arise from the organizational structure) are likely to have less of an impact on outcomes. Similarly, the internal connectivity related benefits of a centralized structure are also less relevant as resources will be easier to find in such smaller organizations. Hence, the mechanisms we describe are only likely to become relevant if at least one of the organizations involved in the partnerships is relatively complex. A related concern is that the partnerships we focus on empirically in this paper are between one large and one small firm. We view the existence of resource mobilization issues only on one side in our setting as an aid to discerning the mechanisms underlying the observed effects, and broadly expect these mechanisms relating to knowledge search and access to continue to operate even if, for instance, both firms are large. The findings from Sytch, Wohlgezogen, and Zajac (2018) offer some support for this view, showing that large firms' propensity to form complex partnerships and the outcomes of those partnerships vary systematically with formal organizational structure.

Third, the nature of managerial incentives is likely to differ in CVC partnerships as compared to other forms of inter-organizational partnership. In CVC partnerships, R&D managers are typically not directly incentivized to work with CVC-invested startups, which may not be the case in other forms of partnership such as R&D Alliances. It is well established in the strategic management literature that an organization’s design can shape managerial incentives (Zenger and

Hesterly, 1997), and that localized autonomy is generally associated with higher powered incentives (Jensen and Meckling, 1992). This is consistent with our expectation that decentralized structures would facilitate an enhanced rate of access to the partner's knowledge as the structure facilitates the creation of localized incentives to promote sharing. Hence, we expect the central trade-off relating to how the structure of a partner may shape the breadth and rate of knowledge access of a focal firm to apply even when the incentive structures diverge from those in the CVC context. However, the specific role of our theorized contingencies may vary when direct incentives to share knowledge play a more prominent role in determining access. Relatedly, CVC managers are rarely members of the top management team of the company (Strebulaev and Wang, 2021). Hence, they typically do not have the unilateral authority to precipitate resource access for startups. However, if the boundary spanners in other types of partnership did possess this level of authority, they may be able to override some of the frictions that we describe here.

Finally, the pharmaceutical industry in the US is distinctive in that relationships between incumbents and startups are commonplace, and the innovation process has some distinctive features such as the involvement of regulatory authorities and the well-defined stages of product development. In industries where the translation of an idea into final offering is relatively straightforward such as basic phone apps, the findings of this study may be less likely to apply directly. However, the basic theoretical mechanisms we outline are likely to have relevance in other high technology areas in which firms face knowledge related challenges associated with the translation of technology into application (Iansiti and West, 1997). Analogs of this from other industries include turning a machine learning routine into a fraud detection tool in banking (Wei et al., 2013), or a digital signal processing chip (DSP) into a hearing aid device (Edwards, 2007). Even in industries such as consumer products, firms create a huge volume of patents but there are significant challenges to translating an idea into a viable product (e.g., Cardinal et al., 2011). In these situations, partnerships are commonplace and the mechanisms we describe relating to knowledge mobilization are likely to be salient (Gans and Stern, 2003).

As with any empirical study, this study has several limitations that could serve as avenues

for future studies. We do not directly capture knowledge flows between and within organizations but infer their occurrence based on changes in firms' knowledge-related outcomes. Our empirical specification focuses on changes in R&D structure within entrepreneurial-established firm dyads and we rule out various alternative explanations for our findings. However, we cannot make strong causal claims regarding the relationship between R&D structure of the established firm and entrepreneurial firms' innovation outcomes given these structural changes are not randomly assigned. It is challenging to identify natural experiments in which an exogenous shock leads to established firms changing their structures as this is a critical managerial decision. We have therefore tried to adopt a 'preponderance of evidence' approach to discern the mechanisms underlying the relationships we observe (e.g., Feldman, Gartenberg, and Wulf, 2018). Further, our empirical characterization of organizational structure is binary, in line with prior work in this domain (Argyres, Rios, and Silverman, 2020). This limits our ability to capture nuanced distinctions between structures by means of which organizations may attempt to adopt features enabling ambidexterity (Raisch and Birkinshaw, 2008). Finally, our empirical design is focused on isolating the startup's access to the incumbent's R&D organization, as it is the principal repository of the knowledge startups require. While unlikely, we cannot rule out the possibility of startups engaging with other parts of the incumbent firm. We control empirically for other incumbent structural characteristics beyond R&D. However, to the extent that R&D structural changes correlate to broader events within the organization, they may also be shaping startups' access to other parts of this firm that impact their outcomes in ways we are not capturing.

Despite these and other limitations, this paper helps to advance our understanding of how a partner's organizational structure can shape a firm's innovative productivity. Firms not only have to find partners with the requisite complementary expertise, but also must navigate the organizational challenges associated with locating and accessing the resources they require within their partners if they are to utilize these partnerships successfully. We demonstrate the critical role played by the partner's organizational structure in this respect.

TABLES AND FIGURES

Table 1: List of 18 R&D Structural Changes in the Sample

#	Year	Firm	Change	Reason
1	1999	Takeda	Centralized to Decentralized R&D	Internal reorganization of research from single to multiple units focused on different elements of the R&D process
2	2000	Novo Nordisk	Decentralized to Centralized R&D	Divestiture of enzymes business prompted internal consolidation of remaining R&D into a single unit
3	2000	Glaxo	Centralized to Decentralized R&D	Decentralization following a merger, split R&D into multiple technology-focused units
4	2001	Takeda	Decentralized to Centralized R&D	Internal reorganization of multiple research units into one pharmaceutical research division under a single head
5	2001	Bristol Myers Squibb	Centralized to Decentralized R&D	Split of R&D along technological lines after departure of Chief Scientific Officer from the company
6	2001	J&J	Decentralized to Centralized R&D	Amalgamation of multiple R&D groups into one under a single head " <i>to facilitate the sharing of scientific knowledge across the company</i> "
7	2002	Glaxo	Decentralized to Centralized R&D	Departure of two senior R&D executives led to the unification of R&D under a single head
8	2003	Amgen	Centralized to Decentralized R&D	Acquisition prompted split of R&D organization
9	2003	Merck	Decentralized to Centralized R&D	Internal reorganization following the retirement of one senior R&D executive and departure of another
10	2003	Bristol Myers Squibb	Decentralized to Centralized R&D	Death of previously senior most R&D executive (who was head of the largest division) prompted unification of the organization under a new appointee.
11	2003	Pfizer	Centralized to Decentralized R&D	R&D was split into multiple divisions focused on basic science or more function-specific applications of science
12	2004	Amgen	Decentralized to Centralized R&D	Consolidation and restructuring of company led to unification of R&D under a single head
13	2006	Pfizer	Decentralized to Centralized R&D	Arrival of new CEO and retirement of a senior R&D executive prompted a reorganization into a single R&D organization
14	2007	Pfizer	Centralized to Decentralized R&D	Raft of leadership changes among senior R&D executives - 2 left the company, 2 promoted, and 4 externally recruited led to R&D being split again into multiple units
15	2009	Roche	Centralized to Decentralized R&D	An acquisition resulted in the split of R&D into three distinct physically separated units
16	2010	Glaxo	Centralized to Decentralized R&D	Imperative to provide more resources and autonomy to specific areas (e.g., vaccines) led to a split of the R&D organization
17	2010	Pfizer	Decentralized to Centralized R&D	Acquisition led to another reorganization, with the R&D organization being unified under head of R&D at Wyeth (the acquired company)
18	2012	Baxter	Centralized to Decentralized R&D	Split of entire company along therapeutic lines

Information collected from company annual reports and 10-K/20-F/DEF 14A SEC filings as well as press releases and archived versions of company web pages accessed via archive.org.

Table 2: Qualitative Examination of the Impact of Structural Changes

Type of change	Company - Year	Impact of structural change
Centralization (D to C)	Novo Nordisk - 2000	<p>In 2000, R&D was centralized into a corporate function under the leadership of the Chief Scientific Officer, Mars Thomsen. A case study of the company’s innovation processes highlights that following the re-structuring the organization benefited from enhanced internal knowledge sharing and recombination. <i>“In addition to coordinating R&D activities, the mandate of the centralized R&D function [at Novo Nordisk] also includes the codification of knowledge, the maintenance of a “talent database” of researchers with particular expertise, and the creation of companywide learning programs and other innovation facilitating assets.”</i></p> <p>However, the study also highlights that decision making in this structure was slowed down by the need for more hierarchical controls: <i>“the innovation process is such that all research moving from idea to product opportunity must be approved by the headquarters before any resources are allocated. This is a two-step process in which R&D subsidiaries first select the most promising ideas internally and then submit them as research proposals to the headquarters”.</i> (Pogrebnyakov and Kristensen, 2011)</p>
Centralization (D to C)	Johnson & Johnson - 2001	<p>The rationale the company offered for the centralization of pharmaceutical R&D in the 2001 annual report was as follows: <i>“We believe these changes will allow us to more rapidly focus on the best opportunities, aggregate and deploy substantial resources against major research programs and facilitate the sharing of scientific knowledge across the Company.”</i></p> <p>Anecdotal evidence would suggest that the structural change brought about a significantly strengthened emphasis on internal collaboration and knowledge sharing in the subsequent period. This was reflected by statements from a number of the senior executives. For instance, a 2004 article on the company described head of R&D Per Peterson as follows – <i>“Peterson feels that one of the greatest hidden assets of the company is its vast technology. He stresses the need for scientists among different sectors to talk to each other in order to take advantage of this nearly unlimited opportunity. He supports a system in which scientists interact and exchange ideas. ‘We have put together joint teams between the pharmaceutical and device sectors to work together and use the best knowledge from both groups to see if they can come up with new products,’ he says.”</i></p> <p>Similarly, J&J’s global chairman Christine Poons was quoted as saying of the re-organization, <i>“I think the organization understands that collaborating and working together is a lot more productive than not... It’s probably the most important thing we’ve set out to do. I think it’s beginning to show in the quality of our pipeline... Whether it’s a diagnostic, a device, or a drug, I think we’ll be seeing more of this convergence of technology, which will require more cross-collaboration in J&J, across the sectors. I think it will create a real competitive advantage for us.”</i> (Paoloni, 2004)</p> <p>The company also launched several “crossover” products in the period following the adoption of a centralized structure, these are products that combine expertise between different areas of R&D. For instance, two years after the restructuring, the company launched a new form of drug-coated heart stents that were the result of combined expertise from pharmaceutical and medical device R&D (Lemos, Serruys, and Sousa, 2003).</p>

Type of change	Company - Year	Impact of structural change
Centralization (D to C)	Merck - 2003	<p>In Jan 2003, two senior R&D leaders departed Merck - Edward Scolnick- Executive Vice President, Science and Technology retired, and Douglas Greene: Executive Vice President, Clinical Sciences and Product Development left to become Chief Medical Officer at Sanofi. This precipitated a unification of the company’s R&D activities under Peter Kim, who was conferred the title of President, Merck R&D. Promoting collaboration and exchange between the different parts of the R&D organization which had hitherto been separated was explicitly articulated by the company as motivation for the change. For instance, <i>“The sharing of ideas across scientific disciplines enables MRL to continue to build on our tradition of innovation. We encourage our scientists to collaborate with peers...”</i> - 2004 Merck Website.</p> <p>Centralized structures also led to some challenges as highlighted by Roger Perlmutter, reflecting on the challenges he faced upon taking over from Peter Kim as head of Merck R&D in an interview with the Wall Street Journal⁷ - <i>“Merck’s science was excellent, but the organization had become so complex that many employees didn’t even know who had authority to make decisions... Some of the complexity in Merck’s R&D unit arose because managers responsible for certain diseases, locations or technical functions, such as chemistry, had overlapping authority.”</i></p>
Decentralization (C to D)	Pfizer - 2007	<p>This re-organization was precipitated by sweeping personnel changes in the leadership of R&D, the 2007 annual report comments <i>“...John LaMattina joined Pfizer in 1977 as a bench scientist and retired in 2007 as President, Pfizer Global Research & Development... The Executive Leadership Team gained a number of new members since my last report to you. These include two outstanding Pfizer leaders as well as four prominent executives recruited from outside Pfizer.”</i> Upon the decentralization of R&D, the CEO of Pfizer highlighted that this had provided greater autonomy and impetus for decision making at lower levels of the organization: <i>“...distinct, but complementary, research organizations, led by the top scientist from each company, will provide sharper focus, less bureaucracy, and clearer accountability in drug discovery.”</i>⁸</p>
Decentralization (C to D)	Roche - 2009	<p>The objective of having a decentralized R&D structure with three “independently operated” R&D units was highlighted by the company’s 2009 annual report as being aimed to <i>“systematically pursue diverse research approaches for innovative healthcare solutions. This creates scope for creativity and increases the chances of devising sustainable medical and therapeutic progress.”</i> The different R&D organizations even joined different industry groups to emphasize the separation. The decentralization was reported to have led to more streamlined decision making across R&D, with one senior executive saying <i>“...the company has embraced the Art Levinson system of making big decisions, which mandates that one person be the decision maker, not a whole committee... Roche historically was consensus-oriented in making decisions.”</i>⁹</p> <p>However, subsequent reports from the company also highlighted that decentralization of R&D led to the creation of silos between the three divisions. This ultimately made it more difficult for managers to find the full breadth of Roche’s R&D expertise. <i>“We talk to each other, but we don’t talk about science too much. We talk about life, books and movies,”</i> Jean-</p>

⁷ <https://www.wsj.com/articles/SB10001424127887324755104579076000194129132>

⁸ <https://cen.acs.org/articles/87/i15/Pfizer-Outlines-RD-Structure.html>

⁹ <https://xconomy.com/san-francisco/2012/05/29/genentech-roche-find-new-balance-three-years-post-merger/4/>

Type of change	Company - Year	Impact of structural change
		Jacques Garaud, Roche's French/American head of pRED ¹⁰ (One of Roches' 3 R&D units)
Decentralization (C to D)	Baxter - 2012	<p>Splitting the R&D organization was focused on developing "<i>The ability to accelerate innovation and allocate necessary resources to areas presenting the highest growth potential.</i>" (2014 Annual report) as well as the "<i>Flexibility to pursue respective growth and investment strategies resulting in revenue acceleration, improved profitability and enhanced returns</i>" (2014 press release).</p> <p>The focus on speedier decision making with more flexibility for different areas of R&D were evident in the investment decisions that followed. Within a year the different parts of the R&D organization announced major partnerships focused on their specific areas - An agreement with Coherus biosciences to develop and commercialize a biosimilar to etanercept for Europe, Canada, Brazil and certain other markets, the opening of a large new recombinant protein center in Singapore¹¹, and a major investment by medical devices into an automated peritoneal dialysis (APD) system being developed in collaboration with another firm - DEKA¹².</p>

Table 3: List of control variables

Variable	Measurement	Reason for inclusion
Business Development TMT	Dummy variable set to 1 if the incumbent firm has a business development manager role within the top management team in the relevant year	Firms with centralized business development units may provide a higher level of support to startups than more ad-hoc arrangements through individual business units as has been observed for alliances and acquisitions (Kale, Dyer, and Singh, 2002; Trichterborn, Zu Knyphausen-Aufseß, and Schweizer, 2016)
Corporate Decentralization	Variable representing whether the incumbent firm is more functionally or more divisionally aligned. This variable is estimated using the composition of firms' TMTs (excluding CEO), dividing the number of business unit leads by the total size of the top management team. The greater the value of this variable, the more decentralized a firm (Albert, 2018).	More divisionalized firms with multiple business units may present even greater barriers for startups trying to find the knowledge and resources that they require and could also be correlated with R&D centralization.
R&D Size	We focus on the size of the incumbent's drug development portfolio. We operationalize this measure as the count of the number of drug candidates in an incumbent firm's development portfolio in 1000s (i.e., in pre-clinical development or Phase 1 to 3 trials) as of the focal year.	The larger the size of an incumbent firm's drug development portfolio the harder it may be for startups to locate the knowledge that they require.
External Portfolio	Proportion of drug candidates in the incumbent firms' portfolios that are externally sourced	External orientation could be related to both the way R&D is structured, and the degree of attention the incumbent pays the startup

¹⁰ <https://www.genengnews.com/news/three-years-after-merger-genentech-rd-outshines-that-of-roches/>

¹¹ <https://www.biopharma-reporter.com/Article/2014/09/12/Baxter-to-spin-off-biopharma-assets-to-form-new-Baxalta>

¹² <https://www.businesswire.com/news/home/20151013005515/en/Baxter-Announces-U.S.-FDA-Clearance-for-AMIA-Automated-Peritoneal-Dialysis-System-with-SHARESOURCE-Connectivity-Platform>

Variable	Measurement	Reason for inclusion
Incumbent Patent Stock	Discounted cumulative number of patents filed by the focal firm (in thousands) (Arora, Belenzon, and Rios, 2014)	Firms with a larger stock of patents may choose not to invest as much effort into their relationships with entrepreneurial firms associated with CVC partnerships.
Slack	Current Ratio, i.e., ratio of current assets to liabilities	Indicative of the slack resources the incumbent firm has on hand. Prior studies have indicated greater slack may enable a firm to make technology focused investments, which could impact their engagement with the startups in which they invest (Greve, 2003).
R&D Intensity	Annual spend on R&D by incumbent firms as a proportion of their annual revenues (Cohen and Levinthal, 1990)	Changes in this measure could be correlated to changes in organization design, and to the knowledge the startup can access.
New CEO	Dummy set to 1 if a firm's CEO changes in any given year, and zero if not	This could precipitate a wide range of organizational changes which could influence structure and external knowledge sharing
Performance (ROA)	Previous year's return on assets of the incumbent firm	Better performing firms may be less reliant of CVC partners and may tend to structure R&D in specific ways.
Number of Operating Segments	Total number of operating segments that established firms report in their financial statements in their annual reporting documents (Albert, 2018)	The degree to which the firm is diversified can influence the variety of knowledge the startup can access, as well as how easily that knowledge can be accessed.
CVC managers with startup experience	The number of CVC investment managers in the incumbent firm in the focal year with prior experience working in an entrepreneurial firm	Having prior experience in an entrepreneurial environment may influence the type of feedback these individuals provide to the startup and the connections they are able to facilitate within the incumbent firm.
CVC managers with R&D experience	The number of CVC investment managers in the incumbent firm in the focal year with prior experience working in the R&D division of an incumbent firm (may be the focal incumbent firm or a different one)	Prior experience in R&D may influence these individuals' connections to the R&D personnel in the incumbent firm as well their understanding of R&D and where knowledge may be located. This could shape what startups get from these partnerships.
Number of CVC Managers	Total number of CVC managers in incumbent firm.	Access to more CVC managers, regardless of experience, may facilitate startups' breadth and rate of access to incumbents' knowledge.
Startup Pre-clinical Candidates	Number of pre-clinical drug candidates startup has in its portfolio	Startups with more pre-clinical drug candidates are more likely to progress more drug candidates into Phase 1 trials.
Startup Patent Stock	Cumulative number of patents filed by the focal startup	This is likely to be related to the startup's own knowledge base as well as its attractiveness as a partner to the incumbent firm
Therapeutic Area Overlap	Degree to which the two firms overlap in the therapeutic areas they focus on. Measured as the minimum complement distance between the firms based on the proportion of active drug candidates they have in each therapeutic area (Bar and Leiponen, 2012), subtracted from 1.	A value of 0 indicates that the firms are targeting distinct therapeutic areas, whereas a value of 1 indicates perfect overlap in the therapeutic areas. This could be related to the amount of useful knowledge the startup could potentially access via the relationship as well as the incumbent firm employees' motivation to support the startup.
Patent Technological Overlap	Degree to which the two firms overlap in the classes in which they file patents. Measured as the minimum complement distance between the firms based on the proportion of their patents in each technology class (Bar and Leiponen, 2012), subtracted from 1.	Captures the degree of similarity in the firms' (incumbent and startup) technological focus which could shape the type of engagement between them

Variable	Measurement	Reason for inclusion
R&D Colocation	Binary variable equal to 1 if the startup is located in the same 2-digit zipcode as one of the incumbent firm's R&D sites. The locations of incumbent firms' R&D sites were identified based on inventor locations on the firm's patents. All locations hosting at least 1% of the firm's inventors in a year were counted as an R&D site. We manually verified the presence of R&D sites at these locations via company filings, annual reports, and online sources for firms responsible for the majority of investments in the sample.	Startups collocated with R&D unit may be better able to access the knowledge they require from the incumbent via their relationships with personnel located at these sites. Physical proximity to R&D may also be systematically correlated with the likelihood of investment under certain R&D structural configurations.

Table 4: Summary statistics (N = 2428)

Variable	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	
1. New Clinical Drug Candidates	0.118	0.329	1.00																								
2. R&D Centralization	0.867	0.340	0.06	1.00																							
3. Therapeutic Diversity Incumbent	0.805	0.126	-0.07	-0.15	1.00																						
4. Therapeutic Diversity Startup	0.132	0.268	0.48	-0.01	-0.12	1.00																					
5. Insider CVC Managers	2.263	1.678	0.10	0.04	0.24	-0.03	1.00																				
6. HQ Colocation	0.091	0.288	0.03	-0.01	-0.14	0.01	-0.06	1.00																			
7. Business Development TMT	0.252	0.434	-0.03	-0.11	-0.05	0.01	-0.28	0.10	1.00																		
8. Corporate Decentralization	0.294	0.207	-0.01	-0.07	0.66	-0.05	0.17	-0.01	-0.00	1.00																	
9. R&D Size	0.142	0.073	-0.04	-0.26	0.65	-0.04	0.06	-0.04	0.13	0.62	1.00																
10. External Portfolio	0.505	0.110	0.09	0.09	-0.26	-0.00	-0.06	0.13	0.01	-0.08	-0.29	1.00															
11. Incumbent Patent Stock	2.882	1.547	-0.02	0.03	0.61	-0.03	0.15	-0.13	-0.13	0.53	0.67	-0.21	1.00														
12. Slack	1.925	0.748	0.02	0.22	-0.46	0.09	-0.25	-0.01	-0.13	-0.49	-0.48	-0.03	-0.43	1.00													
13. R&D Intensity	0.160	0.064	0.07	0.08	-0.53	0.11	-0.32	0.15	0.14	-0.34	-0.24	0.08	-0.26	0.19	1.00												
14. New CEO	0.114	0.317	-0.07	0.02	0.09	-0.03	-0.15	0.01	0.00	-0.03	0.12	-0.04	0.09	-0.00	-0.01	1.00											
15. Performance (ROA)	0.128	0.056	-0.02	0.06	0.14	-0.07	0.54	-0.07	-0.26	0.07	-0.10	-0.06	-0.17	-0.11	-0.51	-0.13	1.00										
16. Number of Operating Segments	2.543	1.091	-0.06	0.02	0.50	-0.04	0.05	-0.13	-0.07	0.42	0.24	-0.01	0.61	-0.38	-0.37	-0.01	-0.13	1.00									
17. CVC mgrs. w. startup exp.	0.783	0.759	-0.02	0.13	-0.05	-0.02	0.53	-0.08	-0.16	-0.09	-0.11	-0.07	-0.12	-0.07	-0.09	-0.07	0.53	-0.03	1.00								
18. CVC mgrs. w. R&D exp.	2.224	1.538	0.11	0.03	0.25	0.03	0.80	-0.03	-0.10	0.28	0.26	0.03	0.29	-0.29	-0.25	-0.05	0.39	0.12	0.44	1.00							
19. No. CVC Mgrs.	6.049	2.474	-0.00	0.11	0.31	-0.09	0.68	-0.08	-0.23	0.28	0.04	0.07	0.30	-0.33	-0.30	-0.03	0.35	0.36	0.57	0.61	1.00						
20. Startup Pre-clinical Candidates	2.262	4.644	0.44	-0.02	-0.04	0.52	-0.04	-0.02	0.03	-0.00	0.01	-0.03	0.06	0.01	0.06	-0.02	-0.06	0.05	-0.03	0.03	-0.04	1.00					
21. Startup Patent Stock	0.012	0.049	-0.00	0.02	0.04	0.03	0.01	-0.04	0.01	0.00	-0.03	0.04	0.00	-0.01	-0.05	0.00	0.03	0.03	0.01	-0.00	0.04	0.03	1.00				
22. Therapeutic Area Overlap	0.128	0.193	0.37	-0.05	-0.02	0.67	-0.05	0.02	0.05	0.03	0.05	-0.05	0.07	0.04	0.12	-0.01	-0.10	0.02	-0.03	0.05	-0.08	0.69	0.00	1.00			
23. Patent Tech. Overlap	0.865	0.179	-0.17	0.03	0.09	-0.33	0.06	-0.02	-0.08	-0.03	-0.05	-0.00	-0.01	-0.06	-0.15	-0.01	0.10	0.08	0.06	-0.06	0.10	-0.35	-0.18	-0.34	1.00		
24. R&D Colocation	0.346	0.476	0.01	0.08	-0.09	-0.00	-0.09	0.38	0.00	0.05	0.03	-0.16	0.14	-0.01	0.19	0.00	-0.19	0.06	-0.02	0.00	0.01	0.07	-0.08	0.05	-0.04	1.00	

Table 5: Effect of incumbent R&D structure change on new drugs into development

DV = New Clinical Drug Candidates	1	2	3	4	5	6
R&D Centralization	0.099** (0.027)	-1.450* (0.679)	0.052** (0.014)	0.052+ (0.025)	0.093** (0.025)	-2.230** (0.613)
H1. R&D Centralization x Therapeutic Diversity Incumbent		1.799* (0.783)				2.580** (0.698)
H2. R&D Centralization x Therapeutic Diversity Startup			0.347* (0.130)			0.401** (0.115)
H3. R&D Centralization x Insider CVC Managers				0.026+ (0.012)		0.025* (0.010)
H4. R&D Centralization x HQ Colocation					0.051** (0.015)	0.058** (0.015)
Therapeutic Diversity Incumbent	-0.202 (0.179)	-1.922* (0.861)	-0.226 (0.178)	-0.217 (0.182)	-0.199 (0.178)	-2.707** (0.809)
Therapeutic Diversity Startup	0.373** (0.068)	0.372** (0.069)	0.068 (0.142)	0.373** (0.068)	0.372** (0.069)	0.019 (0.128)
Insider CVC Managers	0.019 (0.013)	0.012 (0.014)	0.018 (0.013)	-0.003 (0.017)	0.018 (0.013)	-0.013 (0.016)
Business Development TMT	-0.026 (0.032)	-0.033 (0.032)	-0.024 (0.032)	-0.029 (0.032)	-0.027 (0.032)	-0.037 (0.032)
Corporate Decentralization	0.020 (0.049)	0.019 (0.047)	0.021 (0.052)	0.017 (0.049)	0.020 (0.049)	0.018 (0.049)
R&D Size	0.121 (0.208)	0.014 (0.212)	0.188 (0.210)	0.134 (0.221)	0.126 (0.206)	0.063 (0.216)
External Portfolio	-0.145 (0.117)	-0.147 (0.120)	-0.145 (0.112)	-0.141 (0.122)	-0.148 (0.117)	-0.147 (0.117)
Incumbent Patent Stock	-0.044 (0.029)	-0.043 (0.028)	-0.040 (0.027)	-0.044 (0.030)	-0.044 (0.029)	-0.038 (0.025)
Slack	0.004 (0.009)	0.009 (0.010)	0.002 (0.010)	0.003 (0.009)	0.004 (0.009)	0.008 (0.009)
R&D Intensity	-0.052 (0.091)	-0.087 (0.100)	-0.043 (0.088)	-0.066 (0.095)	-0.054 (0.091)	-0.106 (0.097)
New CEO	0.012 (0.015)	0.017 (0.014)	0.006 (0.015)	0.015 (0.014)	0.012 (0.015)	0.014 (0.012)
Performance (ROA)	-0.478** (0.160)	-0.534** (0.174)	-0.459* (0.162)	-0.493** (0.165)	-0.480** (0.160)	-0.553** (0.174)
Number of Operating Segments	0.012 (0.015)	0.010 (0.014)	0.009 (0.017)	0.015 (0.013)	0.012 (0.015)	0.010 (0.013)
CVC mgrs w. Startup exp.	-0.042* (0.020)	-0.037* (0.019)	-0.039* (0.020)	-0.046* (0.019)	-0.042* (0.019)	-0.036* (0.018)
CVC mgrs w. R&D exp.	-0.004 (0.013)	-0.006 (0.013)	-0.004 (0.012)	-0.002 (0.012)	-0.004 (0.012)	-0.005 (0.012)
No. CVC Mgrs.	0.004 (0.005)	0.002 (0.005)	0.005 (0.005)	0.005 (0.005)	0.004 (0.005)	0.003 (0.005)
Startup Pre-clinical Candidates	-0.009 (0.008)	-0.009 (0.008)	-0.011 (0.008)	-0.009 (0.008)	-0.009 (0.008)	-0.011 (0.008)
Startup Patent Stock	-0.111 (0.136)	-0.110 (0.136)	-0.089 (0.124)	-0.116 (0.142)	-0.107 (0.136)	-0.085 (0.128)
Therapeutic Area Overlap	-0.255 (0.236)	-0.252 (0.235)	-0.246 (0.240)	-0.257 (0.234)	-0.258 (0.234)	-0.245 (0.237)
Patent Tech. Distance	-0.077 (0.056)	-0.077 (0.058)	-0.085 (0.059)	-0.080 (0.055)	-0.077 (0.056)	-0.087 (0.060)
R&D Colocation	0.003 (0.021)	0.005 (0.021)	0.003 (0.021)	0.003 (0.021)	0.003 (0.021)	0.006 (0.021)
Startup – Incumbent dyad fixed effects	Y	Y	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y	Y	Y
N	2428	2428	2428	2428	2428	2428
R ²	0.177	0.180	0.190	0.178	0.178	0.199

Standard errors values in parentheses: p-values + < 0.1, * <0.05, ** <0.01. Errors clustered at incumbent firm level. The coefficient of the interaction term (H3) in model 4 has a p value of 0.053.

Table 6: Summary of Robustness Checks

SI	Robustness test	Key result	Table
1	Dichotomized DV based on whether the startup enters a drug into trial or not (1/0)	All hypotheses continue to be supported	B1 – Models 1,2
2	<i>Therapeutic Diversity Incumbent</i> measured as entropy of incumbent’s drug development portfolio	Continues to have positive interaction effect with R&D Centralization	B1 – Models 3,4
3	Startup colocation with incumbent firm headquarters measured based on MSA rather than 2-digit zipcode	Continues to have positive interaction effect with R&D Centralization	B1 – Models 5,6
4	Interaction effect of <i>R&D Centralization</i> with <i>R&D size</i>	Positive interaction effect b/w R&D centralization and R&D size. All other hypotheses still supported.	B2 – Model 1
5	Cut-off for a CVC manager to be an ‘insider’ changed to 1 year and to 5 years (compared to 3 years in the main results)	Continues to have positive interaction effect with R&D Centralization in each case	B2 – Models 2,3
6	Drop all dyads where there are multiple R&D restructurings within a 5-year period	All hypotheses continue to be supported	B2 – Model 4
7	Drop all dyads where startup received investment from more than one corporate VC	All hypotheses continue to be supported	B3
8	Split sample approach to testing interaction effects	All hypotheses continue to be directionally supported though for two hypotheses statistical significance declines	B4
9	Negative binomial regressions with incumbent firm FE (rather than dyad FE) and split sample to test interactions	Hypotheses 1 and 4 still supported. Hypotheses 2 and 3 not supported	B5, B6
10	Wild bootstrap errors to check sensitivity to sampling	All hypotheses continue to be supported	B7
11	OLS models with DV changed to unlogged version of outcome variable	All hypotheses continue to be supported	B8 – Model 1
12	Use Proportion of Insider CVC managers rather than number.	All hypotheses continue to be supported	B8 – Model 2
13	Classify insider CVC managers based only on their prior experience in the R&D division rather than any operating experience	All hypotheses continue to be supported	B8 – Model 3
14	Control for number of startup patents to account for the inventiveness of the startup which may be time varying, and which may correlate with development opportunities	All hypotheses continue to be supported	B8 – Model 4
15	Control for period immediately after R&D structural change to control for shock spillover effects that are not specific to the direction of the structural change	All hypotheses continue to be supported	B8 – Model 5
16	Interaction effect of R&D Centralization with R&D Colocation – i.e., whether the startup is collocated with an R&D site of the incumbent firm	No significant interaction between R&D colocation and R&D centralization. Including this interaction term does not alter other results, all hypotheses continue to be supported	B9
17	Data aggregated from dyad panel to incumbent panel, DV is now mean number of drugs advanced into trial across the incumbent firm’s portfolio of CVC startups	<i>R&D Centralization</i> still has a positive and significant relationship with <i>New Clinical Drug Candidates</i>	B10
18	Descriptive comparison examining firms that centralize and decentralize their R&D units and how <i>New Clinical Drug Candidates</i> changes relative to firms that do not change their R&D structures	Increase in <i>New Clinical Drug Candidates</i> following centralization of R&D and a decrease following decentralization of R&D	Figure B1

Descriptions of each of the above tests and tables showing the results can be found in Online Appendix B

Table 7: Summary of Tests of Alternative Explanations

SI	Alternative explanation	Test	Finding	Table
1	Incumbent firms' approach to managing CVC changes in conjunction with R&D Structure change	Compare various indicators of CVC activity and personnel in the 5 years before versus after R&D structural change via t-tests	No statistically significant difference observed pre vs post R&D structure change	C1
2	R&D personnel more inclined to engage with external partners (such as CVC startups) when R&D is centralized	Compare number of externally focused TMT roles in incumbent firms (corporate dev., business dev., alliance, M&A) with centralized vs decentralized structures via t-tests	No statistically significant differences observed ($p > 0.6$ in all cases)	N/A
3	Startups partnered with incumbents having decentralized R&D move higher quality drugs into trial (though fewer in number) compared to centralized R&D	Change dependent variable to only count number of drugs into trial which are eventually commercialized	Positive but insignificant effect of R&D centralization on outcome, we would expect to see negative relationship if alternative explanation was true	C2
		t-test in full sample of startup drugs to compare whether likelihood of eventual commercialization is different depending on whether incumbent has centralized or decentralized R&D at the time the drug enters clinical trials	7% drugs entering trials when incumbent has centralized R&D are commercialized, 4% for decentralized. Difference not statistically significant. No evidence drugs entering trials when incumbent R&D is decentralized more likely to be commercialized	N/A
4	Decentralized R&D generates higher competition between incumbent and startup	Examine if the baseline effect of R&D centralization on <i>New Clinical Drug Candidates</i> varies with the level of therapeutic area overlap - the extent to which the startup and incumbent are targeting similar therapeutic areas, which is a proxy for the level of competitive forces at play between the two firms	Therapeutic area overlap has no significant interaction effect with <i>R&D Centralization</i> . Also, it has no significant direct effect on the outcome. Little evidence that competitive forces are instrumental in driving the observed results.	C3 - Mod 1,2
		New DV - <i>Incumbent Conversion PCI</i> - proportion of drug candidates that an incumbent firm progresses from pre-clinical to phase 1. Examine if <i>Startup Progress</i> - one-year lagged number of drug candidates startup progresses to Phase 1 has an impact on this outcome	No significant effect observed, no evidence of negative competitive spillover effect of startup progress on incumbent firm	C3 - Mod 3
5a	Decentralized R&D structure associated with faster exit for startups	Event history analyses examining impact of incumbent R&D structure on startup's hazard of exit via acquisition or IPO	Incumbent R&D structure does not show any significant relationship on exit in aggregate, or on IPO or acquisition individually. Main findings are robust to the exclusion of startups which exit	C4
5b	Alliance formation between incumbent and startup (which aids startups to advance drugs) more likely when incumbents have centralized R&D	New DV - binary characterization of whether the startup and incumbent form an alliance in focal period	R&D Centralization has no significant impact on alliance formation	C5
6	Incumbent firms more likely to centralize over time, and startups advance more drugs into trial over time	(a) Included dyad specific time counter variable, (b) lagged DV as control, (c) Arellano-Bond dynamic panel estimator, (d) Arellano-Bover/Blundell-Bond dynamic panel estimator	R&D centralization shows positive and significant effect on outcome across all specifications	C6
7	Heterogeneity in characteristics between dyads where incumbent R&D structure changes and those where it does not	Matching - both Coarsened Exact and Propensity Score, to restrict comparisons to dyads matching on observable characteristics and dropping all unmatched dyads	All four hypotheses continue to be supported	C7

Descriptions of each of the above tests and tables showing the results can be found in Online Appendix C.

Table 8: Temporal variation in size of R&D Centralization effect after structure change

DV	New Clinical Drug Candidates	Marginal Effect of R&D Centralization	β	p val.
R&D Centralization	0.131** (0.036)	First 2 years after	0.025	0.164
R&D Centralization x First 2y post change	-0.106* (0.040)	Years 3 & 4 after	0.094	0.003
R&D Centralization x Next 2y post change	-0.037 (0.057)	Subsequently	0.131	0.000
First 2y post change	0.015 (0.035)			
Next 2y post change	0.022 (0.045)			
Controls	Y			
Year fixed effects	Y			
Dyad Fixed Effects	Y			
N	2428			
R ²	0.138			

Standard errors in parentheses. + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$. Errors clustered at incumbent firm level.

Table 9: Effect of incumbent R&D structure change on startup patenting

DV = New Patents	1	2	3	4	5	6
R&D Centralization	-0.063 (0.041)	0.508 (1.311)	-0.106** (0.032)	-0.194** (0.067)	-0.055 (0.050)	-0.144 (1.501)
H1. R&D Centralization x Therapeutic Diversity Incumbent		-0.663 (1.519)				-0.112 (1.735)
H2. R&D Centralization x Therapeutic Diversity Startup			0.316 (0.188)			0.321 (0.194)
H3. R&D Centralization x Insider CVC Managers				0.073* (0.027)		0.078* (0.030)
H4. R&D Centralization x HQ Colocation					-0.062 (0.216)	-0.053 (0.223)
Controls	Y	Y	Y	Y	Y	Y
Startup - Incumbent dyad fixed effects	Y	Y	Y	Y	Y	Y
Year fixed effects	Y	Y	Y	Y	Y	Y
N	2428	2428	2428	2428	2428	2428
R ²	0.152	0.152	0.154	0.153	0.152	0.156

Standard errors in parentheses. + $p < 0.1$, * $p < 0.05$, ** $p < 0.01$. Errors clustered at incumbent firm level.

Figure 1: Development Timeline for Galera Therapeutics (see Online Appendix A)

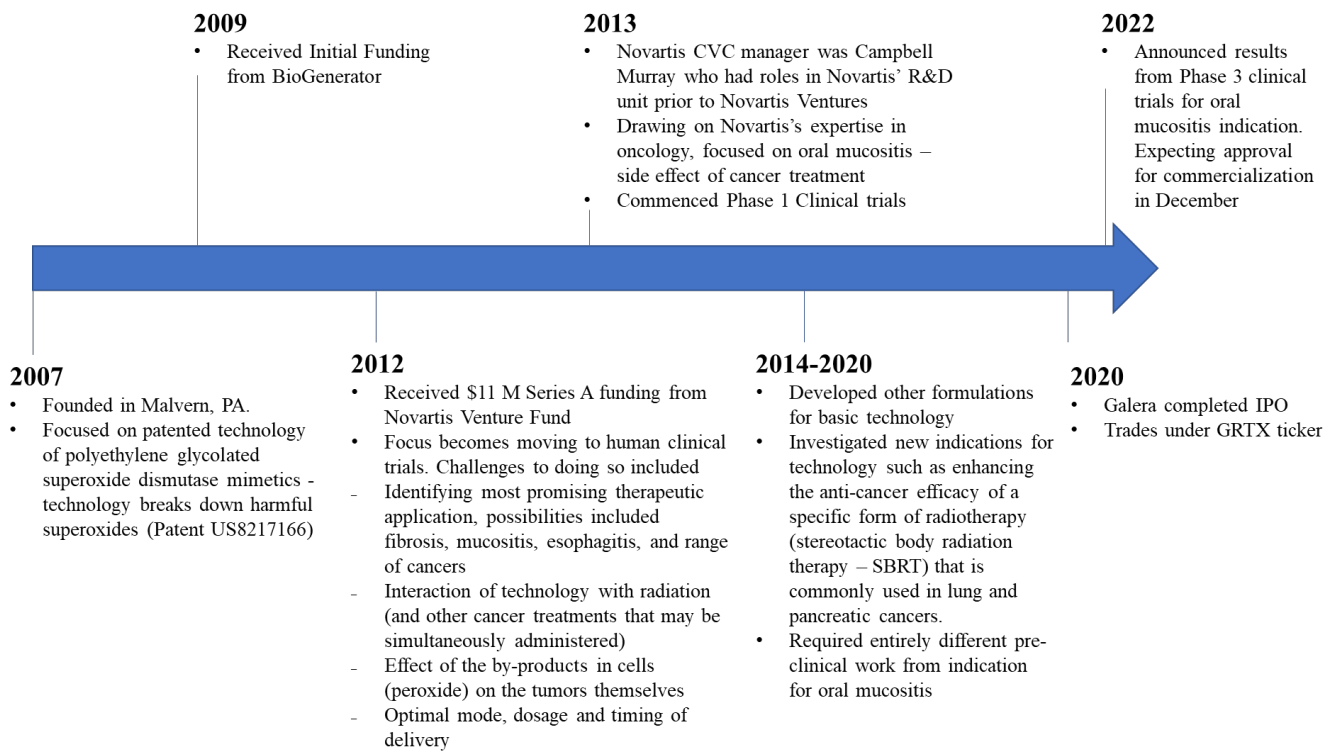


Figure 2: Summary of Theorized Relationships

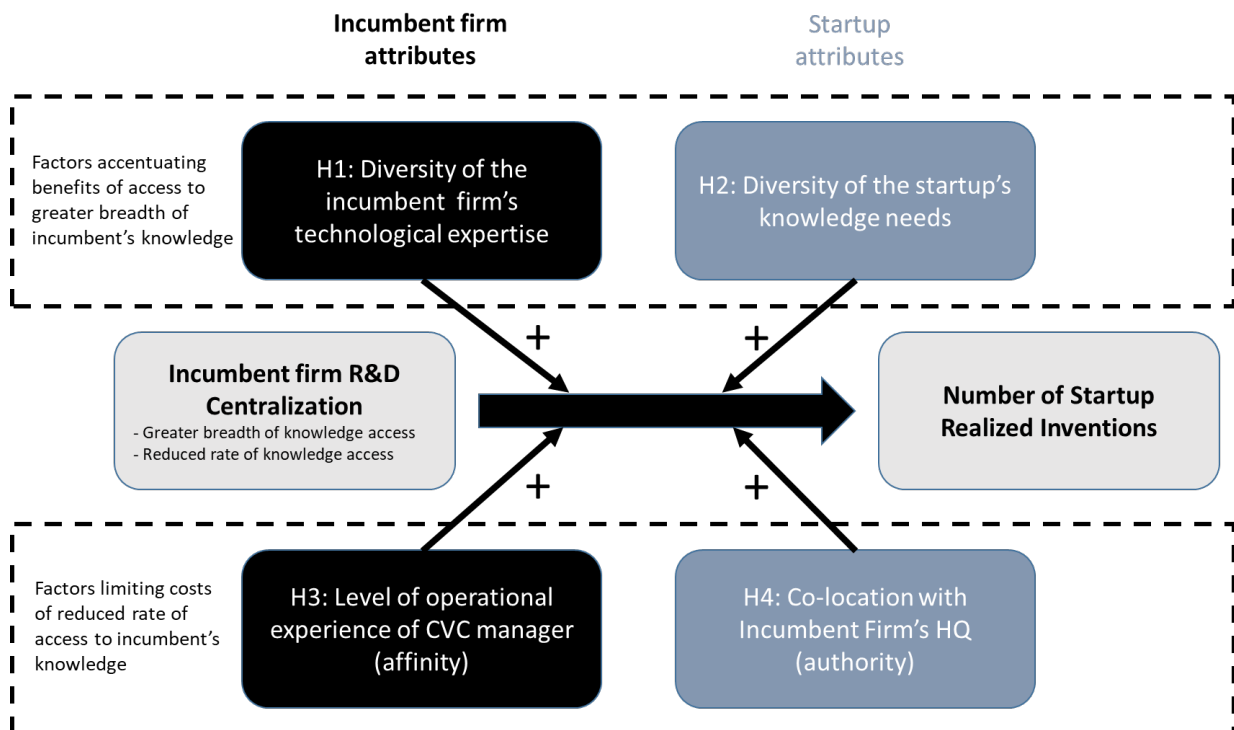


Figure 3: Examination of differences in *New Clinical Drug Candidates* for firms with centralized and decentralized R&D units, above and below the median values of the four hypothesis moderators using raw data. $\Delta\Delta$ represents the difference in differences between firms with centralized and decentralized R&D units, above and below the median value of the moderator, i.e. $[(Cent_{above} - Cent_{below}) - (Decent_{above} - Decent_{below})]$

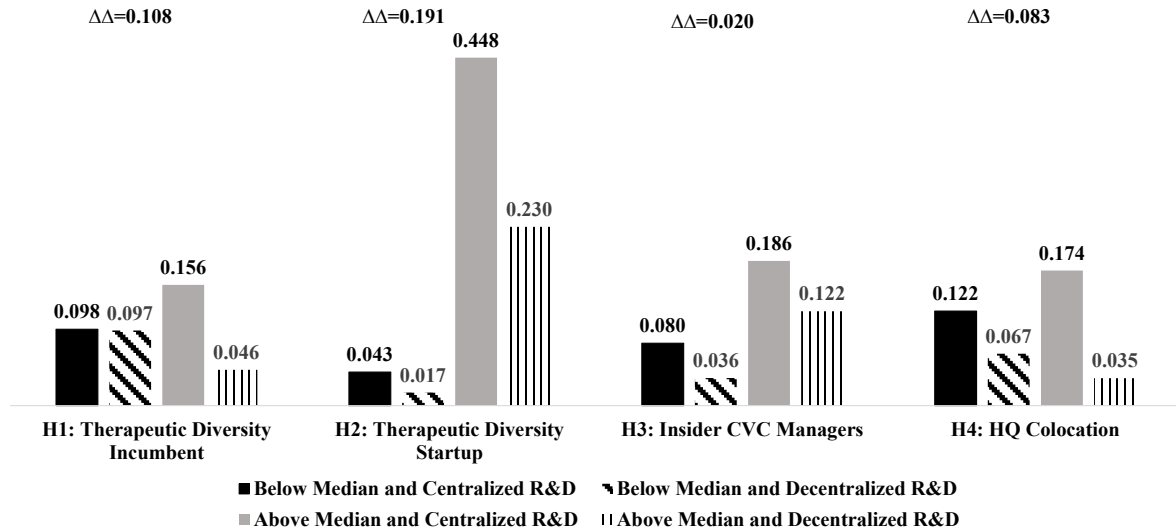


Figure 4: Interaction of *R&D Centralization* with *Therapeutic Diversity Incumbent*

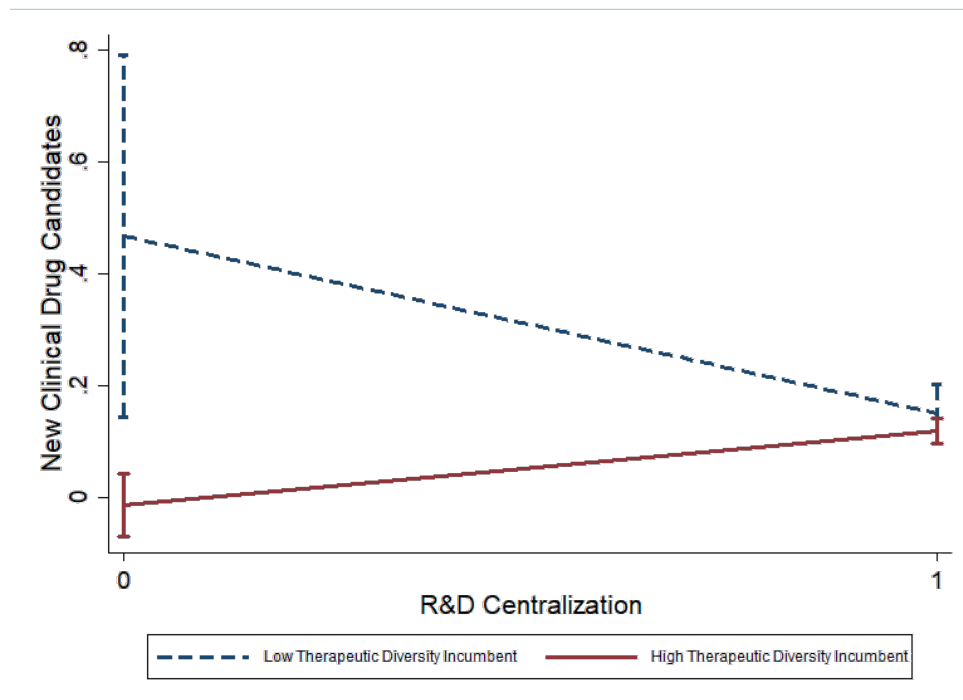


Figure 5: Interaction of *R&D Centralization* with *Therapeutic Diversity Startup*

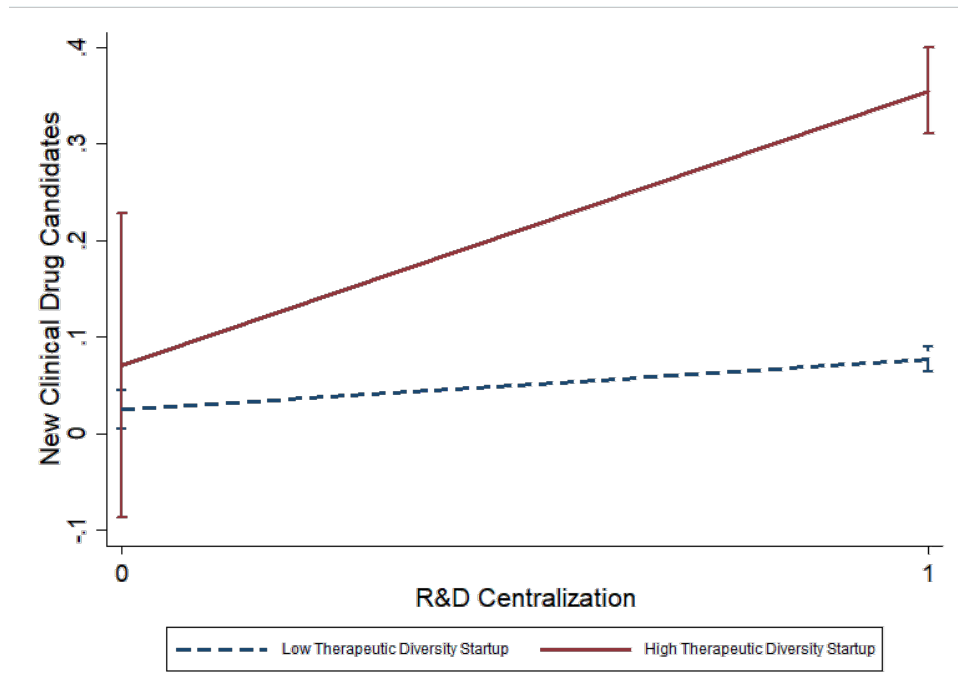


Figure 6 Interaction of *R&D Centralization* with *Insider CVC Managers*

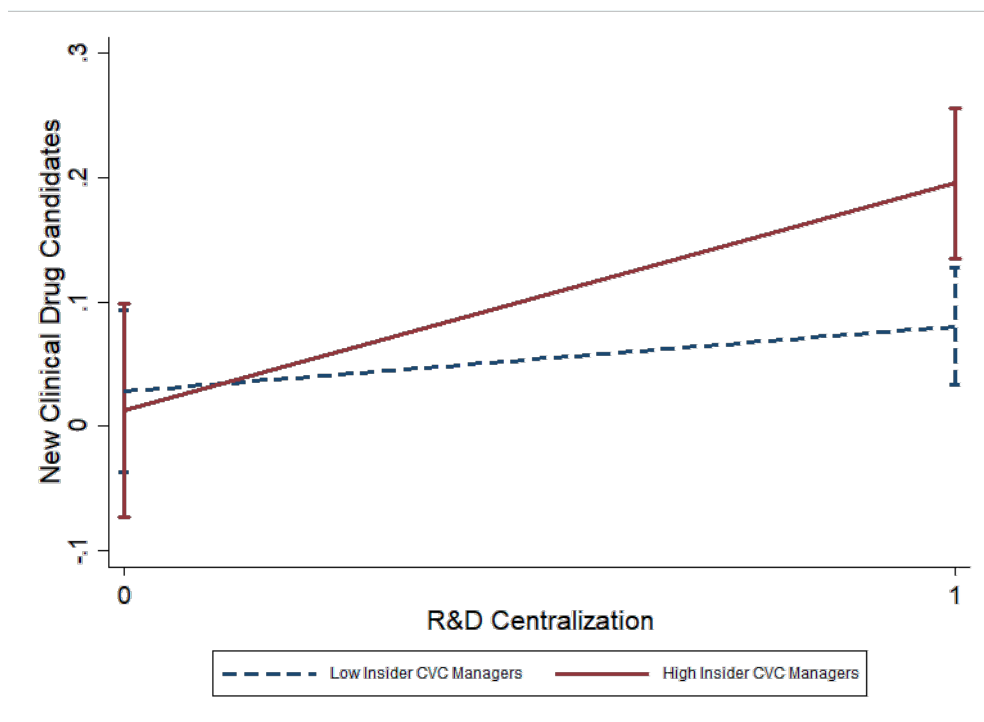


Figure 7: Interaction of R&D Centralization with HQ Colocation

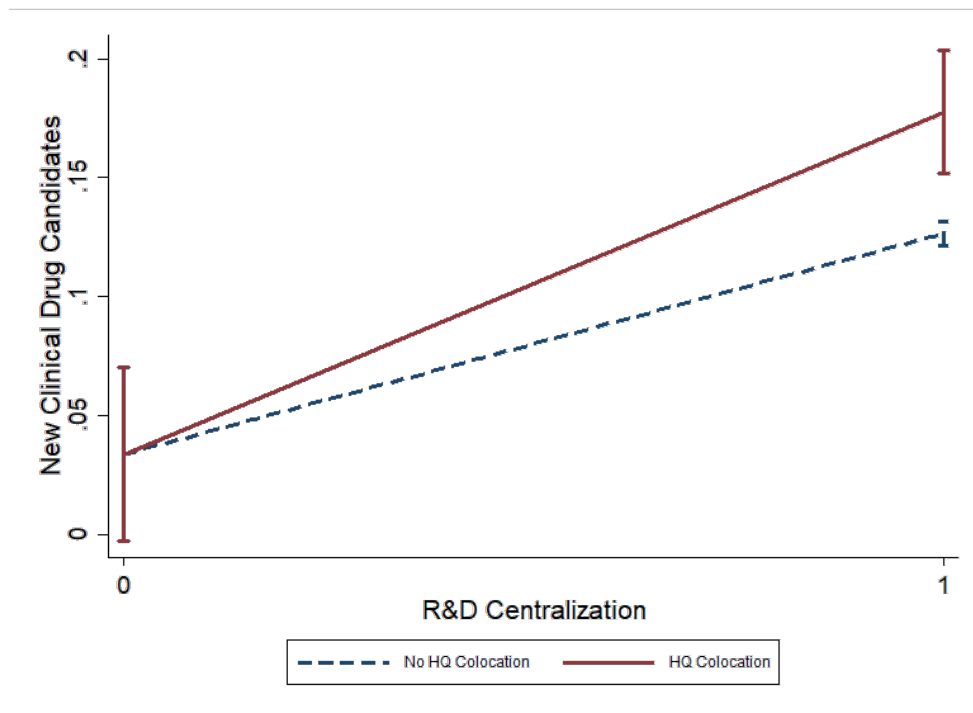
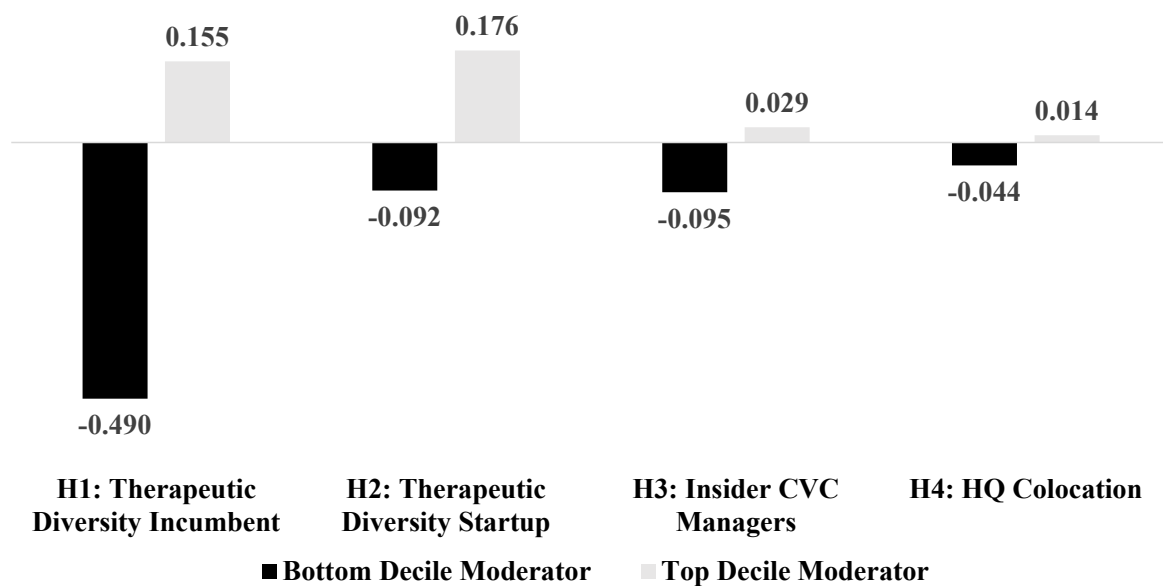


Figure 8: Examination of how the difference in *New Clinical Drug Candidates* between firms with centralized and decentralized R&D units varies between top decile and bottom decile values of the four hypothesis moderators using regression Model 6 in Table 5



REFERENCES

- Adams, J. S.
1976 "The structure and dynamics of behavior in organizational boundary roles." *Handbook of industrial and organizational psychology*, 1175: 1199.
- Adler, P. S. and B. Borys
1996 "Two types of bureaucracy: Enabling and coercive." *Administrative Science Quarterly*: 61-89.
- Aggarwal, V. A., D. H. Hsu, and A. Wu
2020 "Organizing knowledge production teams within firms for innovation." *Strategy Science*, 5: 1-16.
- Aghion, P. and J. Tirole
1997 "Formal and real authority in organizations." *Journal of Political Economy*, 105: 1-29.
- Albert, D.
2018 "Organizational module design and architectural inertia: Evidence from structural recombination in universal banking." *Organization Science*.
- Aldrich, H. and D. Herker
1977 "Boundary spanning roles and organization structure." *Academy of Management Review*, 2: 217-230.
- Alvarez-Garrido, E. and G. Dushnitsky
2016 "Are entrepreneurial venture's innovation rates sensitive to investor complementary assets? Comparing biotech ventures backed by corporate and independent VCs." *Strategic Management Journal*, 37: 819-834.
- Argote, L., M. E. Turner, and M. Fichman
1989 "To centralize or not to centralize: The effects of uncertainty and threat on group structure and performance." *Organizational behavior and human decision processes*, 43: 58-74.
- Argyres, N., L. A. Rios, and B. S. Silverman
2020 "Organizational change and the dynamics of innovation: Formal R&D structure and intrafirm inventor networks." *Strategic Management Journal*, 41: 2015-2049.
- Argyres, N. S. and B. S. Silverman
2004 "R&D, organization structure, and the development of corporate technological knowledge." *Strategic Management Journal*, 25: 929-958.
- Arora, A., S. Belenzon, and L. A. Rios
2014 "Make, buy, organize: The interplay between research, external knowledge, and firm structure." *Strategic Management Journal*, 35: 317-337.
- Astley, W. G. and E. J. Zajac
1991 "Intraorganizational power and organizational design: Reconciling rational and coalitional models of organization." *Organization Science*, 2: 399-411.
- Baker, T. and R. E. Nelson
2005 "Creating something from nothing: Resource construction through entrepreneurial bricolage." *Administrative science quarterly*, 50: 329-366.
- Balachandran, S.
2018 "Pipes or Shackles? How Ties to Incumbents Shape Startup Innovation." Working Paper.
- Balachandran, S.
2023 "The Inside Track: Entrepreneurs' Corporate Experience and Startups' Access to Incumbent Partners' Resources." Working Paper.
- Baldwin, C. Y.
2007 "Where do transactions come from? Modularity, transactions, and the boundaries of firms." *Industrial and Corporate Change*, 17: 155-195.
- Bar, T. and A. Leiponen
2012 "A measure of technological distance." *Economics letters*, 116: 457-459.
- Barden, J. Q. and W. Mitchell
2007 "Disentangling the influences of leaders' relational embeddedness on interorganizational exchange." *Academy of Management journal*, 50: 1440-1461.
- Barge-Gil, A. and A. López

- 2015 "R versus D: estimating the differentiated effect of research and development on innovation results." *Industrial and Corporate Change*, 24: 93-129.
- Barley, S. R.
1990 "The alignment of technology and structure through roles and networks." *Administrative Science Quarterly*: 61-103.
- Barney, J. and T. Felin
2013 "What are microfoundations?" *Academy of Management Perspectives*, 27: 138-155.
- Baum, J. R. and S. Wally
2003 "Strategic Decision Speed and Firm Performance." *Strategic Management Journal*, 24: 1107-1129.
- Bernstein, S., X. Giroud, and R. R. Townsend
2016 "The impact of venture capital monitoring." *The journal of Finance*, 71: 1591-1622.
- Blau, P. M. and R. Schoenherr
1971 *The Structure of Organizations*. NY. USA: Basic Books.
- Bloom, N., R. Sadun, and J. Van Reenen
2012 "Americans do IT better: US multinationals and the productivity miracle." *American economic review*, 102: 167-201.
- Bouquet, C. and J. Birkinshaw
2008 "Weight versus voice: How foreign subsidiaries gain attention from corporate headquarters." *Academy of Management journal*, 51: 577-601.
- Burt, R. S.
2005 *Brokerage and closure: An introduction to social capital*: Oxford University Press.
- Burton, M. D., M. G. Colombo, C. Rossi-Lamastra, and N. Wasserman
2019 "The organizational design of entrepreneurial ventures." *Strategic Entrepreneurship Journal*, 13: 243-255.
- Burton, R. M. and B. Obel
2004 *Strategic organizational diagnosis and design: The dynamics of fit*: Springer Science & Business Media.
- Burton, R. M., B. Obel, and G. DeSanctis
2011 *Organizational Design: A Step-by-Step Approach*, 2nd ed. Cambridge, UK: Cambridge University Press.
- Cai, J. and A. Szeidl
2018 "Interfirm relationships and business performance." *The Quarterly Journal of Economics*, 133: 1229-1282.
- Cardinal, L. B., S. F. Turner, M. J. Fern, and R. M. Burton
2011 "Organizing for product development across technological environments: Performance trade-offs and priorities." *Organization Science*, 22: 1000-1025.
- Chandy, R., B. Hopstaken, O. Narasimhan, and J. Prabhu
2006 "From invention to innovation: Conversion ability in product development." *Journal of marketing research*, 43: 494-508.
- Chesbrough, H. W.
2006 *Open innovation: The new imperative for creating and profiting from technology*: Harvard Business Press.
- Chhibber, P. and K. Kollman
1998 "Party aggregation and the number of parties in India and the United States." *American political science review*, 92: 329-342.
- Child, J.
1973 "Predicting and understanding organization structure." *Administrative Science Quarterly*: 168-185.
- Clark, K. D., K. G. Smith, and C. Oliver
2003 "Top management team social networks and organizational innovation: an information theory explanation of TMT value creation." *Administrative Science Quarterly*, 26.
- Cohen, M. D., J. G. March, and J. P. Olsen
1972 "A garbage can model of organizational choice." *Administrative Science Quarterly*: 1-25.
- Cohen, W. M. and D. A. Levinthal

- 1990 "Absorptive Capacity: A new perspective on learning and capacity." *Administrative Science Quarterly*, 35: 128-152.
- Csaszar, F. A.
2013 "An Efficient Frontier in Organization Design: Organizational Structure as a Determinant of Exploration and Exploitation." *Organization Science*, 24: 1083-1101.
- Cummings, S.
1995 "Centralization and decentralization: The neverending story of separation and betrayal." *Scandinavian Journal of Management*, 11: 103-117.
- Cunningham, C., F. Ederer, and S. Ma
2021 "Killer acquisitions." *Journal of Political Economy*, 129: 649-702.
- Daft, R. L. and A. Y. Lewin
1993 "Where are the theories for the "new" organizational forms? An editorial essay." *Organization Science*: i-vi.
- Damanpour, F.
1991 "Organizational Innovation: A Meta-Analysis of Effects of Determinants and Moderators." *Academy of Management journal*, 34: 555-590.
- Damanpour, F. and D. Aravind
2012 "Organizational structure and innovation revisited: From organic to ambidextrous structure." *Handbook of organizational creativity*, 15: 502-503.
- Dattée, B., J.-L. Arrègle, P. Barbieri, T. C. Lawton, and D. N. Angwin
2022 "The Dynamics of Organizational Autonomy: Oscillations at Automobili Lamborghini." *Administrative Science Quarterly*: 00018392221091850.
- Denrell, J., C. Fang, and S. G. Winter
2003 "The Economics of Startegic Opportunity." *Strategic Management Journal*, 24: 977-990.
- DeSanctis, G., J. T. Glass, and I. M. Ensing
2002 "Organizational designs for R&D." *The Academy of Management Executive*, 16: 55-66.
- DeSantola, A. and R. Gulati
2017 "Scaling: Organizing and growth in entrepreneurial ventures." *Academy of management Annals*, 11: 640-668.
- Dougherty, D.
1992 "Interpretive barriers to successful product innovation in large firms." *Organization Science*, 3: 179-202.
- Drover, W., L. Busenitz, S. Matusik, D. Townsend, A. Anglin, and G. Dushnitsky
2017 "A review and road map of entrepreneurial equity financing research: venture capital, corporate venture capital, angel investment, crowdfunding, and accelerators." *Journal of Management*, 43: 1820-1853.
- Dushnitsky, G.
2012 "Corporate venture capital in the 21st century: an integral part of firms' innovation toolkit." *Oxford handbooks: The Oxford handbook of venture capital*: 156-210.
- Dushnitsky, G. and M. J. Lenox
2005 "When do firms undertake R&D by investing in new ventures?" *Strategic Management Journal*, 26: 947-965.
- Dushnitsky, G. and Z. B. Shapira
2010 "Entrepreneurial Finance Meets Organizational Reality: Comparing Investment Practices and Performance of Corporate and Independent Venture Capitalists." *Strategic Management Journal*, 31: 990-1017.
- Dyer, J. H. and K. Nobeoka
2000 "Creating and managing a high-performance knowledge-sharing network: the Toyota case." *Strategic Management Journal*, 21: 345-367.
- Edwards, B.
2007 "The future of hearing aid technology." *Trends in amplification*, 11: 31-45.
- Eisenhardt, K. M.
1989 "Building Theories from Case Study Research." *Academy of Management Review*, 14: 532-550.
- Eisenhardt, K. M., N. R. Furr, and C. B. Bingham

- 2010 "CROSSROADS—Microfoundations of performance: Balancing efficiency and flexibility in dynamic environments." *Organization Science*, 21: 1263-1273.
- Eklund, J. and R. Kapoor
2022 "Mind the Gaps: How Organization Design Shapes the Sourcing Of Inventions." *Organization Science*, 33: 1319-1339.
- Eklund, J. C.
2022 "The knowledge-incentive tradeoff: Understanding the relationship between research and development decentralization and innovation." *Strategic Management Journal*.
- Feldman, E. R., C. Gartenberg, and J. Wulf
2018 "Pay inequality and corporate divestitures." *Strategic Management Journal*, 39: 2829-2858.
- Festinger, L., S. Schachter, and K. Back
1950 "Social pressures in informal groups; a study of human factors in housing."
- Fleming, L.
2001 "Recombinant uncertainty in technological search." *Management Science*, 47: 117-132.
- Fleming, L. and O. Sorenson
2004 "Science as a map in technological search." *Strategic Management Journal*, 25: 909-928.
- Funk, R. J.
2014 "Making the most of where you are: Geography, networks, and innovation in organizations." *Academy of Management journal*, 57: 193-222.
- Galbraith, J.
1973 "Designing complex organizations." Reading, Mass.
- Galbraith, J. R.
1977 *Organization design*: Addison Wesley Publishing Company.
- Gans, J. S. and S. Stern
2003 "The product market and the market for "ideas": commercialization strategies for technology entrepreneurs." *Research Policy*, 32: 333-350.
- Garicano, L.
2000 "Hierarchies and the Organization of Knowledge in Production." *Journal of Political Economy*, 108: 874-904.
- Garicano, L. and E. Rossi-Hansberg
2004 "Inequality and the Organization of Knowledge." *American economic review*, 94: 197-202.
- Garicano, L. and E. Rossi-Hansberg
2006 "Organization and inequality in a knowledge economy." *The Quarterly Journal of Economics*, 121: 1383-1435.
- Garicano, L. and Y. Wu
2012 "Knowledge, Communication, and Organizational Capabilities." *Organization Science*, 23: 1382-1397.
- Garud, R., P. Tuertscher, and A. H. Van de Ven
2013 "Perspectives on innovation processes." *Academy of management Annals*, 7: 775-819.
- Gavetti, G.
2005 "Cognition and hierarchy: Rethinking the microfoundations of capabilities' development." *Organization Science*, 16: 599-617.
- Ghosh, A. and L. Rosenkopf
2014 "PERSPECTIVE—shrouded in structure: challenges and opportunities for a friction-based view of network research." *Organization Science*, 26: 622-631.
- Gibson, C. B., P. D. Dunlop, and J. L. Cordery
2019 "Managing formalization to increase global team effectiveness and meaningfulness of work in multinational organizations." *Journal of International Business Studies*, 50: 1021-1052.
- Girod, S. J. and R. Whittington
2015 "Change escalation processes and complex adaptive systems: From incremental reconfigurations to discontinuous restructuring." *Organization Science*, 26: 1520-1535.
- Giroud, X.
2013 "Proximity and investment: Evidence from plant-level data." *The Quarterly Journal of*

- Economics, 128: 861-915.
- Glaser, B. G. and A. L. Strauss
1967 "The discovery of grounded theory: Strategies for qualitative research." Chicago: Aldine.
- Gould, R. V.
1996 "Patron-client ties, state centralization, and the whiskey rebellion." *American Journal of Sociology*, 102: 400-429.
- Greve, H. R.
2003 *Organizational learning from performance feedback: A behavioral perspective on innovation and change*: Cambridge University Press.
- Guadalupe, M., H. Y. Li, and J. Wulf
2014 "Who Lives in the C-Suite? Organizational Structure and the Division of Labor in Top Management." *Management Science*, 60: 824-844.
- Gulati, R., D. Lavie, and R. R. Madhavan
2011 "How do networks matter? The performance effects of interorganizational networks." *Research in Organizational Behavior*, 31: 207-224.
- Gulati, R. and P. Puranam
2009 "Renewal through reorganization: The value of inconsistencies between formal and informal organization." *Organization Science*, 20: 422-440.
- Gulati, R., M. Sytch, and P. Mehrotra
2008 "Breaking up is never easy: Planning for exit in a strategic alliance." *California Management Review*, 50: 147-163.
- Hage, J. and M. Aiken
1967 "Relationship of centralization to other structural properties." *Administrative Science Quarterly*: 72-92.
- Hansen, M. T. and M. R. Haas
2001 "Competing for attention in knowledge markets: Electronic document dissemination in a management consulting company." *Administrative Science Quarterly*, 46: 1-28.
- Helfat, C. E. and M. Campo-Rembado
2010 "Integrative capabilities, vertical integration, and innovation over successive technology lifecycles."
- Hounshell, D. A. and J. K. Smith
1989 *Science and corporate strategy*, 1 ed. Cambridge, UK: Cambridge Books.
- Hsu, D. H. and R. H. Ziedonis
2013 "Resources as dual sources of advantage: Implications for valuing entrepreneurial-firm patents." *Strategic Management Journal*, 34: 761-781.
- Hughes, J. and J. Weiss
2007 "Simple rules for making alliances work." *Harvard Business Review*, 85: 122.
- Iansiti, M. and J. West
1997 "Technology integration: Turning great research into great products." *Harvard Business Review*, 75: 69-79.
- Jaffe, A. B., M. Trajtenberg, and R. Henderson
1993 "Geographic Localization of Knowledge Spillovers as Evidenced by Patent Citations." *The Quarterly Journal of Economics*, 108: 577-598.
- Jensen, M. C. and W. H. Meckling
1992 "Specific and general knowledge and organizational structure." *Social Science Research Network (SSRN)*, Abstract 6658.
- Joseph, J., R. Klingebiel, and A. J. Wilson
2016 "Organizational Structure and Performance Feedback: Centralization, Aspirations, and Termination Decisions." *Organization Science*, 27: 1065-1083.
- Juillerat, T. L.
2010 "Friends, not foes?: Work design and formalization in the modern work context." *Journal of Organizational Behavior*, 31: 216-239.
- Kale, P., J. H. Dyer, and H. Singh
2002 "Alliance capability, stock market response, and long-term alliance success: the role of the alliance function." *Strategic Management Journal*, 23: 747-767.

- Kalnins, A. and F. Lafontaine
2013 "Too far away? The effect of distance to headquarters on business establishment performance." *American Economic Journal: Microeconomics*, 5: 157-179.
- Kaplan, S. N. and J. Lerner
2016 "Venture capital data: Opportunities and challenges." National Bureau of Economic Research.
- Kapoor, R. and N. R. Furr
2015 "Complementarities and competition: Unpacking the drivers of entrants' technology choices in the solar photovoltaic industry." *Strategic Management Journal*, 36: 416-436.
- Kapoor, R. and T. Klueter
2015 "Decoding the Adaptability-Rigidity Puzzle: Evidence from Pharmaceutical Incumbents' Pursuit of Gene Therapy and Monoclonal Antibodies." *Academy of Management journal*, 58: 1180-1207.
- Karim, S. and A. Kaul
2015 "Structural Recombination and Innovation: Unlocking Intraorganizational Knowledge Synergy Through Structural Change." *Organization Science*, 26: 439-455.
- Katila, R., J. D. Rosenberger, and K. M. Eisenhardt
2008 "Swimming with Sharks: Technology Ventures, Defense Mechanisms and Corporate Relationships." *Administrative Science Quarterly*, 53: 295-332.
- Kay, N.
1988 "The R&D function: corporate strategy and structure." In D. G. F. C, N. R, S. G, and S. C (eds.), *Technical change and economic theory*: 283-294. London: Pinter.
- Kelly, L., C. Medina, and D. Cameron
2014 *Rebels at work: A handbook for leading change from within*: "O'Reilly Media, Inc."
- Kim, C. M., C. Cunningham, and J. E. Joseph
2022 "Corporate Proximity and Product Market Reentry: The Role of Corporate Headquarters in Business Unit Response to Product Failure." *Academy of Management journal*.
- Kleinbaum, A. M. and T. E. Stuart
2014 "Inside the black box of the corporate staff: Social networks and the implementation of corporate strategy." *Strategic Management Journal*, 35: 24-47.
- Klueter, T., L. F. Monteiro, and D. R. Dunlap
2017 "Standard vs. partnership-embedded licensing: Attention and the relationship between licensing and product innovations." *Research Policy*, 46: 1629-1643.
- Kownatzki, M., J. Walter, S. W. Floyd, and C. Lechner
2013 "Corporate control and the speed of strategic business unit decision making." *Academy of Management journal*, 56: 1295-1324.
- Lavie, D. and L. Rosenkopf
2006 "Balancing exploration and exploitation in alliance formation." *Academy of Management journal*, 49: 797-818.
- Lawrence, P. R. and J. W. Lorsch
1967 "Organization and Environment: Managing Differentiation and Integration (Harvard Business School Classics)."
- Lee, S.
2022 "The myth of the flat start-up: Reconsidering the organizational structure of start-ups." *Strategic Management Journal*, 43: 58-92.
- Lemos, P. A., P. W. Serruys, and J. E. Sousa
2003 "Drug-eluting stents: cost versus clinical benefit." *Circulation*, 107: 3003-3007.
- Lerner, J.
2013 "Corporate Venturing." *Harvard Business Review*, 91: 86-94.
- Lerner, J. and J. Wulf
2007 "Innovation and incentives: Evidence from corporate R&D." *The Review of Economics and Statistics*, 89: 634-644.
- Levinthal, D. A.
1997 "Adaptation on Rugged Landscapes." *Management Science*, 43: 934-950.
- Lifshitz-Assaf, H.

- 2018 "Dismantling knowledge boundaries at NASA: The critical role of professional identity in open innovation." *Administrative Science Quarterly*, 63: 746-782.
- Lin, X. and R. Germain
2003 "Organizational structure, context, customer orientation, and performance: lessons from Chinese state-owned enterprises." *Strategic Management Journal*, 24: 1131-1151.
- Lumineau, F. and N. Oliveira
2018 "A pluralistic perspective to overcome major blind spots in research on interorganizational relationships." *Academy of management Annals*, 12: 440-465.
- Lungeanu, R. and E. J. Zajac
2019 "Thinking broad and deep: Why some directors exert an outsized influence on strategic change." *Organization Science*, 30: 489-508.
- Macher, J. T. and C. Boerner
2012 "Technological development at the boundaries of the firm: a knowledge-based examination in drug development." *Strategic Management Journal*, 33: 1016-1036.
- Macher, J. T. and C. S. Boerner
2006 "Experience and scale and scope economies: trade-offs and performance in development." *Strategic Management Journal*, 27: 845-865.
- Mansfield, R.
1973 "Bureaucracy and centralization: An examination of organizational structure." *Administrative Science Quarterly*: 477-488.
- Manso, G.
2011 "Motivating Innovation." *Journal of Finance*, 66: 1823-1860.
- March, J. G.
1962 "The business firm as a political coalition." *The Journal of Politics*, 24: 662-678.
- March, J. G. and H. A. Simon
1958 *Organizations*. New York: John Wiley & Sons.
- McEvily, B., G. Soda, and M. Tortoriello
2014 "More formally: Rediscovering the missing link between formal organization and informal social structure." *Academy of management Annals*, 8: 299-345.
- Mintzberg, H.
1980 "Structure in 5's: A Synthesis of the Research on Organization Design." *Management Science*, 26: 322-341.
- Nickerson, J. A. and T. R. Zenger
2002 "Being efficiently fickle: A dynamic theory of organizational choice." *Organization Science*, 13: 547-566.
- Owen-Smith, J. and W. W. Powell
2004 "Knowledge networks as channels and conduits: The effects of spillovers in the Boston biotechnology community." *Organization Science*, 15: 5-21.
- Pahnke, E. C., R. Katila, and K. M. Eisenhardt
2015 "Who takes you to the dance? How partners' institutional logics influence innovation in young firms." *Administrative Science Quarterly*, 60: 596-633.
- Paoloni, E.
2004 "Standing Out, Fitting In." *Pharmaceutical Executive*, 24: 3-7.
- Pennings, J. M.
1976 "Dimensions of organizational influence and their effectiveness correlates." *Administrative Science Quarterly*: 688-699.
- Perrone, V., A. Zaheer, and B. McEvily
2003 "Free to be trusted? Organizational constraints on trust in boundary spanners." *Organization Science*, 14: 422-439.
- Petrova, E.
2014 "Innovation in the pharmaceutical industry: The process of drug discovery and development." *Innovation and marketing in the pharmaceutical industry: 19-81*: Springer.
- Pfeffer, J. and C. Lammerding
1981 *Power in organizations*: Pitman Marshfield, MA.
- Pfeffer, J. and R. I. Sutton

- 1999 *The knowing-doing gap: How smart companies turn knowledge into action*: Harvard business press.
- Phelps, C., R. Heidl, and A. Wadhwa
2012 "Knowledge, networks, and knowledge networks: A review and research agenda." *Journal of Management*, 38: 1115-1166.
- Podolny, J. M.
2001 "Networks as the pipes and prisms of the market." *American Journal of Sociology*, 107: 33-60.
- Podolny, J. M. and K. L. Page
1998 "Network forms of organization." *Annual Review of Sociology*, 24: 57-76.
- Pogrebnyakov, N. and J. D. Kristensen
2011 "Building innovation subsidiaries in emerging markets: The experience of Novo Nordisk." *Research-Technology Management*, 54: 30-37.
- Pontikes, E. G. and W. P. Barnett
2017 "The coevolution of organizational knowledge and market technology." *Strategy Science*, 2: 64-82.
- Powell, W. W., K. W. Koput, and L. Smith-Doerr
1996 "Interorganizational Collaboration and the Locus of Innovation: Networks of Learning in Biotechnology." *Administrative Science Quarterly*, 41: 116-145.
- Powell, W. W., D. R. White, K. W. Koput, and J. Owen-Smith
2005 "Network dynamics and field evolution: The growth of interorganizational collaboration in the life sciences." *American Journal of Sociology*, 110: 1132-1205.
- Puranam, P.
2018 *The microstructure of organizations*: Oxford University Press.
- Puranam, P., O. Alexy, and M. Reitzig
2014 "What's "New" About New Forms of Organizing?" *Academy of Management Review*, 39: 162-180.
- Puranam, P., H. Singh, and M. Zollo
2006 "Organizing for innovation: Managing the coordination-autonomy dilemma in technology acquisitions." *Academy of Management journal*, 49: 263-280.
- Raisch, S. and J. Birkinshaw
2008 "Organizational ambidexterity: Antecedents, outcomes, and moderators." *Journal of Management*, 34: 375-409.
- Raveendran, M., L. Silvestri, and R. Gulati
2020 "The role of interdependence in the micro-foundations of organization design: task, goal, and knowledge interdependence." *Academy of management Annals*, 14: 828-868.
- Rothaermel, F. T. and D. L. Deeds
2004 "Exploration and exploitation alliances in biotechnology: A system of new product development." *Strategic Management Journal*, 25: 201-221.
- Sah, R. K. and J. E. Stiglitz
1986 "The architecture of economic systems: Hierarchies and polyarchies." *The American Economic Review*: 716-727.
- Schumpeter, J. A.
1934 *The theory of economic development: An inquiry into profits, capital, credit, interest, and the business cycle*. Cambridge, MA: Harvard University Press.
- Sengul, M. and J. Gimeno
2013 "Constrained delegation: Limiting subsidiaries' decision rights and resources in firms that compete across multiple industries." *Administrative Science Quarterly*, 58: 420-471.
- Shane, S.
2000 "Prior knowledge and the discovery of entrepreneurial opportunities." *Organization science*, 11: 448-469.
- Simon, H. A.
1947 *Administrative behavior*, 1st ed. New York: Macmillan New York.
- Simon, H. A.
1991 "Bounded rationality and organizational learning." *Organization Science*, 2: 125-134.

- Smith-Doerr, L. and W. W. Powell
2010 "17 Networks and Economic Life." *The handbook of economic sociology*: 379.
- Strebulaev, I. A. and A. Wang
2021 "Organizational structure and decision-making in corporate venture capital." Available at SSRN 3963514.
- Sytch, M. and Y. H. Kim
2021 "Quo Vadis? From the Schoolyard to the Courtroom." *Administrative Science Quarterly*, 66: 177-219.
- Sytch, M., F. Wohlgezogen, and E. J. Zajac
2018 "Collaborative by Design? How Matrix Organizations See/Do Alliances." *Organization Science*, 29: 1130-1148.
- Szulanski, G.
1996 "Exploring internal stickiness: Impediments to the transfer of best practice within the firm." *Strategic Management Journal*, 17: 27-43.
- Ter Wal, A. L., P. Criscuolo, B. McEvily, and A. Salter
2020 "Dual Networking: How Collaborators Network in Their Quest for Innovation." *Administrative Science Quarterly*: 0001839219893691.
- Thompson, J. D.
1967 *Organizations in action: Social science bases of administrative theory*.
- Tortoriello, M. and D. Krackhardt
2010 "Activating cross-boundary knowledge: The role of Simmelian ties in the generation of innovations." *Academy of Management journal*, 53: 167-181.
- Trichterborn, A., D. Zu Knyphausen-Aufseß, and L. Schweizer
2016 "How to improve acquisition performance: The role of a dedicated M&A function, M&A learning process, and M&A capability." *Strategic Management Journal*, 37: 763-773.
- Tushman, M. L. and T. J. Scanlan
1981 "Boundary spanning individuals: Their role in information transfer and their antecedents." *Academy of Management journal*, 24: 289-305.
- Uzzi, B.
1997 "Social structure and competition in interfirm networks." *Administrative Science Quarterly*, 42: 37-69.
- Van de Ven, A. H., R. Leung, J. P. Bechara, and K. Sun
2012 "Changing organizational designs and performance frontiers." *Organization Science*, 23: 1055-1076.
- Wei, W., J. Li, L. Cao, Y. Ou, and J. Chen
2013 "Effective detection of sophisticated online banking fraud on extremely imbalanced data." *World Wide Web*, 16: 449-475.
- Wiedner, R. and S. Mantere
2019 "Cutting the cord: Mutual respect, organizational autonomy, and independence in organizational separation processes." *Administrative Science Quarterly*, 64: 659-693.
- Williamson, O.
1979 "Transaction-Cost Economics: The Governance of Contractual Relations." *Journal of Law and Economics*, 22: 233-261.
- Yue, L. Q., H. Rao, and P. Ingram
2013 "Information spillovers from protests against corporations: A tale of Walmart and Target." *Administrative Science Quarterly*, 58: 669-701.
- Zahra, S. A. and G. George
2002 "Absorptive capacity: A review, reconceptualization, and extension." *Academy of Management Review*, 27: 185-203.
- Zenger, T. R. and W. S. Hesterly
1997 "The disaggregation of corporations: Selective intervention, high-powered incentives, and molecular units." *Organization Science*, 8: 209-222.
- Zhang, J., C. Baden-Fuller, and V. Mangematin
2007 "Technological knowledge base, R&D organization structure and alliance formation: Evidence from the pharmaceutical industry." *Research Policy*, 36: 515-528.