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Geographic Co-location of Partners and Rivals:
Implications for the Design of R&D Alliances

ABSTRACT

This study advances previous research on the competitive aspects of R&D collaborations that has been mainly interested in knowledge protection concerns in alliances between direct rivals. We join the alliance and agglomeration literatures and argue that geographic co-location between a focal firm's partner and rivals introduces potential indirect paths of knowledge leakage to rivals. Geographic co-location creates significant risks of unintentional knowledge spillovers to rivals while it also increases the likelihood of transactions between the partner firm and the rivals in which firm knowledge can be misappropriated. As a consequence of these risks associated with the co-location of partners and rivals, the focal firm is more likely to employ defense mechanisms when designing alliances. In particular, the focal firm will use equity structures to provide greater monitoring, control, and incentive alignment and will reduce the alliance's scope as well as task interdependence to address knowledge leakage concerns.

INTRODUCTION

Alliance research has emphasized the competitive tensions inherent in collaborations between direct rivals, most notably the risks of knowledge misappropriation emanating from partner competition. Studies have considered a number of different types of knowledge-related challenges arising in such dyadic collaborations, including asymmetric learning (Hamel, Doz, & Prahalad, 1989), learning races (Khanna, Gulati, & Nohria, 1998), inseparability of operational routines across functions (Oxley & Sampson, 2004), and collaboration failure more generally (Park & Russo, 1996). What remains relatively less explored, however, is how partnering with other firms may give rise to knowledge protection and competitive concerns even in situations where the partners themselves are not direct rivals. That is, the alliance literature has not emphasized situations that create *indirect* exposure to rivals and how firms can manage this risk. Such indirect exposure can occur when a partner is located near rivals of the focal firm, and the focal firm's knowledge can leak out to these nearby rivals. Our purpose in this research is to advance the literature on the interplay between competition and cooperation in collaborative relationships by investigating this particular form of indirect exposure and competitive tension affecting interfirm collaborations. Specifically, we draw upon agglomeration theory to suggest that geographic co-location between an allying firm's partner and its rivals is an important but understudied factor affecting the risk of knowledge loss and therefore carries important implications for alliance governance and design (e.g., Gulati & Singh, 1998; Pisano, 1989).

Many industries exhibit agglomeration, or geographic concentration of economic activity, with notable examples in high-tech industries such as semiconductors and biotechnology. Agglomeration theory argues that co-located firms in related industries create a pool of knowledge that spills over among those firms. This research further suggests that firms may

benefit from forming alliances with partners located in industry clusters (e.g., Rothaermel, 2002) as a means to tap into the pool of knowledge spillovers embedded in the cluster. Somewhat surprisingly, however, this research has paid less attention to the fact that allying with a partner located in a cluster also exposes the firm to the risk of its knowledge spilling out into the cluster and becoming accessible to proximate rivals. Partner proximity to rival firms also increases the potential for knowledge misappropriation because such proximity increases the odds that the partner and a rival decide to initiate a collaboration (e.g., Narula & Santangelo, 2009; Reuer & Lahiri, 2014). However, the existing literature provides little guidance on how firms can manage this knowledge concern when partnering with clustered firms.

In this paper, we investigate how firms address the risk of rivals' gaining access to firm knowledge in these situations (i.e., "risk from partner-rival co-location"). Our context is R&D alliances in the biopharmaceutical industry in which pharmaceutical firms (which we will refer to as the "focal firms") form R&D alliances with biotechnology ventures (the "partners") who are often geographically co-located with other pharmaceutical firms (the "nearby rivals"). We theorize and empirically corroborate that the focal firm mitigates the risk from partner-rival co-location by (1) using equity structures to provide enhanced monitoring, control, and incentive alignment, (2) limiting the vertical scope of alliances to restrict access to knowledge, and (3) reducing task interdependence to limit interactions and knowledge sharing.

The primary contribution of this study lies in highlighting an understudied but interesting competitive issue – indirect links to rival firms resulting from the geographic location of partners – and how it affects alliance governance and design. Broadening the focus of inquiry beyond the competitive concerns within a particular alliance dyad also enables us to build upon and extend recent research in other contexts that has begun to investigate the risk of indirect ties to rivals.

For example, Pahnke, McDonald, Wang, and Hallen (2015) examined the negative effects of competitive exposure to rivals via shared intermediary organizations (i.e., venture capitalists). Similarly, Hernandez, Sanders, and Tuschke (2015) focused on knowledge spillover concerns created when board interlocks result in indirect connections to rival firms. Beyond these connections to rivals resulting from shared formal relationships, our work draws upon agglomeration theory to explain how exposure to rivals may also result from the informal ties and interactions spanning organizations within a partner's geographic cluster. By attending to the knowledge protection and competitive concerns of incumbent firms (Davis, 2016; Davis & Eisenhardt, 2011), we also extend prior alliance research that has largely focused on how smaller technology ventures can protect themselves from their larger, more powerful incumbent firm partners (Diestre & Rajagopalan, 2012; Katila, Rosenberger, & Eisenhardt, 2008; Yang, Zheng, & Zhao, 2014). The knowledge protection and competitive concerns of incumbent firms remain relatively less explored, which is noteworthy because these firms are also exposed to the risk of knowledge loss to their rivals. Finally, we contribute to the agglomeration literature by adding new theoretical arguments and findings to research on the potential downsides or drawbacks of agglomeration (e.g., Shaver and Flyer, 2000). We suggest that a firm engaged in alliances with partners in knowledge-rich clusters may also entail risks in those cases where a partner shares a location populated with the firm's rivals.

THEORY AND HYPOTHESES

Theoretical Background

Cooperation and competition in R&D alliances. The formation of research and development (R&D) alliances between companies in high-technology industries is a common phenomenon, with a number of potential strategic and cost-economizing motives explaining their

prevalence (Eisenhardt & Schoonhoven, 1996; Hagedoorn, 2002). In addition to their potential benefits, however, these relationships raise significant concerns related to the protection of knowledge because achieving the objectives of an R&D alliance often requires firms to share valuable knowledge. For example, several forms of knowledge are at risk in R&D collaborations, including information about partner strategies and possible directions of future technology search, competitor benchmarking data, possible key employees who might be hired away, codified formulas or designs, and tacit knowledge (Oxley and Sampson, 2004). Leakage of this information might allow rivals to compete more effectively using the acquired competitive intelligence or to operate more successfully in developing competing technology and products. Accordingly, the concern over knowledge leakage and misappropriation has been a core theme of research in the alliance literature (Gulati & Singh, 1998; Oxley, 1997; Pisano, 1990) as well as a significant concern among practitioners (e.g., Wilson & Tuttle, 2008).

The research stream that Chen (2008) termed the "competition-oriented cooperation" literature has therefore emphasized the specific risks of knowledge leakage and misappropriation in R&D alliances between rivals. For example, Dussauge, Garrette, and Mitchell (2000) suggested that alliance partners who are direct competitors to each other have strong incentives to acquire partner capabilities and, as a result, are more likely to reorganize or take over the alliance. In addition, based on the rationale that end-market competition between alliance partners increases the pay-off from free-riding or misappropriation, Oxley and Sampson (2004) claimed and showed that alliance partners with market overlap tend to limit R&D alliance activities to R&D alone rather than extend them to related manufacturing and/or marketing activities in order to reduce knowledge losses.

Although the previous competition-oriented cooperation literature has focused on the

dyadic competitive relationship between alliance partners, more recent work has begun to extend the scope of inquiry from dyadic ties to a broader set of relationships. This work recognizes that competitive risks exist, even when not directly partnering with rivals. For example, Mesquita, Anand, and Brush (2008) considered the effects of buyers sharing knowledge and developing new technologies with suppliers in vertical supply alliances. They suggested that this knowledge was subject to use by partner suppliers with other buyers and argued that focal buyers need to invest in partnership-specific assets and capabilities and use relational governance mechanisms to address this risk. Other research from outside the alliance context has highlighted that firm knowledge may be exposed to rivals via other shared formal relationships that create indirect ties to rivals. For example, Pahnke et al. (2015) investigated the situation where an entrepreneurial firm is indirectly connected to rival firms via common venture capitalists, showing that information leakage via these indirect ties to competitors negatively affected entrepreneurial firms' innovation activities. In addition, Hernandez et al. (2015) examined the hazards of knowledge leakage to rivals via indirect ties formed by board interlock networks. The authors argued that firms control such risks by terminating and avoiding ties that could create indirect paths to rivals. They also address risks by embedding themselves in dense networks where social monitoring is more prevalent. While this literature is not concerned with interfirm collaboration *per se*, it highlights the point that firms should consider risks not only from partnering directly with rivals but also from indirect competitive relationships surrounding collaborations. We next explain how similar knowledge concerns can arise from ties that exist even in the absence of shared formal relationships, such as when partners are located in geographic proximity to rivals.

Geographic co-location and knowledge protection concerns. Knowledge spillovers are more intense between spatially proximate firms relative to distant counterparts. The benefits of

localized knowledge spillovers have been repeatedly highlighted in the agglomeration literature as one of the key advantages of co-location in a geographic cluster, which Porter (1998) defined as a geographically proximate group of interconnected firms and related institutions in a particular field. Geographic proximity enables face-to-face communication that is critical to transferring tacit knowledge (Daft & Lengel, 1986). Co-location in a cluster fosters knowledge spillovers not only due to geographic proximity but also through the various information channels it provides, such as employees joining community groups, residing in the same neighborhoods (Yates, 1983), and participating in local industry events (Almeida & Kogut, 1999; Saxenian, 1990). Moreover, knowledge transfers are fostered by employee mobility within the local area (Rosenkopf & Almeida, 2003).

There has been a substantial body of empirical research corroborating that geographic proximity fosters knowledge spillovers. For instance, Jaffe et al. (1993) supported geographic localization of knowledge spillovers by showing that patent citations are more likely to come from the same state and Metropolitan Statistical Area (MSA) compared with the pre-existing concentration of related research activity. Similarly, Rosenkopf and Almeida (2003) noted a positive relationship between geographic proximity and knowledge flows measured by patent citations in the semiconductor industry.

Forming relationships with firms in clusters has been suggested as a way for isolated firms to access the benefits of clusters (McCann & Folta, 2008). Empirical research has indicated that clustered firms are involved in more acquisitions (Almazan, DeMotta, Titman & Uysal, 2010) and are targeted more frequently in online B2B markets (Lanzolla & Frankort, 2016). Both Rothaermel (2002) and Folta, Cooper, and Baik (2006) provided similar evidence of the higher levels of partnering with firms located in biotechnology clusters, just as Coombs, Mudambi and

Deeds (2006) showed that the technological munificence of a biotechnology firm's region plays an important role in attracting alliance capital from corporate partners.

Although much of the agglomeration literature emphasizes the benefits of access to knowledge spillovers, the literature does note that spillovers may represent a risk to firms who possess knowledge. For example, Shaver and Flyer (2000) argued that a firm with better technologies or human capital would be less likely to locate in a cluster because it would contribute more to the pool of spillovers, which would benefit rivals and reduce the firm's own relative advantages. This is because the knowledge that spills over to the competitors is likely to be more valuable than the knowledge the firm itself obtains from the cluster. In addition, Alcácer and Chung (2007) similarly showed that in foreign firms' location choices for greenfield investments in the U.S., technology leaders choose only locations with high levels of academic activity and avoid locations with more intensive industrial activity in order to distance themselves from competitors. Although this literature focused on a different decision (location choice), we contend a similar concern of spillovers to rivals arises via the indirect paths that partnering involves. Given that geographic proximity and co-location in a cluster facilitates knowledge spillovers, a focal firm is prone to the risk of knowledge leakage to its rivals when its R&D partner is co-located with the focal firm's rivals (henceforth, "risk from partner-rival co-location"). In particular, knowledge spillovers by informal channels such as interpersonal networks and labor mobility can take place even when the partner firm does not have any intention of misappropriation.

Partner-rival co-location also raises the potential risks associated with intentional knowledge misappropriation. We suggest that partner-rival co-location can aggravate this concern for two reasons. First, co-location increases the likelihood that the partner may form a

future formal relationship with the focal firm's rivals and jointly misappropriate the focal firm's knowledge, as geographic proximity has been demonstrated to promote both alliances (Narula & Santangelo, 2009; Reuer & Lahiri, 2014) and acquisitions (Chakrabarti & Mitchell, 2013). Second, the benefits of co-location noted above in promoting transfer of tacit knowledge also apply to knowledge a partner elects to misappropriate via transfer to rivals. In such cases, the effectiveness of the transfer is enhanced due to the geographic co-location.

In developing research hypotheses below, we explain how risk from partner-rival co-location induces firms to adopt mechanisms to reduce the potential for knowledge leakage from R&D collaborations. Prior to turning to those detailed arguments, we wish to clarify the nature of our focal construct of risk from partner-rival co-location. This construct reflects the degree of harm a focal firm might incur if knowledge leaks from partners to rivals co-located with the partners. We view this risk of harm as elevated when three conditions jointly exist – when there are more rivals, rivals are particularly strong (e.g., they have a significant presence in product markets where the knowledge may be relevant), and knowledge is especially important to the focal firm (e.g., it is related to a product market that makes up a significant portion of the firm's sales). If there are few co-located rivals, or if those rivals do not operate in product markets utilizing the knowledge deployed in the collaboration, or if the knowledge is tangential to the firm's central operations, the risk will be lower. In the hypotheses developed below, we draw upon the literature on alliance governance and design to identify three specific ways in which firms respond to the risk from partner-rival co-location.

Hypotheses Development

***Knowledge protection and choice of equity as a governance mechanism*.** Since knowledge is intangible, R&D partners have difficulty measuring and monitoring each other's

behaviors and outcomes. In addition, R&D activities entail a high level of uncertainty. These attributes of R&D alliances make it difficult to write complete, enforceable contractual agreements, so partners will be exposed to opportunistic behaviors absent other governance mechanisms (Oxley, 1997). As a remedy for such contractual hazards, equity arrangements have long been suggested in the alliance literature. Equity ownership helps align partners' incentives (Williamson, 1991), delineates partners' rights (Grossman & Hart, 1986), and also provides hierarchical controls (Gulati & Singh, 1998; Pisano, 1989).

Equity participation in R&D alliances between focal firms and partners may take several forms, including minority investment of the focal firm in the partner or the formation of a joint venture. In both cases, we anticipate that the inclusion of equity in R&D alliances will increase the focal firm's ability to mitigate spillovers and misappropriation of its knowledge to rivals co-located with the partner by enhancing monitoring, control, and incentive alignment.

To begin with, the inclusion of equity fosters monitoring, as it provides greater access to information. For example, equity investments often include representation on the partner's board. Board participation provides observational and/or voting rights enabling the investing firm to better monitor its partner's behavior, such as the use of contributed assets and development of new assets (Kumar & Seth, 1998; Pisano, 1989). The increased ability to monitor afforded by equity alliances fosters the early discovery of possible spillovers of knowledge, allowing the focal firm to quickly take steps to address the situation in the event of unintended knowledge spillovers. Monitoring also establishes formal communication channels and can therefore reduce unnecessary information sharing in the first place.

Second, equity ownership provides greater control and influence for the focal firm. For example, the focal firm's existing ownership position gives it preferential access to the partner as an acquisition candidate. Even if the focal firm elects not to acquire the partner itself, the focal firm can use its voting rights to block transactions between the partner and the nearby rivals, such as R&D alliances and acquisitions (García-Canal, 1996; Mjoen & Tallman, 1997; Yan & Gray, 1994). Even when the focal firm's voting rights may not be strong enough to veto an R&D alliance with or an acquisition by a nearby rival, the focal firm's ownership in the partner and its intellectual property rights can help safeguard certain knowledge.

A third benefit of equity participation is that it can help align the incentives between the focal firm and the partner and, as a result, mitigate potential opportunistic behaviors. In general, equity participation enhances incentive alignment mainly by two mechanisms. First, equity participation penalizes opportunism through reductions in the value of equity holdings (Pisano, 1989: 112). Second, since shares of ownership reflect relative contributions of each partner, the alliance partners are incentivized to make the requisite *ex ante* commitments, and thus the risk of reneging on a future commitment is attenuated (Pisano, 1989: 112).

Given these monitoring, control, and incentive alignment benefits from equity arrangements, a focal firm will turn to equity arrangements to a larger extent when it faces a higher risk of knowledge acquisition by its rivals via its partners. When a focal firm collaborates with a partner, the risk of knowledge spillovers to and misappropriation by nearby rivals increases as the partner is surrounded by more and stronger rivals of the focal firm. Therefore, as this risk from partner-rival co-location increases, the focal firm will have a greater need for the monitoring, control, and incentive alignment benefits that equity arrangements offer. Thus, we posit:

Hypothesis 1. The greater the risk from partner-rival co-location, the greater the likelihood the R&D alliance is equity-based.

Knowledge protection and choice of alliance scope. The alliance literature has also suggested that alliance scope is an important alliance design parameter that can have a bearing on knowledge leakage and misappropriation risks, so we expect that a firm's alliance scope decisions will be responsive to the risk of partner-rival co-location. More specifically, some R&D alliances involve a broader vertical scope as they entail other downstream activities such as manufacturing and marketing. These R&D alliances (i.e., R&D plus manufacturing and/or marketing) are regarded as broader in vertical scope than pure R&D alliances. Research in the field of technology and operations management has highlighted that firms can reduce time-to-market and improve quality of new product introductions by having overlapping activities and using cross-function teams (Loch & Terwiesch, 2000). Although this argument concerns within-firm arrangements, the same logic can apply to interfirm cooperation, leading to the conclusion that including manufacturing and/or marketing functions in R&D alliances can provide the same benefits of reduced time-to-market and improved quality of new product introductions (Oxley & Sampson, 2004).

Notwithstanding such merits of collaborations entailing broader vertical scope, previous research has also emphasized that broader vertical scope can exacerbate a partner's ability to misappropriate knowledge. First, alliances that are broader in vertical scope simply require more knowledge inputs that are put at risk of leakage in the first place. Broad vertical scope enlarges the extent of knowledge sharing between alliance partners due to increased points of contact (Reuer, Zollo, & Singh, 2002). Broad vertical scope also facilitates the transfer of tacit knowledge embedded in operational routines linking different functions (Oxley & Sampson, 2004). Broader scope increases knowledge protection concerns for a second set of reasons.

Combining R&D activities with other functions makes it more challenging for the partners to write complete and enforceable contracts because broad scope not only increases the number of contingencies that surround a collaboration, but it also aggravates the difficulties in specifying partners' rights and obligations (Pisano, 1989). In addition, during the execution of contracts, broad scope also renders monitoring more difficult and costly due to increased complexity (Oxley, 1997).

Given the increased difficulties in knowledge protection implied by broad vertical scope, firms can limit the scope of alliance when they anticipate knowledge leakage might result in substantial damage. For example, Oxley and Sampson (2004) argued that when partners in R&D alliances are direct competitors, they are less likely to include manufacturing and/or marketing in addition to R&D activities in their collaboration because knowledge leaked to the partners can directly harm their relative competitive positions. We also expect that the harm associated with indirect knowledge spillovers to rivals would also lead firms to reduce the risks associated with partner-rival co-location. That is, as the partner is co-located with more and stronger rivals of the focal firm, knowledge spillovers can undermine the focal firm's relative competitive position to a larger extent, so it will be more likely to limit the vertical scope of alliance. We therefore posit:

Hypothesis 2. The greater the risk from partner-rival co-location, the greater the likelihood the R&D alliance has a narrow scope.

Knowledge protection and choice of interdependence level. The alliance literature suggests there are other design choices that can address knowledge leakage to rivals, even in alliances of broader scope. In particular, a critical aspect of alliance design that is directly related to partners' tasks and interactions is their level of interdependence (Aiken & Hage, 1968; Thompson, 1967; Van De Ven, Delbecq, & Koenig, 1976). Viewing organizations as information processing systems facing uncertainty, Tushman and Nadler (1978) posited that the

amount of task interdependence between subunits increases the need for effective coordination and joint problem solving. This heightened need for interaction then increases work-related uncertainty and, as a result, the required information processing. Similarly, in the context of alliances, Krishnan, Martin, and Noorderhaven (2006) argued that high interdependence between alliance partners requires them to share valuable knowledge-intensive resources. Therefore, if the tasks in an R&D alliance between a focal firm and a partner are interdependent, they have to share more knowledge between them and, therefore, are exposed to a larger risk of knowledge leakage.

Indeed, the alliance literature has paid substantial attention to interdependence between alliance partners, but interdependence has typically been considered as a given task attribute affecting governance choice rather than a decision variable that alliance partners have to consider (Aggarwal, Siggelkow, & Singh, 2011; Gulati & Singh, 1998). However, alliance partners can decide the level of interdependence by choosing different types of relationships with partners for their R&D collaborations. Thompson (1967) classified the types of interdependence based on input-output relationships. The types of interdependence are pooled, sequential, and reciprocal in order of increasing complexity. Pooled interdependence refers to no direct input-output relationship between subunits; that is, each subunit performs completely separate functions. Sequential interdependence occurs when the output of one unit's activity is necessary for the performance by the next subunit, just as in a classic assembly line. Reciprocal interdependence is similar to sequential interdependence in that the output of one subunit becomes the input of another, but is more complex because the input-output relationship is bi-directional.

Increasing levels of interdependence require closer working relationships and more knowledge transfer, which also increases the amount of knowledge that may leak to partners.

Larger amounts of transferred and leaked knowledge therefore increase the risks this knowledge may be acquired by nearby rivals. As a consequence, we expect the focal firm's choice of interdependence to be associated with the degree of harm the firm would incur if its knowledge is leaked to and acquired by nearby rivals. Because geographic co-location of rivals increases the risks of knowledge leakage by both spillovers and misappropriation, the focal firm faces a higher risk of knowledge acquisition by rivals as the partner is co-located with more and stronger rivals of the focal firm. Accordingly, we predict that the focal firm will choose a lower level of task interdependence to curb interactions and knowledge transfers in order to reduce the potential risk as the nearby rivals around the partner are more serious competitors to the focal firm. Thus, we posit:

Hypothesis 3. The greater the risk from partner-rival co-location, the greater the likelihood the R&D alliance has low task interdependence.

METHODS

Data and Sample

We chose domestic R&D alliances between U.S. pharmaceutical firms (i.e., focal firms) and U.S. biotechnology ventures (i.e., partner firms) in the biopharmaceutical industry as our research setting. Although the risk created by partner-rival co-location applies to some degree to all R&D alliances, R&D alliances between pharmaceutical firms and biotechnology ventures provide an appropriate and valuable empirical context for several reasons. First, because of liability of newness or smallness (Bruderl & Schussler, 1990; Stinchcombe, 1968) and the lack of biotechnology ventures' downstream capabilities, first-order knowledge leakage from pharmaceutical firms to biotechnology ventures is less concerning to pharmaceutical firms than leakage to their major rivals, who compete with them in downstream product markets. This second-order, or indirect, knowledge leakage to a pharmaceutical firm's rivals via biotechnology

ventures could be substantially harmful because the rivals could immediately take advantage of the leaked knowledge to undermine the pharmaceutical firm in product markets. Second, given our interest in mechanisms chosen to address the risk associated with partner-rival co-location, it is important to examine partnerships in which the partner exposed to the risk has the ability to influence the structuring of the partnership. In R&D alliances between pharmaceutical firms and biotechnology ventures, the former typically have significant bargaining power and thus are able to influence the design of the alliance (e.g., Mason & Drakeman, 2014). Third, in R&D alliances between pharmaceutical firms and biotechnology ventures, the latter are R&D-dedicated partners and thus R&D activities take place mainly in their location, which is consistent with our focus on the location of partners. Fourth, R&D alliances between pharmaceutical firms and biotechnology ventures are regarded as beneficial for both and thus are frequently observed in the industry, just as these collaborations present knowledge leakage and misappropriation concerns (e.g., Pisano, 1990). Finally, in this industry product markets are very clearly defined by therapeutic classes. In our study, clear market definitions are important because firms defined to be a pharmaceutical firm's rivals should be actual, meaningful competitors whose products are substitutes for those of the pharmaceutical firm. Defining markets by therapeutic classes is widely-accepted and commonly-used by U.S. government authorities, industry players, and academic researchers (Anand, Mesquita, & Vassolo, 2009; Lerner, 1997; Rothaermel, 2001; Vassolo, Anand, & Folta, 2004).

In this paper, we focus on domestic deals for the following reasons. First, the choice of U.S.-based biotechnology ventures helps ensure that we have an empirical context that features meaningful levels of co-location among partners and rival firms. Prior research clearly indicates that the U.S. biopharmaceutical industry is characterized by significant geographic

agglomeration (Folta, Cooper, & Baik, 2006). Second, our choice of U.S. pharmaceutical firms helps ensure that we do not include cases where focal firms and potential rivals focus on different geographic markets, such that they would not be serious rivals in a particular product market (Jayachandran, Gimeno, & Varadarajan, 1999).

For the alliance data, we drew on Thomson Reuters' Recap database, which provides detailed information on alliance governance and design. As one of the most robust and representative data sources on alliances in the biopharmaceutical industry (Schilling, 2009) , Recap has served as a data source for a number of investigations of biopharmaceutical alliance activity (e.g., Reuer & Devarakonda, 2016, Robinson & Stuart, 2007; Rothaermel and Boeker, 2008). To define pharmaceutical firms' rivals, we relied on the IMS Health database, which provides prescription drug sales by therapeutic class. We also used the IMS Health database to ensure that the biotechnology ventures in our sample are R&D-dedicated firms without a presence in product markets. For patent data, we used information from the U.S. Patent and Trademark Office (USPTO). In the Recap database, there were 639 such R&D alliances in the 2007-2013 timeframe formed between 114 U.S. pharmaceutical firms and 481 U.S. biotechnology ventures.[1]

Measures

Dependent variables. The first of our three dependent variables, *Equity Alliance*, is a dichotomous variable coded one if a focal R&D alliance between a focal firm and a partner is equity-based, and zero otherwise (Gulati, 1995; Hagedoorn & Narula, 1996; Phene & Tallman,

[1] Drawing on company websites and other sources (e.g., Bloomberg Company Information), we checked whether the R&D-dedicated partners in our sample include contract research organizations (CRO). Among the 481 partners, 38 (7.9%) were identified as CROs. Since the risk of indirect knowledge leakage to nearby rivals can still exist even if partners are CROs, we kept them in our sample. As a supplementary analysis, we also re-estimated the models with a sample excluding CROs and obtained consistent results and interpretations.

2012; Pisano, 1989; Robinson & Stuart, 2007). Out of the 639 R&D alliances, 595 (93.1%) were non-equity alliances while the remaining 44 (6.9%) were equity-based alliances.[2]

The second dependent variable is *Scope*, a categorical variable taking the value of one when a focal alliance involves manufacturing or/and marketing activities in addition to collaborative R&D, and zero otherwise (i.e., pure R&D) (Oxley & Sampson, 2004). Out of the 639 R&D alliances in our sample, 543 (84.98%) were pure R&D alliances while the remaining 96 (15.02%) include manufacturing and/or marketing activities.

Our third dependent variable is *Reciprocal Interdependence*, a binary variable which distinguishes the level of task independence between a focal firm and a partner. To construct this variable, we followed the approach of Reuer and Devarakonda (2016), coding the variable as one if a focal R&D alliance is classified as "Collaboration" or "Co-Development" in Recap and zero otherwise. Recap assigns an R&D agreement to one of these categories when both parties jointly participate in the research and development, and this combined participation of both partners in R&D activities implies reciprocal input-output relationships. Recap codes agreements as "Research" or "Development" if only one of the parties (i.e., the biotechnology venture) performs research or development. These agreements fall into the category of sequential interdependence because the research output of one party (i.e., biotechnology venture) is the input of an activity in another (i.e., pharmaceutical firm). Reciprocal interdependence (the categories of Collaboration and Co-Development) implies stronger interdependence than sequential interdependence (Thompson, 1967) and thus *Reciprocal Interdependence* reflects the level of task interdependence between R&D partners consistent with Thompson's (1967) definitions. Because R&D alliances require at least some minimal level of input-output

[2] Given the low percentage of equity-based alliances in our sample, we used Firth logit models to address the concern about rare event bias (Firth, 1993) and the results were qualitatively consistent with our main results.

relationship, Thompson's (1967) third category of pooled interdependence does not apply to our sample of alliances. Out of the 639 R&D alliances in our sample, 295 (46.17%) were classified as involving reciprocal interdependence while the remaining 344 (53.83%) sequential interdependence.[3]

Independent variable. Our core independent variable captures the expected degree of harm the focal firm might incur in the product markets associated with the R&D alliance if knowledge shared and created in the R&D alliance is leaked to the nearby rivals. This risk of harm is made up of a number of components: it increases when (1) more rivals are co-located with the partner, (2) the rivals have stronger market positions in the particular product markets, and (3) the markets are more important to the focal firm.

Competing pharmaceutical firms were considered nearby rivals if (a) they were co-located with the partner and (b) they had sales in the product markets corresponding to therapeutic areas of the R&D alliance. Potential rivals were drawn from the list of the 1,000 largest pharmaceutical companies in 2007; these firms accounted for 97.52% of the entire global prescription drug market in that year. Potential rivals are defined to be co-located if their headquarters are located within the same geographic cluster as the partner.[4] To define geographic clusters, we used Metropolitan Statistical Areas (MSAs). In the agglomeration literature, different levels of aggregation have been used to identify clusters. Our definition of clusters should be aligned with the distance over which the benefits of knowledge spillovers might

[3] Task interdependence might be expected to be closely related to equity involvement and scope. In our sample, however, task interdependence is quite evenly distributed across equity versus non-equity alliance as well as narrow versus broad scope. In equity alliances, sequential (reciprocal) interdependence accounts for 54.5% (45.5%) while in non-equity alliances sequential (reciprocal) 53.8% (46.2%). In narrow-scope alliances, sequential (reciprocal) interdependence accounts for 52.7% (47.3%) while in broad-scope alliances sequential (reciprocal) 60.4% (39.6%).
[4] In the few cases in which a focal R&D alliance is a joint venture, we used the location of the joint venture instead of the location of the technology venture. Inclusion or exclusion of joint ventures from the sample did not affect the interpretation of the results.

meaningfully extend. Since Jaffe et al. (1993) found that localization of knowledge spillovers was stronger at the MSA level than at the state level, we elected to use the former. This aggregation level is also consistent with prior studies of agglomeration in the biotechnology industry (e.g., DeCarolis & Deeds, 1999; Folta et al., 2006).[5]

To determine the product markets in which potential rivals sell, we drew from the IMS Health database, which reports sales of pharmaceutical firms by product markets. Markets are classified using the categories defined by the Anatomical Therapeutic Chemical (ATC) Classification System of the World Health Organization Collaborating Center for Drug Statistics Methodology (WHOCC). We matched the first level of the ATC Classification System (e.g., cardiovascular system, dermatologicals) to the therapeutic class of the R&D alliance as reported by Recap to determine whether the sales were in the product market corresponding to therapeutic area of the R&D alliance (Anand et al., 2009). Based on this information, we measured the independent variable, *Risk from Partner-Rival Co-location*, by calculating the weighted average of the aggregate market shares held by the nearby rivals in the focal product markets (i.e., therapeutic classes) of the R&D alliance. The weight is the importance of that market to the focal firm, as indicated by the percentage of overall firm revenue derived from sales in that product market. More specifically, our measure is calculated as follows:

[5] Regarding headquarter locations, in our sample the most agglomerated MSAs for the pharmaceutical firms include New York-Northern New Jersey-Long Island, NY-NJ-PA MSA (26 firms, 22.81%); Boston-Cambridge-Quincy, MA-NH MSA (11 firms, 9.65%); Philadelphia-Camden-Wilmington, PA-NJ-DE-MD MSA (9 firms, 7.89%), Chicago-Naperville-Joliet, IL-IN-WI MSA (8 firms, 7.02%); San Diego-Carlsbad-San Marcos, CA MSA (8 firms, 7.02%); and San Francisco-Oakland-Fremont, CA MSA (8 firms, 7.02%). On the other hand, the most agglomerated MSAs for biotechnology venture partners include Boston-Cambridge-Quincy, MA-NH MSA (92 partners, 19.13%); San Francisco-Oakland-Fremont, CA MSA (66 partners, 13.72%); New York-Northern New Jersey-Long Island, NY-NJ-PA MSA (42 partners, 8.73%); San Diego-Carlsbad-San Marcos, CA MSA (41 partners, 8.52%); Philadelphia-Camden-Wilmington, PA-NJ-DE-MD MSA (22 partners, 4.57%); and San Jose-Sunnyvale-Santa Clara, CA MSA (21 partners, 4.37%).

$$Risk\ from\ Partner\text{-}Rival\ Co\text{-}location_{ij} = \sum_{m}\left(Importance_{m} \times \sum_{r} MS_{rm}\right)$$

i: Pharmaceutical Firm
j: Biotechnology Venture Partner
m: Product markets (therapeutic classes) of R&D alliance between Pharmaceutical Firm *i* and Biotechnology Venture Partner *j*
r: Pharmaceutical Firm *i*'s US-based rival located within the same Metropolitan Statistical Area (MSA) as Biotechnology Venture Partner *j*
MS_{rm}: The market share of US-based rival *r* in product market *m*.

Given the importance of this core independent variable in our study, we investigated alternative ways to measure it, including different approaches for determining whether rivals were co-located with the partner as well as using different identification approaches for nearby rivals. First, we used two alternative definitions of agglomeration in measuring the independent variable. Specifically, we considered the broader level of Combined Statistical Areas (CSAs), which are comprised of adjacent MSAs, in case knowledge might spill out more broadly than the MSA level. We also examined an alternative measure for which rivals were defined to be co-located if they were located within a 50-mile radius of the partner. We chose 50 miles based on the work of Orlando (2004) indicating that knowledge spillovers (i.e., patent citations) from firms within the same 3-digit SIC class tend to attenuate beyond a radius of 50 miles.

Second, when identifying nearby rivals, we considered the possibility that they have multiple locations. For the main results, we identified the location of nearby rivals based on their headquarters, following previous alliance research that implicitly assumes that alliance decisions are made there (Hitt, Dacin, Levitas, Arregle, & Borza, 2000; Tyler & Steensma, 1998), and headquarters would tend to lead competitive intelligence activities and be co-located with main R&D facilities. However, it is possible that nearby rivals have multiple locations, in particular multiple R&D locations. Given that R&D facilities can play an important role in absorbing any knowledge spilled over from other pharmaceutical firms, the measure based only on the location

of headquarters might underestimate the risk from knowledge leakage to rivals. To address this issue, we identified nearby rivals based not only on the location of headquarters, but also on patenting locations (e.g., Lahiri, 2010; Narula & Santangelo, 2009). That is, we used the location (i.e., city) information of the first inventor in a patent as an indication of where firms are conducting research.[6] Based on this information, we examined all MSAs where a firm is filing patents and then chose MSAs accounting for more than 10%, 20%, or 30% of the patents applied in the past ten years respectively to identify R&D locations.

Control variables. We controlled for a number of additional factors that the previous literature has argued affect knowledge misappropriation and spillover concerns and therefore could affect alliance governance and design. The alliance literature has long argued that social networks in which alliance partners are embedded provide controls for opportunistic behaviors and thus might also affect the risk of knowledge losses as well as the alliance design choices firms make (Jones, Hesterly, & Borgatti, 1997). Following Rothaermel and Boeker (2008), we controlled for an alliance dyad's social embeddedness, using variables to capture the partners' prior ties, indirect ties between the two firms in the dyad, and each partner's degree centrality. To construct *Prior Ties*, we counted the number of prior alliances between the two partners in the past ten years (Gulati, 1995). For *Indirect Ties*, we counted the number of indirect ties between the two partners at degree distance two, using all the alliances reported in Recap to represent the entire network in the biopharmaceutical industry as much as possible (Powell, Koput, & Smith-Doerr, 1996). Lastly, we constructed the *Degree Centrality of Focal Firm* (*Partner*), using the total number of ties the pharmaceutical firm (biotechnology venture) had

[6] Although convention may favor listing the most significant contributor to the patent first in the order of names, there is no legal requirement to do so. To the extent that alternative ordering choices introduce noise into the measures, the precision of our estimates would be reduced. As such, these alternative estimates may be seen as more conservative. We thank an anonymous reviewer for noting this point.

entered within the entire industry network in the past ten years (Ahuja, 2000; Powell et al., 1996). To ensure that the measure of degree centrality is independent from the relational embeddedness between the two partners, we excluded the prior ties between them in measuring each partner's degree centrality (Rothaermel & Boeker, 2008).

We also included several firm-level attributes that may influence alliance governance and design. The alliance literature has claimed that when alliance partners are asymmetric in size, they tend to have more conflicts (Li et al., 2012), which may affect alliance governance. To control these effects, we incorporated the prescription drug sales of the pharmaceutical firm in a given dyad, i.e., *Size of Focal Firm* (Gimeno, 2004). Size of the partner is not included because the biotechnology venture partners in our sample have no sales. Firms with significant knowledge bases may be more concerned about knowledge leakage and accordingly prefer more protective governance and design mechanisms (Phene & Tallman, 2012). To control for these effects, we constructed controls for the *Patent Counts of Focal Firm* and *Patent Counts of Partner*.

We also included *Cluster Size*, which was measured by the number of biopharmaceutical companies in the MSA of the partner (McCann & Folta, 2011), to control for the possible governance benefits of being located within a cluster. Since regional clusters feature dense networks that provide control functions (Saxenian, 1996) as well as relational macroculture defined as "the shared values of forbearance, cooperation, and bilateralism across organizations with a cluster" (Bell, Tracey, & Heide, 2009), firms located within larger regional clusters might have less concern about partner opportunism in interfirm transactions.

Research on geographic distance between alliance partners has also maintained that geographic proximity reduces information asymmetry between alliance partners and can also

facilitate monitoring (e.g., McCann, Reuer, & Lahiri, 2015; Reuer & Lahiri, 2014). Therefore, we included in the model the distance between a pharmaceutical firm and a biotechnology venture in a given dyad, which was measured based on the ZIP codes of their headquarters. Since the effects of distance might diminish, we also used the natural log of the variable as a robustness check and obtained consistent results.

Lastly, we included four different types of fixed effects to capture other sources of heterogeneity. The risk of knowledge leakage and misappropriation may be influenced by the types of technologies and diseases for a focal R&D project. Therefore, we included technological domain fixed effects and therapeutic area fixed effects in the model. In addition, if activities in a given R&D project are more explorative, appropriation concerns become stronger because adequate specification of property rights can be problematic (Freeman, 1997; Mowery & Rosenberg, 1991). In our context, the degree of exploration is well approximated by phases in new drug development (Robinson & Stuart, 2007). Accordingly, we also controlled for phase fixed effects. Finally, year fixed effects were also included to capture any broader, economy-wide factors affecting firms' decisions on alliance governance and design.

Statistical Techniques

Since our dependent variables, *Equity Alliance*, *Scope*, and *Reciprocal Interdependence*, are all binary, we elected to use probit regression with cluster-robust standard errors by pharmaceutical firms (i.e., focal firms) to mitigate concerns about the dependence across observations caused by the repeat occurrence of the pharmaceutical firms in our sample. We also estimated the probit models with several different specifications of standard errors. The results were consistent not only with robust (White-Huber) standard errors but also with one-way clustered standard errors by biotechnology ventures and two-way clustered standard errors by

both pharmaceutical firms and biotechnology ventures.[7] In addition, because decisions on equity involvement, scope, and task interdependence may be made jointly, we also considered possible correlations among the errors in each model by using multivariate probit models and also obtained qualitatively consistent results.

RESULTS

Table 1 provides descriptive statistics and a correlation matrix for the variables used in the analyses. Although many pairs of variables in Table 1 show significant pairwise correlations, multicollinearity is not a serious issue in our models. The mean value of variance inflation factor (VIF) is 1.89. *Degree Centrality of Focal Firm* had the highest VIF (8.90), but is still below the recommended cutoff level of 10 (Neter, Kutner, Nachtsheim, & Wasseman, 1996).

---------- Insert Table 1 about Here ----------

Table 2 presents the results of the models analyzing the probability that a particular R&D alliance is equity-based, involves a broad scope (i.e., R&D plus manufacturing or/and marketing), or includes reciprocal interdependence. Model 1 is a baseline specification including control variables only, and Model 2 introduces *Risk from Partner-Rival Co-location* to test our first hypothesis. The significant positive coefficient on this independent variable (b = 3.795 and p = 0.004) supports Hypothesis 1. That is, as the risk from partner-rival co-location increases, the likelihood increases that the R&D alliance is equity-based rather than a non-equity transaction. To evaluate the economic significance of the effect, we estimated the predicted average probability of equity alliances at various values of *Risk from Partner-Rival Co-location*. That is, we calculated the response for each observation and then averaged those responses at the median, top 10%, top 5%, and top 1% quantiles of the variable given its highly skewed

[7] For two-way clustered standard errors, we used the user-written 'clus_nway' module in Stata 14 (Cameron, Gelbach, & Miller, 2011; Kleinbaum, Stuart, & Tushman, 2013) and obtained qualitatively consistent results.

distribution (Hoetker, 2007; Train, 1986). The predicted average probabilities were 6.28%, 7.00%, 9.15%, and 24.86% respectively. That is, when the value of *Risk from Partner-Rival Co-location* increases from the median to top 10%, top 5%, and top 1%, the predicted average probability increases by 11.28%, 45.59%, and 295.72% respectively.

---------- Insert Table 2 about Here ----------

Model 4 tests our second hypothesis on risk from partner-rival co-location as a determinant of alliance scope. Since the coefficient of the variable is negative and significant (b = -3.981 and p = 0.013), Hypothesis 2 is also supported. Focal firms are less likely to choose a broad scope alliance (i.e., R&D plus manufacturing and/or marketing) as the risk from partner-rival co-location increases. To assess economic significance, we again estimated the predicted average probability of broad scope at the four values of the independent variable as above and obtained point estimates of 15.76%, 14.47%, 11.42%, and 3.16% respectively. Compared to the predicted value at the median of 15.76%, the last three values represent decreases of 8.20%, 27.55%, and 79.96% in the likelihood of broad scope, respectively.

Model 6 shows the results related to Hypothesis 3, which predicts the likelihood of reciprocal interdependence decreases the greater is the risk from partner-rival co-location. The significant negative coefficient of the variable (b = -2.602 and p = 0.032) supports Hypothesis 3. This result indicates that focal firms are less likely to choose reciprocal interdependence over sequential interdependence as they anticipate a greater risk of partner-rival co-location. To evaluate the economic significance of the effect, we again calculated the predicted average probability of reciprocal interdependence at the four values of the independent variable (i.e., median, top 10%, top 5%, and top 1% quantiles). The values were 47.16%, 45.58%, 41.48%, and

24.72% respectively. That is, the last three values represent decrease of 3.34%, 12.04%, and 47.58% compared to the predicted value at the median of 47.14%.

Robustness Checks

As an initial robustness check to address possible concerns about skewness or outlying values in the main independent variable, we re-ran all models using the log transformed values as well as the winsorized values at 98th and 99th percentiles and obtained similar results.[8] In addition, we calculated Cook's Distance to inspect potentially influential observations and found that all values were far less than 1.0, which mitigated the concern about influences of outliers (Cook & Weisberg, 1982). Table 3 contains results from additional robustness analyses using alternative ways to measure the independent variable (i.e., *Risk from Partner-Rival Co-location*). The first two approaches use CSAs rather than MSAs and a 50-mile radius from the partner, respectively, to capture nearby rivals in our core independent variable. The third approach relies on the measure that considers rivals' multiple locations in the MSAs in which they file more than 30% of their patents. These results also provided consistent support to the hypotheses, though the variable constructed based on CSAs is only modestly significant in Model 7 for firms' task interdependence choices (b = -1.903 and p = 0.055).[9]

---------- Insert Table 3 about here ----------

We also tested our hypotheses with Heckman probit models to control for potential selection bias. Because our sample consists of realized alliance deals, the dyads in our sample may be systematically different from the other possible unrealized dyads and thus selection bias

[8] Results for the reciprocal interdependence dependent variable became marginally significant under the winsorization approach.

[9] For further robustness checks, we identified the multiple locations of nearby rivals considering MSAs where they file more than 10% and 20% of their patents respectively. Using the independent variable using these cutoffs, we obtained qualitatively similar results to the main results for all the hypotheses (results available upon request).

may be a concern. To construct a sample of both realized partnerships and non-realized partnerships serving as counterfactuals, we first obtained all the possible unrealized dyads between the pharmaceutical firms and the biotechnology ventures that have been involved in any R&D alliances in year *t*. Then, for each realized dyad in year *t*, we added 10 randomly chosen unrealized dyads. For an exclusion restriction, we used the number of alliances the top 10 rivals of a given pharmaceutical firm had formed in the previous year to predict formation of an alliance. Garcia-Pont and Nohria (2002) showed that the propensity of firms to form alliances increases with the frequency of alliance formation in previous periods by other firms occupying the same strategic niche; however, this variable is unlikely to be related to the governance and design of the focal agreement.

Table 4 shows the results from Heckman probit models. In the first-stage selection model (Model 1), the coefficient of the number of alliances top 10 rival firms had formed in one year prior to a focal year (*Rivals' Num. of Alliances (t-1)*) is positive and highly significant ($b = 0.020$ and $p = 0.000$), supporting the appropriateness of the variable as exclusion restriction. In addition, the correlation between the independent variable and the inverse Mills ratio is also not significant ($r = -0.010$ and $p = 0.801$), which also supports the appropriateness of our exclusion restriction (Leung & Yu, 1996). The negative and significant coefficients for the inverse Mills ratio variable in Models 3 and 7 ($b = -1.096$ and $p = 0.001$; $b = -0.614$ and $p = 0.015$ respectively) indicate that these models may be subject to selection concerns.[10] Nevertheless, the

[10] Significant coefficients of inverse Mills ratio (i.e., lambda) do not necessarily imply selection concerns if the independent variable of interest is not significant in the first stage (i.e., selection) model. However, one limitation we have in employing Heckman models is that the independent variable (i.e., risk from partner-rival co-location) is available only for realized deals in our setting, so we cannot test the significance of the independent variable in the first stage model (Certo, Busenbark, Woo, & Semadeni, 2016). Furthermore, given (1) the negative association between the independent variable and task interdependence and (2) the negative correlation between error terms in the selection and outcome equations which is indicated by the negative lambda, Model 7 is subject to Type II error (i.e., failures to detect real significant relationships), which makes our main results more conservative (Certo et al., 2016),

results from the Heckman probit models again provided results consistent with those from probit models.

---------- Insert Tables 4 about here ----------

DISCUSSION

Contributions and Implications

Our theory and evidence make several contributions to the alliance literature as well as to the agglomeration literature. Our most immediate contribution to the alliance literature lies in building upon and extending the literature that investigates the competitive aspects of collaborations and the potential risks of partnering with rivals (Hamel et al., 1989; Khanna et al., 1998; Oxley & Sampson, 2004; Park & Russo, 1996). This literature has paid attention to dyadic competitive relationships with direct rivals while related research has just recently begun to consider the threats of knowledge leakage to rivals via indirect links such as through common suppliers, shared intermediary organizations, and board interlocks (Hernandez et al., 2015; Mesquita et al., 2008; Pahnke et al., 2015). We complement this emerging literature that has paid attention to shared formal ties among firms by suggesting that geographic co-location between a focal firm's partner and its rivals is an overlooked but important factor that can present risks of knowledge losses through other mechanisms (e.g., interpersonal interactions and mobility in a location and possible future interfirm transactions), and focal firms respond to the risks from partner-rival co-location through their alliance governance design choices. It would be interesting and valuable in future research outside the R&D alliance context to examine how the presence of nearby rivals has consequences for firm behavior and outcomes.

We also contribute to the literature on R&D alliances between incumbent firms and technology ventures. The literature has typically focused on incumbent firms' misappropriation

of technology ventures' knowledge. Since technology ventures have greater difficulty in learning partner knowledge, controlling knowledge flows, and reacting to misappropriation by partners (Alvarez & Barney, 2001), it makes sense that the previous literature has mainly focused on the technology venture's perspective. However, we shift the focus to the counterpart (i.e., incumbent firm), which might also be concerned about indirect knowledge losses, particularly to nearby rivals who are competitors in product markets. Despite their superior resources and bargaining power, incumbent firms are also prone to the risk of knowledge loss in R&D alliances with technology ventures, and they can devise appropriate defense mechanisms (e.g., equity arrangements, narrow alliance scope, and limits on task interdependence) to address the risk from partner-rival co-location. Future research might consider other ways that incumbent firms might cope with these risks, including opting for other partners presenting lesser knowledge spillover and misappropriation concerns, relying on relational governance mechanisms, or acquiring firms rather than partnering with them.

One related contribution we make to the alliance literature is that we further extend the important but relatively sparse literature treating task interdependence as a decision variable. Organizational researchers have long suggested the level of task interdependence as a critical design element of organization that influences the intensity of interactions and information sharing (Aiken & Hage, 1968; Thompson, 1967; Van De Ven et al., 1976). Notwithstanding this tradition, alliance research has tended to regard task interdependence as an exogenously given condition that mainly affects alliance governance decisions by increasing coordination costs (Gulati & Singh, 1998). Our results suggest that firms can decide upon the level of interaction and coordination with partners depending upon the potential for knowledge losses and risk from partner-rival co-location. It would therefore be valuable for future research to consider task

interdependence as an alliance design choice for different partnerships and collaboration contexts, rather than as an exogenous attribute of an alliance.

Lastly, we also contribute to the agglomeration literature by adding new insights and findings to the research on the downsides of agglomeration. The predominant emphasis in the agglomeration literature has been on the benefits of geographic clustering, particularly because geographic co-location fosters access to a pool of knowledge spillovers. A small subset of the studies in this literature has raised the concern that firms not only draw from, but also contribute to, that pool. This concern has led some scholars to predict that firms with superior resources may be less likely to choose clustered locations in the first place (Shaver & Flyer, 2000). We raise a related concern in the context of allying with clustered firms; although such collaborations represent an opportunity to indirectly tap into the cluster's pool of knowledge spillovers, the risk of contributing to the pool and losing relative advantages exists in these relationships. To address this risk, firms should consider employing protective governance and design elements in their partnerships. It would be valuable in future research to confirm in fine-grained terms the various mechanisms through which such knowledge losses occur (e.g., formal channels such as future agreements among firms in the cluster, or informal channels such as interpersonal interactions and labor mobility). More broadly, we would encourage future research that devotes more attention to the downsides of clusters and how firms might still obtain benefits of clusters despite the risks that firms encounter.

Limitations and Future Research

This study has several limitations that provide fruitful opportunities for extensions to address. In this paper, we focused only on the increasing risk of knowledge spillovers and misappropriation when a focal firm's partner is co-located with the rivals of the focal firm. As

noted above, however, geographic proximity between the partner and the nearby rivals might also increase the benefit of knowledge spill-ins from the rivals to the focal firm through the partner. Although this benefit of potential knowledge spill-ins exists, our theoretical arguments build on an assumption that interest in this potential spill-in benefit is relatively less consequential compared to the concern for possible knowledge leakage in the case of R&D alliances. That is, we anticipate managers will be more motivated to avoid loss of knowledge relative to achieving gains from competitive intelligence spill-ins. We believe this assumption is justified for several reasons. First, while an R&D alliance definitely involves the focal firm exposing a portion of its knowledge to the partner (and thereby creating a risk of leakage to nearby rivals), uncertainty exists around whether a partner has access to competitively relevant information on nearby rivals and which ones. Second, given that the primary purpose of the partnerships we study is to conduct research and development activities, protection of knowledge is likely to be of high salience. The consequences of leakage of R&D-related knowledge to nearby rivals who are definitely operating in the same product markets are quite serious. Although benefits such as access to intelligence on nearby rivals may accrue to the focal firm, these benefits are secondary to the primary purpose of the partnership and as such are less likely to draw attention when structuring the partnership. For these reasons, we see the leakage concern as a first-order influence compared to the potential benefit of indirect access to competitive intelligence. However, future research could explore situations where potential benefits of knowledge spill-ins play a larger role than potential risk of knowledge spillovers and misappropriation.

For parsimony and to build upon previous alliance research, we selected three facets of alliance governance and design. Although these selections were informed by guidance drawn

from the prior literature indicating that these are among the more significant choices made by firms in alliance design, these are certainly not the only ways in which firms might address knowledge leakage concerns when forming alliances with partners co-located with rivals. For example, firms might limit the type of projects, or turn to social remedies, such as only collaborating with trusted partners with whom they have collaborated in the past. Although contractual remedies suffer from incompleteness, firms may also attempt to address these concerns with non-disclosure agreements or securing certain monitoring and control rights in collaborations. Extensions to this research might therefore obtain primary data on such details on alliance governance and alternative remedial mechanisms firms employ. Moreover, our use of secondary data led us to use a dichotomous measure of task interdependence. Although this is consistent with the seminal work on this construct (Thompson, 1967), primary data would foster examination of distinctions within each category (e.g., how firms allocate responsibilities for particular tasks). In addition, given that different forms of knowledge (e.g., codified formulas and designs or competitor benchmarking data) can be leaked through different pathways (e.g., interpersonal channels or labor mobility), primary data might help to answer whether some certain types of information are more likely to be leaked through some specific pathways, which can provide implications for those designing R&D alliances. These alternative approaches all represent opportunities to extend our findings more broadly to a fuller set of design choices. Furthermore, while our study has focused on the antecedents of firms' alliance governance design choices when firms are subject to the risk from partner-rival co-location, it would be interesting to examine the implications of these choices as well as of partner-rival location. In particular, it would be interesting to investigate the extent to which indirect loss of knowledge occurs and how it affects nearby rivals' competitive behaviors.

CONCLUSION

To the best of our knowledge, this is the first study that explicitly examines how co-location between a focal firm's partner and rivals affects the design and governance of R&D alliances. We theorize that co-location increases the risk of rivals' gaining access to a focal firm's knowledge, so the focal firm mitigates this concern by opting for equity governance structures to provide greater incentive alignment, control, and monitoring and limiting alliance scope and task interdependence to reduce indirect knowledge losses to rivals. Our results support our hypotheses on the relationship between the risk from partner-rival co-location and alliance governance and design. We hope this paper more broadly stimulates future research that considers the implications of the competitive context of collaboration, including potential downsides of agglomeration and the indirect ways in which competition can shape inter-firm collaboration.

REFERENCES

Almazan, A., De Motta, A., Titman, S., & Uysal, V. 2010. Financial structure, acquisition opportunities, and firm locations. ***Journal of Finance***, 65(2): 529–563.

Aggarwal, V. A., Siggelkow, N., & Singh, H. 2011. Governing collaborative activity: Interdependence and the impact of coordination and exploration. ***Strategic Management Journal***, 32(7): 705–730.

Ahuja, G. 2000. Collaboration networks, structural holes, and innovation: A longitudinal study. ***Administrative Science Quarterly***, 45(3): 425–455.

Aiken, M., & Hage, J. 1968. Organizational interdependence and intra-organizational structure. ***American Sociological Review***, 33(6): 912–930.

Alcácer, J., & Chung, W. 2007. Location strategies and knowledge spillovers. ***Management Science***, 53(5): 760–776.

Almeida, P., & Kogut, B. 1999. Localization of knowledge and the mobility of engineers in regional networks. ***Management Science***, 45(7): 905–917.

Alvarez, S. A., & Barney, J. B. 2001. How entrepreneurial firms can benefit from alliances with large partners. ***Academy of Management Executive***, 15(1): 139–148.

Anand, J., Mesquita, L. F., & Vassolo, R. S. 2009. The dynamics of multimarket competition in exploration and exploitation activities. ***Academy of Management Journal***, 52(4): 802–821.

Anderson, E., & Weitz, B. 1989. Determinants of continuity in conventional industrial channel dyads. ***Marketing Science***, 8(4): 310–323.

Baker, W. E. 1990. Market networks and corporate behavior. ***American Journal of Sociology***, 96(3): 589–625.

Bell, S. J., Tracey, P., & Heide, J. B. 2009. The organization of regional clusters. ***Academy of Management Review***, 34(4): 623–642.

Bruderl, J., & Schussler, R. 1990. Organizational mortality: The liabilities of newness and adolescence. ***Administrative Science Quarterly***, 35(3): 530–547.

Burt, R. S., & Knez, M. 1995. Kinds of third-party effects on trust. ***Rationality and Society***, 7(3): 255–292.

Cameron, A. C., Gelbach, J. B., & Miller, D. L. 2011. Robust inference with multiway clustering. ***Journal of Business & Economic Statistics***, 29(2): 238–249.

Certo, S. T., Busenbark, J. R., Woo, H., & Semadeni, M. 2016. Sample selection bias and Heckman models in strategic management research. ***Strategic Management Journal***, 37(13): 2639–2657.

Chakrabarti, A., & Mitchell, W. 2013. The persistent effect of geographic distance in acquisition target selection. ***Organization Science***, 24(6): 1805–1826.

Chen, M.-J. 2008. Reconceptualizing the competition— cooperation relationship: A transparadox perspective. ***Journal of Management Inquiry***, 17(4): 288–304.

Cohen, W. M., & Levinthal, D. A. 1990. Absorptive capacity: A new perspective on learning and innovation. ***Administrative Science Quarterly***, 35(1): 128–152.

Coleman, J. S. 1988. Social capital in the creation of human capital. ***American Journal of Sociology***, 94: S95–S120.

Cook, R. D., & Weisberg, S. 1982. ***Residuals and Influence in Regression***. New York: Chapman and Hall.

Coombs, J. E., Mudambi, R., & Deeds, D. L. 2006. An examination of the investments in US biotechnology firms by foreign and domestic corporate partners. ***Journal of Business Venturing***, 21(4): 405–428.

Daft, R. L., & Lengel, R. H. 1986. Organizational information requirements, media richness and structural design. ***Management Science***, 32(5): 554–571.

Davis, J. P. 2016. The group dynamics of interorganizational relationships: Collaborating with multiple partners in innovation ecosystems. ***Administrative Science Quarterly***, 61(4): 621–661

Davis, J. P., & Eisenhardt, K. M. 2011. Rotating leadership and collaborative innovation: Recombination processes in symbiotic relationships. ***Administrative Science Quarterly***, *56*(2): 159–201.

DeCarolis, D. M., & Deeds, D. L. 1999. The impact of stocks and flows of organizational knowledge on firm performance: An empirical investigation of the biotechnology industry. ***Strategic Management Journal***, 20(10): 953–968.

Diestre, L., & Rajagopalan, N. 2012. Are all "sharks" dangerous? New biotechnology ventures and partner selection in R&D alliances. ***Strategic Management Journal***, 33(10): 1115–1134.

Dussauge, P., Garrette, B., & Mitchell, W. 2000. Learning from competing partners: Outcomes and durations of scale and link alliances in Europe, North America and Asia. ***Strategic Management Journal***, 21(2): 99–126.

Eisenhardt, K. M., & Schoonhoven, C. B. 1996. Resource-based view of strategic alliance formation: Strategic and social effects in entrepreneurial firms. ***Organization Science***, 7(2): 136–150.
Firth, D. 1993. Bias reduction of maximum likelihood estimates. ***Biometrika***, 80(1): 27–38.
Fligstein, N. 1985. The spread of the multidivisional form among large firms, 1919-1979. ***American Sociological Review***, 50(3): 377–391.
Folta, T. B., Cooper, A. C., & Baik, Y. 2006. Geographic cluster size and firm performance. ***Journal of Business Venturing***, 21(2): 217–242.
Freeman, C. 1997. ***The Economics of Industrial Innovation***. UK: Psychology Press.
García-Canal, E. 1996. Contractual form in domestic and international strategic alliances. ***Organization Studies***, 17(5): 773.
Garcia-Pont, C., & Nohria, N. 2002. Local versus global mimetism: The dynamics of alliance formation in the automobile industry. ***Strategic Management Journal***, 23(4): 307–321.
Gimeno, J. 2004. Competition within and between networks: The contingent effect of competitive embeddedness on alliance formation. ***Academy of Management Journal***, 47(6): 820–842.
Grossman, S. J., & Hart, O. D. 1986. The costs and benefits of ownership: A theory of vertical and lateral integration. ***Journal of Political Economy***, 94(4): 691–719.
Gulati, R. 1995. Does familiarity breed trust? The implications of repeated ties for contractual choice in alliances. ***Academy of Management Journal***, 38(1): 85–112.
Gulati, R., & Gargiulo, M. 1999. Where do interorganizational networks come from? ***American Journal of Sociology***, 104(5): 1439–1493.
Gulati, R., & Singh, H. 1998. The architecture of cooperation: Managing coordination costs and appropriation concerns in strategic alliances. ***Administrative Science Quarterly***, 43(4): 781–814.
Gulati, R., & Sytch, M. 2008. Does familiarity breed trust? Revisiting the antecedents of trust. ***Managerial and Decision Economics***, 29(2–3): 165–190.
Hagedoorn, J. 2002. Inter-firm R&D partnerships: An overview of major trends and patterns since 1960. ***Research Policy***, 31(4): 477–492.
Hagedoorn, J., & Narula, R. 1996. Choosing organizational modes of strategic technology partnering: International and sectoral differences. ***Journal of International Business Studies***, 27(2): 265–284.
Hamel, G., Doz, Y. L., & Prahalad, C. k. 1989. Collaborate with Your Competitors–and Win. ***Harvard Business Review***, 67(1): 133–139.
Hernandez, E., Sanders, W. G., & Tuschke, A. 2015. Network defense: Pruning, grafting, and closing to prevent leakage of strategic knowledge to rivals. ***Academy of Management Journal***, 58(4): 1233–1260.
Hitt, M. A., Dacin, M. T., Levitas, E., Arregle, J.-L., & Borza, A. 2000. Partner selection in emerging and developed market contexts: Resource-based and organizational learning perspectives. ***Academy of Management Journal***, 43(3): 449–467.
Hoetker, G. 2005. How much you know versus how well I know you: Selecting a supplier for a technically innovative component. ***Strategic Management Journal***, 26(1): 75–96.
Hoetker, G. 2007. The use of logit and probit models in strategic management research: Critical issues. ***Strategic Management Journal***, 28(4): 331–343.
Jaffe, A. B., Trajtenberg, M., & Henderson, R. 1993. Geographic localization of knowledge spillovers as evidenced by patent citations. ***Quarterly Journal of Economics***, 108(3): 577–598.
Jayachandran, S., Gimeno, J. and Varadarajan, P.R., 1999. The theory of multimarket competition: A synthesis and implications for marketing strategy. ***Journal of Marketing***, 63(3): 49–66.
Jones, C., Hesterly, W. S., & Borgatti, S. P. 1997. A general theory of network governance: Exchange conditions and social mechanisms. ***Academy of Management Review***, 22(4): 911–945.
Katila, R., Rosenberger, J. D., & Eisenhardt, K. M. 2008. Swimming with sharks: Technology ventures, defense mechanisms and corporate relationships. ***Administrative Science Quarterly***, 53(2): 295–332.
Khanna, T., Gulati, R., & Nohria, N. 1998. The dynamics of learning alliances: Competition, cooperation, and relative scope. ***Strategic Management Journal***, 19(3): 193–210.
Kleinbaum, A. M., Stuart, T. E., & Tushman, M. L. 2013. Discretion within constraint: Homophily and structure in a formal organization. ***Organization Science***, 24(5): 1316–1336.
Krishnan, R., Martin, X., & Noorderhaven, N. G. 2006. When does trust matter to alliance performance? ***Academy of Management Journal***, 49(5): 894–917.
Kumar, S., & Seth, A. 1998. The design of coordination and control mechanisms for managing joint venture–parent relationships. ***Strategic Management Journal***, 19(6): 579–599.

Lahiri, N. 2010. Geographic distribution of R&D activity: How does it affect innovation quality? ***Academy of Management Journal***, 53(5): 1194–1209.
Lanzolla, G., & Frankort, H. T. 2016. The online shadow of offline signals: Which sellers get contacted in online B2B marketplaces? ***Academy of Management Journal***, 59(1): 207–231.
Lerner, J. 1997. An empirical exploration of a technology race. ***RAND Journal of Economics***, 28(2): 228–247.
Leung, S. F., & Yu, S. 1996. On the choice between sample selection and two-part models. ***Journal of Econometrics***, 72(1–2): 197–229.
Li, D., Eden, L., Hitt, M. A., Ireland, R. D., & Garrett, R. P. 2012. Governance in multilateral R&D alliances. ***Organization Science***, 23(4): 1191–1210.
Loch, C. H., & Terwiesch, C. 2000. Product development and concurrent engineering. In P. M. Swamidass (Ed.), ***Innovations in Competitive Manufacturing***: 263–273. Springer US.
Marshall, A. 1920. ***Principles of Economics*** (8th edn). London, UK: Macmillan.
Mason, R., & Drakeman, D. L. 2014. Comment on "fishing for sharks: Partner selection in biopharmaceutical R&D alliances" by diestre and rajagopalan. ***Strategic Management Journal***, 35(10): 1564–1565.
McCann, B. T., & Folta, T. B. 2008. Location matters: Where we have been and where we might go in agglomeration research. ***Journal of Management***, 34(3): 532–565.
McCann, B. T., & Folta, T. B. 2011. Performance differentials within geographic clusters. ***Journal of Business Venturing***, 26(1): 104–123.
McCann, B. T., Reuer, J. J., & Lahiri, N. 2015. Agglomeration and the choice between acquisitions and alliances: An information economics perspective. ***Strategic Management Journal***, n/a-n/a.
Mesquita, L. F., Anand, J., & Brush, T. H. 2008. Comparing the resource-based and relational views: Knowledge transfer and spillover in vertical alliances. ***Strategic Management Journal***, 29(9): 913–941.
Mjoen, H., & Tallman, S. 1997. Control and performance in international joint ventures. ***Organization Science***, 8(3): 257–274.
Mowery, D. C., & Rosenberg, N. 1991. ***Technology and the Pursuit of Economic Growth***. UK: Cambridge University Press.
Narula, R., & Santangelo, G. D. 2009. Location, collocation and R&D alliances in the European ICT industry. ***Research Policy***, 38(2): 393–403.
Neter, J., Kutner, M., Nachtsheim, C., & Wasseman, W. 1996. ***Applied Linear Statistical Models***. New York: McGraw-Hill.
Orlando, M. J. 2004. Measuring spillovers from industrial R&D: On the importance of geographic and technological proximity. ***RAND Journal of Economics***, 35(4): 777–786.
Osborn, R. N., & Baughn, C. C. 1990. Forms of interorganizational governance for multinational alliances. ***Academy of Management Journal***, 33(3): 503–519.
Oxley, J. E. 1997. Appropriability hazards and governance in strategic alliances: A transaction cost approach. ***Journal of Law, Economics, and Organization***, 13(2): 387–409.
Oxley, J. E., & Sampson, R. C. 2004. The scope and governance of international R&D alliances. ***Strategic Management Journal***, 25(8–9): 723–749.
Pahnke, E. C., McDonald, R., Wang, D., & Hallen, B. 2015. Exposed: Venture capital, competitor ties, and entrepreneurial innovation. ***Academy of Management Journal***, 58(5): 1334–1360.
Park, S. H., & Russo, M. V. 1996. When competition eclipses cooperation: An event history analysis of joint venture failure. ***Management Science***, 42(6): 875–890.
Parkhe, A. 1993. Strategic alliance structuring: A game theoretic and transaction cost examination of interfirm cooperation. ***Academy of Management Journal***, 36(4): 794–829.
Phene, A., & Tallman, S. 2012. Complexity, context and governance in biotechnology alliances. ***Journal of International Business Studies***, 43(1): 61–83.
Pisano, G. P. 1989. Using equity participation to support exchange: Evidence from the biotechnology industry. ***Journal of Law, Economics, & Organization***, 5(1): 109–126.
Pisano, G. P. 1990. The R&D boundaries of the firm: An empirical analysis. ***Administrative Science Quarterly***, 35(1): 153–176.
Porter, M. E. 1998. Clusters and Competition. New Agenda for Companies. ***Governments and Institutions, in: Ibid., On Competition***, 197–287.
Powell, W. W., Koput, K. W., & Smith-Doerr, L. 1996. Interorganizational collaboration and the locus of innovation: Networks of learning in biotechnology. ***Administrative Science Quarterly***, 41(1): 116–145.
Raub, W., & Weesie, J. 1990. Reputation and efficiency in social interactions: An example of network effects. ***American Journal of Sociology***, 96(3): 626–654.

Reuer, J. J., & Devarakonda, S. V. 2016. Mechanisms of hybrid governance: Administrative committees in non-equity alliances. ***Academy of Management Journal***, 59(2): 510–533.
Reuer, J. J., & Lahiri, N. 2014. Searching for alliance partners: Effects of geographic distance on the formation of R&D collaborations. ***Organization Science***, 25(1): 283–298.
Reuer, J. J., Zollo, M., & Singh, H. 2002. Post-formation dynamics in strategic alliances. ***Strategic Management Journal***, 23(2): 135–151.
Robinson, D. T., & Stuart, T. E. 2007. Financial contracting in biotech strategic alliances. ***Journal of Law and Economics***, 50(3): 559–596.
Rosenkopf, L., & Almeida, P. 2003. Overcoming local search through alliances and mobility. ***Management Science***, 49(6): 751–766.
Rothaermel, F. T. 2001. Incumbent's advantage through exploiting complementary assets via interfirm cooperation. ***Strategic Management Journal***, 22(6–7): 687–699.
Rothaermel, F. T. 2002. Technological discontinuities and interfirm cooperation: What determines a startup's attractiveness as alliance partner? ***IEEE Transactions on Engineering Management***, 49(4): 388–397.
Rothaermel, F. T., & Boeker, W. 2008. Old technology meets new technology: Complementarities, similarities, and alliance formation. ***Strategic Management Journal***, 29(1): 47–77.
Saxenian, A. 1990. Regional networks and the resurgence of Silicon Valley. ***California Management Review***, 33(1): 89–112.
Saxenian, A. 1996. ***Regional Advantage: Culture and Competition in Silicon Valley and Route 128***. Cambridge, MA: Harvard University Press.
Schilling, M. A. 2009. Understanding the alliance data. ***Strategic Management Journal***, 30(3): 233–260.
Shaver, J. M., & Flyer, F. 2000. Agglomeration economies, firm heterogeneity, and foreign direct investment in the United States. ***Strategic Management Journal***, 21(12): 1175–1193.
StataCorp. 2015. ***Stata Statistical Software: Release 14.*** College Station, TX: StataCorp LP.
Stinchcombe, A. L. 1968. ***Constructing Social Theories***. Chicago: University of Chicago Press.
Thompson, J. D. 1967. ***Organizations in Action: Social Science Bases of Administrative Theory***. Piscataway, NJ: Transaction Publishers.
Train, K. 1986. ***Qualitative Choice Analysis: Theory, Econometrics, and an Application to Automobile Demand***. Cambridge, MA: MIT Press.
Tsai, W. 2001. Knowledge transfer in intraorganizational networks: Effects of network position and absorptive capacity on business unit innovation and performance. ***Academy of Management Journal***, 44(5): 996–1004.
Tushman, M. L., & Nadler, D. A. 1978. Information processing as an integrating concept in organizational design. ***Academy of Management Review***, 3(3): 613–624.
Tyler, B. B., & Steensma, H. K. 1998. The effects of executives' experiences and perceptions on their assessment of potential technological alliances. ***Strategic Management Journal***, 19(10): 939–965.
Van De Ven, A. H., Delbecq, A. L., & Koenig, R. 1976. Determinants of coordination modes within organizations. ***American Sociological Review***, 41(2): 322–338.
Vassolo, R. S., Anand, J., & Folta, T. B. 2004. Non-additivity in portfolios of exploration activities: A real options-based analysis of equity alliances in biotechnology. ***Strategic Management Journal***, 25(11): 1045–1061.
Vincenty, T. 1975. Direct and inverse solutions of geodesics on the ellipsoid with application of nested equations. ***Survey Review***, 23(176): 88–93.
Walker, G., Kogut, B., & Shan, W. 1997. Social capital, structural holes and the formation of an industry network. ***Organization Science***, 8(2): 109–125.
Williamson, O. E. 1991. Comparative economic organization: The analysis of discrete structural alternatives. ***Administrative Science Quarterly***, 36(2): 269–296.
Wilson, S. & Thttle, D. 2008. Opening up: The promise and pitfalls of alliances. ***Deloitte Review***, issue 3: 25-33.
Yan, A., & Gray, B. 1994. Bargaining power, management control, and performance in United States-China joint ventures: A comparative case study. ***Academy of Management Journal***, 37(6): 1478–1517.
Yang, H., Zheng, Y., & Zhao, X. 2014. Exploration or exploitation? Small firms' alliance strategies with large firms. ***Strategic Management Journal***, 35(1): 146–157.
Yates, B.W. 1983. ***The decline and fall of the American automobile industry.*** New York: Empire Books.

Table 1. Descriptive Statistics and Correlation Matrix[a]

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)
(1) Equity Alliance	1														
(2) Scope	0.01	1													
(3) Reciprocal Interdependence	0.00	-0.06	1												
(4) Risk from Partner-Rival Co-location (based on MSAs)	**0.10**	-0.04	-0.06	1											
(5) Risk from Partner-Rival Co-location (based on CSAs)	**0.08**	-0.06	-0.06	**0.91**	1										
(6) Risk from Partner-Rival Co-location (based on 50-mile radial distance)	**0.08**	-0.07	-0.04	**0.88**	**0.88**	1									
(7) Prior Ties	-0.04	-0.04	-0.03	-0.01	0.03	0.00	1								
(8) Indirect Ties	-0.05	-0.03	0.02	0.07	0.07	**0.08**	0.38	1							
(9) Degree Centrality of Focal Firm	-0.04	**-0.11**	0.06	-0.03	-0.02	-0.00	**0.12**	**0.24**	1						
(10) Degree Centrality of Partner	-0.07	-0.02	0.00	0.02	0.03	0.01	**0.33**	**0.64**	0.00	1					
(11) Size of Focal Firm	0.00	**-0.16**	0.06	-0.03	-0.03	0.00	0.05	**0.16**	**0.84**	-0.01	1				
(12) Patent Counts of Focal Firm	0.02	-0.04	0.06	**0.08**	0.08	0.07	**0.08**	**0.17**	**0.33**	**0.10**	**0.32**	1			
(13) Patent Counts of Partner	-0.02	-0.01	0.05	-0.02	-0.02	-0.01	**0.10**	0.02	0.03	0.05	-0.01	0.02	1		
(14) Cluster Size	0.00	0.06	-0.05	**0.47**	**0.39**	**0.36**	0.05	0.07	**-0.09**	**0.13**	-0.08	0.04	-0.04	1	
(15) Distance (miles)	-0.05	-0.01	0.02	**-0.19**	**-0.20**	**-0.16**	-0.01	0.01	0.04	-0.02	0.04	-0.03	-0.01	**-0.12**	1
Mean	0.07	0.15	0.46	0.01	0.02	0.02	0.10	0.92	101.79	10.46	18.8	181.40	97.70	57.84	1170.2
Standard Deviation	0.25	0.36	0.50	0.05	0.06	0.05	0.37	2.61	88.48	27.57	20.30	283.09	1258.1	54.52	1007.0
Min	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0
Max	1	1	1	0.46	0.54	0.46	3	38	265	282	61.8	2932	31323	214	2701.0

[a] N=639. Bolded pairwise correlations are significant at least at 0.05 level.

Table 2. Probit Model Estimation Results[a]

	Model					
	(1)	(2)	(3)	(4)	(5)	(6)
	H1		H2		H3	
Variables	Equity Alliance		Scope		Reciprocal Interdependence	
Risk from Partner-Rival Co-location		3.795***		-3.981**		-2.602**
(based on MSAs)		(1.328)		(1.594)		(1.211)
Direct Ties	-0.180	-0.128	-0.208	-0.229	-0.283*	-0.300**
	(0.387)	(0.384)	(0.188)	(0.191)	(0.152)	(0.149)
Indirect Ties	0.066	0.052	0.018	0.028	0.011	0.018
	(0.079)	(0.086)	(0.029)	(0.028)	(0.027)	(0.028)
Degree Centrality of Focal Firm	-0.004**	-0.004**	0.003**	0.003**	0.000	0.000
	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)
Degree Centrality of Partner	-0.024	-0.024	-0.004	-0.005	-0.001	-0.001
	(0.022)	(0.023)	(0.003)	(0.003)	(0.003)	(0.003)
Size of Focal Firm	0.000*	0.000*	-0.000***	-0.000***	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Patent Counts of Focal Firm	0.000	-0.000	-0.000*	-0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Patent Count of Partner	-0.002**	-0.002**	-0.000	-0.000	0.000*	0.000*
	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
Cluster Size	0.000	-0.002*	0.001	0.002	-0.001	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Distance	-0.000	-0.000	0.000	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Technology Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Therapeutic Area Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Phase Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-1.395***	-1.411***	-5.827***	-5.791***	-0.013	-0.015
	(0.395)	(0.405)	(0.291)	(0.289)	(0.280)	(0.280)
Log Pseudolikelihood	-127.31	-124.56	-204.83	-203.06	-372.59	-370.70
Wald Chi-squared	301.8***	286.5***	2309.9***	2547.0***	425.6***	464.8***
Pseudo R^2	0.2052	0.2224	0.2424	0.2490	0.1552	0.1595
Observations	639	639	639	639	639	639

[a] Cluster-robust standard errors by focal firms in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 3. Probit Model Estimation Results – Robustness Analyses[a]

	Model								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	H1			H2			H3		
Variables	Equity Alliance			Scope			Reciprocal Interdependence		
Risk from Partner-Rival Co-location	2.787***			-3.957***			-1.903*		
(based on CSAs)	(1.066)			(1.449)			(0.993)		
Risk from Partner-Rival Co-location		2.825**			-4.396**			-1.702**	
(based on 50-mile radial distance)		(1.118)			(1.766)			(0.868)	
Risk from Partner-Rival Co-location			3.107***			-4.399***			-1.692**
(based on MSAs patenting more than 30%)			(0.972)			(1.462)			(0.751)
Direct Ties	-0.145	-0.146	-0.142	-0.226	-0.219	-0.228	-0.281*	-0.293*	-0.295**
	(0.384)	(0.387)	(0.391)	(0.195)	(0.191)	(0.193)	(0.159)	(0.151)	(0.150)
Indirect Ties	0.056	0.051	0.052	0.028	0.029	0.029	0.015	0.017	0.016
	(0.084)	(0.084)	(0.085)	(0.027)	(0.027)	(0.027)	(0.029)	(0.028)	(0.028)
Degree Centrality of Focal Firm	-0.004**	-0.004**	-0.004**	0.003**	0.003*	0.003*	0.000	0.000	0.000
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)
Degree Centrality of Partner	-0.024	-0.024	-0.024	-0.005	-0.005*	-0.005*	-0.001	-0.001	-0.001
	(0.022)	(0.023)	(0.022)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Size of Focal Firm	0.000*	0.000	0.000*	-0.000***	-0.000***	-0.000***	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Patent Counts of Focal Firm	0.000	-0.000	0.000	-0.000	-0.000	-0.000	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Patent Count of Partner	-0.002**	-0.002**	-0.002**	-0.000	-0.000	-0.000	0.000*	0.000*	0.000*
	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Cluster Size	-0.002	-0.002	-0.002*	0.002	0.002	0.003*	0.000	-0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
Distance	-0.000	-0.000	-0.000	0.000	0.000	0.000	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Technology Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Therapeutic Area Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Phase Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-1.444***	-1.446***	-1.480***	-5.775***	-5.779***	-5.759***	0.009	0.008	0.008
	(0.410)	(0.406)	(0.415)	(0.292)	(0.292)	(0.289)	(0.284)	(0.285)	(0.284)
Log Pseudolikelihood	-125.24	-125.33	-124.47	-202.45	-202.44	-201.78	-370.91	-371.34	-371.24
Wald Chi-squared	282.7***	283.5***	283.9***	2609.5***	2453.3***	2776.0***	449.8***	434.8***	515.3***
Pseudo R^2	0.2181	0.2176	0.2229	0.2512	0.2512	0.2537	0.1590	0.1580	0.1583
Observations	639	639	639	639	639	639	639	639	639

[a] Cluster-robust standard errors by focal firms in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 4. Heckman Probit Model Estimation Results[a]

	Model						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Selection	Outcome					
		H1		H2		H3	
Variables		Equity Alliance		Scope		Reciprocal Interdependence	
Risk from Partner-Rival Co-location			3.772**		-3.885**		-2.725**
(based on MSAs)			(1.467)		(1.809)		(1.231)
Direct Ties	0.304***	-0.356	-0.305	-0.106	-0.129	-0.408**	-0.428***
	(0.092)	(0.404)	(0.406)	(0.214)	(0.214)	(0.161)	(0.162)
Indirect Ties	0.006	0.053	0.041	0.022	0.032	0.007	0.013
	(0.014)	(0.088)	(0.092)	(0.034)	(0.036)	(0.031)	(0.032)
Degree Centrality of Focal Firm	-0.000	-0.005***	-0.005***	0.004**	0.004**	-0.001	-0.001
	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)	(0.001)	(0.001)
Degree Centrality of Partner	-0.001	-0.024	-0.024	-0.005	-0.005*	0.000	-0.000
	(0.001)	(0.022)	(0.023)	(0.003)	(0.003)	(0.003)	(0.003)
Size of Focal Firm	0.000	-0.000	-0.000	-0.000*	-0.000*	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Patent Counts of Focal Firm	0.000	-0.000	-0.000	-0.000	-0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Patent Count of Partner	0.000	-0.003*	-0.003*	-0.000	-0.000	0.000	0.000
	(0.000)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)	(0.000)
Cluster Size	-0.000	0.000	-0.002	0.001	0.002*	-0.001	0.000
	(0.000)	(0.001)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)
Distance	-0.000	-0.000	-0.000	0.000	0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	-1.728***	0.798	0.742	-6.801***	-6.750***	1.206**	1.233**
	(0.076)	(0.744)	(0.757)	(0.824)	(0.824)	(0.560)	(0.562)
Rivals' Num. of Alliances (t-1)	0.020***						
	(0.002)						
Inverse Mills Ratio		-1.119***	-1.096***	0.449	0.441	-0.599**	-0.614**
		(0.337)	(0.344)	(0.365)	(0.367)	(0.250)	(0.251)
Technology Fixed Effects	No	Yes	Yes	Yes	Yes	Yes	Yes
Therapeutic Area Fixed Effects	No	Yes	Yes	Yes	Yes	Yes	Yes
Phase Fixed Effects	No	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Log Pseudolikelihood	-1899.38	-123.99	-121.41	-204.09	-202.35	-369.85	-367.85
Wald Chi-squared	479.7***	92.3***	95.4***	1232.7***	1344.8***	123.6***	129.6***
Pseudo R^2	0.1130	0.2259	0.2420	0.2452	0.2516	0.1614	0.1659
Observations	7,029	639	639	639	639	639	639

[a] Cluster-robust standard errors by focal firms in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Geographic Locations of Partners and Rivals:
Implications for the Design of R&D Alliances
AMJ-2016-0416.R1
Response to the Associate Editor

AE.C1: ***Remaining issues.*** *The way I see it, many of the remaining issues from the reviewers are mostly about clarifications, or simpler additional analyses. I would expect you to provide a detailed response to their concerns, so I can check how you responded to those in the next round. The reviewers are very encouraging about the paper, and have an interest to help you produce the best possible outcome, so please take their concerns as serious as you did in the prior round. I believe it will be well worth it.*

Response: We are very glad that you and the reviewers viewed our previous revision positively. We also think the paper was improved substantially in the review process thanks to your clear guidance as well as the thoughtful and constructive comments from you and the reviewers. Following your advice, we have provided detailed responses to each comment from the reviewers. As we endeavored to address the reviewer comments, we found the paper to be further improving, and we hope you will have the same impression. We again appreciate your helpful suggestions about the directions for our revision to take as well as the valuable feedback from you and the reviewers.

AE.C2: ***Streamline the paper.*** *I have now read the paper multiple times, and I believe some parts of the paper are unnecessarily repetitive and verbose. This version is much better than the first, but please pay attention to this once again. The basic structure of the argument works, but I would urge you to shorten the paper and read through it with a focus on making it more concise and even more to the point. I believe that will ultimately maximize the impact of the paper as well.*

Response: We appreciate the advice to streamline the paper. We have made a number of efforts to reduce areas of repetition and to ensure the arguments are as concise as possible. As just one example, the advice we received related to the introduction resulted in reducing that material to under three total pages. Overall, we reduced the length of the paper by 11%.

AE.C3: ***Theorizing.*** *Overall, I was very happy about the trajectory of the paper. I will highlight some issues in the interest of making the paper as impactful as possible. All three reviewers point out that there is room to center the theorizing. What seems unique here is the dyadic focus, so please re-work the introduction so it is more at the core to this. I know it is "AMJ-style" to elaborate on all contributions in the introduction, but I think this is something which you could also shorten significantly. Tell us what you do, what is unique, and what the core insight is. As you know, AMJ is more of a broad journal compared with more strategy-focused journals, and I think it is particularly important to summarize the core idea for which you want to get this paper remembered.*

Response: As briefly mentioned above, we have substantially revised the introduction. It now more clearly highlights the unique aspect of moving beyond the dyadic focus of direct competition between direct rivals who form partnerships. We have also significantly tightened

the description of the contributions, providing a clear, concise explanation of what we have done and why we think it is unique while providing emphasis of the core idea.

AE.C4: ***Empirics.*** *Reviewer 2 has important considerations about the extreme values. I had a similar reaction when reading the descriptive statistics and it would be useful to show whether this is an issue. I think it would be enough to discuss this issue in the robustness checks of the paper. Please summarize the core findings on this issue too.*

Response: As detailed in the response to Reviewer 2 (R2C3), we took several approaches to investigate possible concerns about outliers and influential points. First, we re-estimated the models using the log transformed value of the independent variable (i.e., *Risk from Partner-Rival Co-location*) to suppress the influence of the observations with extreme values. Second, also focusing on the outliers of the independent variable, we winsorized it at 99th, 98th, and 90th percentiles and re-ran the models. Third, we took multivariate approaches using studentized residuals and Cook's Distance to inspect observations with high discrepancy and influence respectively. In sum, our results were robust to these remedies for outliers and influential points. The full results are reported in our response to R2C3 below. We also included the summary results of these robustness checks in the revised paper in the section devoted to robustness analyses.

AE.C5: ***Other Miscellaneous Issues.*** *Finally, there are some other minor issues to address as you move toward the final version of this work. These include:*

(a) Please remove any citations or references to From the Editors--the editorials that begin each issue of AMJ--from your manuscript. From the Editors are typically 4-5 pages in length, are written by members of the editorial team, and do not have traditional bylines or abstracts. AMJ's website lists the members of the past two editorial teams (http://aom.org/Publications/AMJ/Welcome-to-AMJ.aspx) if you are not certain whether a given article is indeed a From the Editors. Authors are asked to remove citations to From the Editors to avoid the appearance that the Journal is trying to encourage unnecessary self-citations. Please find appropriate substitutes for those citations and references where needed.

(b) When you submitted your manuscript, you were asked to indicate to the action editor whether you had previously published another manuscript that uses either some of the same variables from this data collection effort, or that uses some of the same cases/observations from this data collection effort. You were also asked to explain, in detail, the nature of that overlap. If you indicated that there is some overlap in variables or cases/observations, please now detail the precise nature of that overlap for the reader in your Method section, including all necessary citations and references. Those passages are important in order to give the reader a sense of where this paper fits into your larger stream of research, and are also critical to future meta-analysts who may need to gauge the non-independence of findings across studies. Please reproduce the text inserted into your Method section in your responses document, so that the action editor can inspect it clearly and comprehensively.

Response: We checked our references to ensure that the paper does not cite any 'From the Editors' articles. Also, please note that the dataset in this paper has not been used in any other

publications. We did make a few minor revisions to clarify that Recap is an available secondary data source that has been used by other researchers and that we followed the general approach of one of those papers (Reuer & Devarakonda, 2016) in constructing one of our variables (*Reciprocal Interdependence*). Those two revisions read as follows:

- "For the alliance data, we drew on Thomson Reuters' Recap database, which provides detailed information on alliance governance and design. As one of the most robust and representative data sources on alliances in the biopharmaceutical industry (Schilling, 2009), Recap has served as a data source for a number of investigations of biopharmaceutical alliance activity (e.g., Reuer & Devarakonda, 2016, Robinson & Stuart, 2007; Rothaermel and Boeker, 2008)." (page 17)
- "Our third dependent variable is *Reciprocal Interdependence*, a binary variable which distinguishes the level of task independence between a focal firm and a partner. To construct this variable, we followed the approach of Reuer and Devarakonda (2016), coding the variable as . . ." (page 18)

Response to Reviewer 1

In the R1 version of this paper, the authors weave theoretical arguments from alliance and agglomeration studies to propose that geographic co-location between a firm's partner and rival, because it presents a potential indirect path for knowledge leakage, which trigger the firm adopting defensive mechanisms when designing the alliance, such as equity (for monitoring and control) and reduced alliance scope and interdependence. The authors advance a much stronger and compelling argument compared to the previous version, and I can only applaud the review work done. Importantly, the paper weaves conceptual arguments from two literatures to put forth the idea that a firm must take preventive steps to secure its knowledge from spilling over onto its ally as well as its rivals co-located with the partner. This is novel in the literature (though I don't think this is counter intuitive, that is given dangers of leakage, one would naturally seek stronger governance mechanisms) so it deserves consideration.

R1C1. *1) FRAMING – I like your framing much more this time. I particularly think the reference to focal firm, partner, and nearby rival makes the story weaving much cleaner and straightforward, thus helping you carve a niche for your study.*

Response: N/A – we were pleased to receive these positive comments from the reviewer.

R1C2. *2) Your introduction has 2 full pages of 'contributions'. I agree it is important to give readers a sense of value delivered, though let me suggest you help readers by pacing it up a bit. Your main contribution lies with the literature concerned with indirect exposure through alliances, which speaks to your 'theoretical hook' of competition - cooperation (i.e., your 1st paragraph in the laundry list) but can you say the same with half the words?, while the protection against knowledge leakage can be folded into the 1st paragraph, and the contribution to the agglomeration literature can be outlined more parsimoniously. Ultimately, fold your introduction into 2 ½ pages?*

Response: We have substantially shortened the introduction, including the contributions. As suggested, the revised manuscript clearly emphasizes that the main contribution is concerned with the issue of indirect exposure via alliances. The revised introduction is now under three pages per the suggestion.

R1C3. *3) THEORY – your theory is significantly improved. Your theoretical arguments leading to each hypothesis statement, which I had previously criticized for being insufficient and lacking in logic, now are more thoroughly delineated. I particularly like your arguments on how equity can help prevent knowledge leakage in the partner firm towards a co-located rival (e.g., observational and voting rights, monitoring and alignment incentive). The mechanisms are more clearly established. The arguments for scope, regarding how vertical scope entails the possible transfer of know how are also intriguing. And the idea that levels of interdependencies relate to the risk of knowledge leakage are also well delineated, in my view.*

Response: N/A – we were pleased to receive these positive comments from the reviewer.

R1C4. *4) CONSTRUCT and METRIC: I also like your more precise definition of 'risk from partner-rival co-location'. The metric is an improvement as well, based on a 3-way scope of risk exposure, based on number of rivals co-located, strength of rivals, and market importance to focal firm. This metric encompasses the probability set as well as relative size of loss, correctly representing the notion of 'risk'.*

Response: N/A – we were pleased to receive these positive comments from the reviewer.

R1C5. *5) WRITING – I was able to follow your writing well, but you may want to consider some polishing and editing.*

a. In some cases passages can be streamlined, and word repetition reduced (e.g., in the 2nd paragraph of the 1st page, you use the word exposure 4 times in 3 lines). Use it only once, or if twice, use a synonym.

b. Your writing is still verbose. Reduce word count for things that quite obvious (e.g., "…between an allying firm's partner and rivals of the allying firm…" – why not just "… between a firm's alliance partner and rivals…". This version is much improved from the last, regarding this issue, but the author can take a second round of efforts to improve it to a higher level still.

c. Punctuation – check the use of semi colon. In "… path to rivals; they also address…", for example, the 2 sentences are reasonably disconnected, and stand alone nicely, so a period can be used instead. Again, check Kolln's 'rhetoric and grammar' for these nuances.

d. There's some repetition throughout the document, which you can eliminate, making for a more concise and fluid reading. For example, you indicate twice that you focus on domestic alliances by US pharmaceutical and biotech ventures. You also repeat that US pharmaceutical industry is characterized by significant geographic agglomeration. Also, words and sometimes entire

phrases travel from the introduction into the literature review, as well as theory. Try and trim down the manuscript across these passages. A professional copy editor can help.

e. You can bring manuscript down from 47 pages to the usual 40 by implementing the above changes.

Response: We appreciate the advice to further edit the paper. In addition to the specific suggestions included in the comment, which we have addressed, we re-read and revised the paper in its entirety to make additional improvements.

Finally, let me convey my impression that you did a thorough job addressing not only my earlier suggestions on theory, but most importantly, the empirics. I am much more optimistic about your empirical analyses, which now control for multiple alternative explanations that the previous metrics could not. The efforts have paid off, in my view. I hope my new suggestions above help you tighten the study further, and reach the level readers deserve. Warm wishes!

Response: N/A – we were pleased to receive these positive comments from the reviewer.

Response to Reviewer 2

Thank you very much for your revisions and the detailed responses to previous comments. Many aspects of the theory and analysis have become clearer and more convincing. For the most part, I find the theoretical background and hypotheses sections clear and convincing, and believe the paper is much more closely aligned with the alliance literature now that you have added scope as a dependent variable. Scope itself has not been studied very much, in my reading of the literature, and certainly not in relation to the co-location of partners and rivals. That said, I still have a number of questions and suggestions that I hope you are willing to consider. These mostly concern the exact positioning of the paper and several empirical issues.

Main issues

R2C1. *You position the paper in the literature by noting a lack of systematic understanding on the interplay between competition and collaboration in the field of strategy. This framing is overly broad and unnecessary for my taste because the alliance literature has in many ways had a strong and longstanding emphasis on aspects of competition and misappropriation. Of course, you acknowledge this and I agree that misappropriation has largely been looked at through a dyadic lens. I wonder whether this specific observation would make for a more focused starting point of the paper?*

Response: Regarding the positioning of the paper in the literature, in the revised paper we have followed the advice to avoid the overly broad framing of a general lack of systematic understanding on the interplay between competition and collaboration in the field of strategy. Instead, as suggested in this comment, we narrowed the positioning to focus on the fact that the alliance literature has paid attention to knowledge leakage to rivals stemming from direct collaborations, but not to the same risk through indirect exposure to rivals created by partner-rival co-location.

R2C2. *In my view, perhaps the thinnest aspect of your motivation is the claim that the agglomeration literature has suggested it may be beneficial for outsiders to deal with partners located in a cluster. In your framing, this claim is important for you to be able to offer the insight that there may also be downsides. You only cite Rothaermel (2002) to support this point, as far as I could see, yet I believe there is much more you need to do to convince the reader that prior literature empirically makes the specific point on which you build. Findings exist outside the R&D alliance context, for example, showing that firms in clusters are targeted relatively more frequently in online B2B markets (Lanzolla & Frankort 2016 AMJ: 223-24), but I believe more specific evidence relevant to your context is also necessary. Relatedly, please be careful in your language not to mix the downside of location in a geographic cluster with that of partnering with a firm located in a geographic cluster (e.g., p. 5).*

Response: We have taken the following actions in response to the two suggestions in this comment.

First, we have cited additional work beyond Rothaermel (2002) to support the point that location in a cluster helps firms draw outside partners. In addition to the Lanzolla and Frankort (2016) suggested study, which we appreciate, we also now cite Almazan, DeMotta, Titman and Uysal (2010) who describes the increased formation of acquisitions with clustered firms. To provide more specific evidence relevant to our context, we now mention Folta, Cooper, and Baik (2006) who provide evidence of the higher levels of partnering with firms located in biotechnology clusters and Coombs, Mudambi and Deeds (2006) who show that the technological munificence of a biotechnology firm's region plays an important role in attracting alliance capital from corporate partners. Please see page 7 for these changes.

Second, we have revised our language consistent with the suggestion to not mix downsides of locating in a cluster with that of partnering with clustered firms.

R2C3. *Your key independent variable (based on MSAs) has a mean of 0.01, a SD of 0.05, and a maximum of 0.46 (Table 1, p. 43). I expect these numbers to be similar in spirit (but likely smaller given fewer rivals in a smaller area) for the alternative specifications based on CSAs and a 50-mile radius. First, please report summary statistics and correlations for all three measures in Table 1. Second, the summary statistics suggest that the key independent variable is skewed to the right and I would preferably see the full distribution as a histogram in your response. It is certainly necessary to perform and discuss some analysis of influence. For example, what do averages for the DVs by deciles or quartiles of the independent variables look like? And what happens when you winsorize or trim the independent variable(s) above the 90th, 95th, 98th, or 99th percentiles? Given that you exploit variance across alliances, one might worry that some extreme values are driving much of what we see in the results. It is important, in my view, to triangulate analysis of this issue in order to put such concerns to rest in a compelling and transparent way. Several of the controls also show strong skew and so multivariate approaches to identifying and selectively excluding influential cases may also be necessary.*

Response: The summary statistics for *Risk from Partner-Rival Co-location* based on MSA, CSA, and 50-mile radial distance are reported for comparison as follows:

Risk from Partner-Rival Co-location	Obs	Mean	S.D.	Min	Max
MSA-based	639	0.0117	0.0491	0	0.4606
CSA-based	639	0.0156	0.0594	0	0.5361
50-mile radial distance-based	639	0.0167	0.0548	0	0.4606

Per the suggestion, we included not only this information but also correlations in Table 1 in the revised paper.

Regarding Reviewer 2's concern that some extreme values of *Risk from Partner-Rival Co-location* might be driving the results, we did several supplementary analyses for robustness checks. First, we reran the models using the log transformed values of the variable. As can be seen in the below table, our results are robust to this transformation.

Probit results using log transformation of the independent variable

	Model		
	(1)	(2)	(3)
	H1	H2	H3
Variables	Equity Alliance	Scope	Reciprocal interdependence
Log(Risk from Partner-Rival Co-location + 1) (based on MSAs)	4.519***	-4.420**	-2.954**
	(1.559)	(1.787)	(1.402)
Direct Ties	-0.127	-0.228	-0.300**
	(0.384)	(0.191)	(0.150)
Indirect Ties	0.052	0.028	0.018
	(0.087)	(0.028)	(0.028)
Degree Centrality of Focal Firm	-0.004**	0.003**	0.000
	(0.002)	(0.002)	(0.001)
Degree Centrality of Partner	-0.025	-0.005	-0.001
	(0.023)	(0.003)	(0.003)
Size of Focal Firm	0.000*	-0.000***	-0.000
	(0.000)	(0.000)	(0.000)
Patent Counts of Focal Firm	-0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)
Patent Count of Partner	-0.002**	-0.000	0.000*
	(0.001)	(0.000)	(0.000)
Cluster Size	-0.002*	0.002	0.000
	(0.001)	(0.001)	(0.001)
Distance	-0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)
Technology Fixed Effects	Yes	Yes	Yes
Therapeutic Area Fixed Effects	Yes	Yes	Yes
Phase Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Constant	-1.411***	-5.792***	-0.013
	(0.404)	(0.289)	(0.280)

Log Pseudolikelihood	-124.51	-203.08	-370.76
Wald Chi-squared	288.00	2525.15	463.89
Pseudo R^2	0.2227	0.2489	0.1594
Observations	639	639	639

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Second, we also re-ran the models using winsorized values of *Risk from Partner-Rival Co-location.* In an effort to follow the norms of *AMJ*, we checked the approach of prior published papers in *AMJ* that used winsorized values based on percentile cutoffs. As summarized below, the most common approach of papers that winsorized was to winsorize at the 1st / 99th percentile. We also saw two papers that noted winsorization at the 2nd / 98th percentile. Thus, we checked the robustness of our results per the most standard approaches in *AMJ* (i.e., winsorization at the 99th and 98th percentile).

Study	**1st / 99th**	**2nd / 98th**	**10th /90th**
Crossland et al. (2014)		**X**	
Gomulya &Mishina (2017)	**x**		
Inoue, Lazzarini &Musacchio (2013)	**x**		
Martin, Gomez-Mejia & Wiseman (2013)	**x**		
McNamara, Haleblian & Dykes (2008)	**x**	**X**	**x**
Titus, Parker & Bass (2017)	**x**		
Zhang & Qu (2016)	**x**		

As can be seen in the table below, our results are largely robust to these transformations as well (given that there was one study that utilized winsorization at the 90th percentile, we also checked the results under this more aggressive cutoff. Under winsorization at the 90th percentile, the respective p-values for the hypothesized relationships are 0.086, 0.045, and 0.183). We have revised the paper (page 27) to note the results associated with these additional checks.

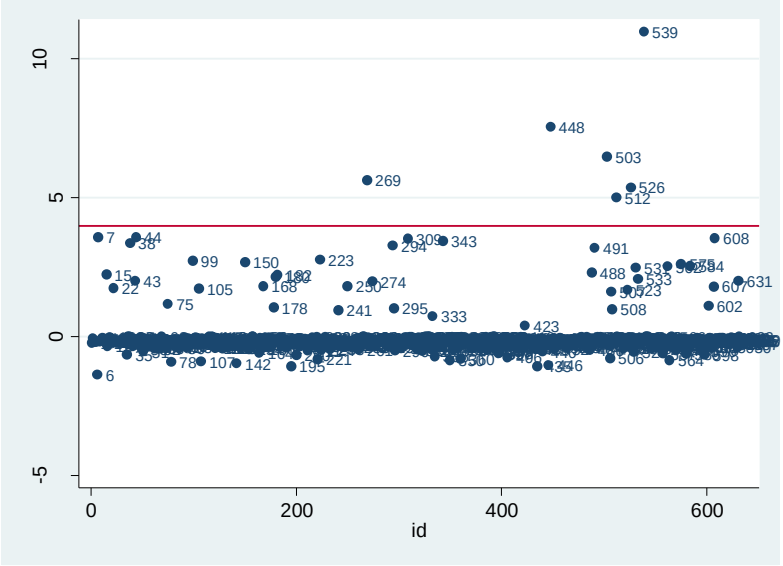
Probit results using winsorized values of *Risk from Partner-Rival Co-location.*

	Model					
	(1)	(2)	(3)	(4)	(5)	(6)
	H1		H2		H3	
Variables	Equity Alliance		Scope		Reciprocal Interdependence	
Risk from Partner-Rival Co-location	6.57***		-4.33*		-3.50*	
(based on MSA & winsorized at 98%)	(2.52)		(2.32)		(1.92)	
Risk from Partner-Rival Co-location		4.97***		-4.26**		-2.74*
(based on MSA & winsorized at 99%)		(1.74)		(1.82)		(1.52)
Direct Ties	-0.13	-0.12	-0.22	-0.23	-0.30**	-0.30**
	(0.38)	(0.39)	(0.19)	(0.19)	(0.15)	(0.15)
Indirect Ties	0.05	0.05	0.03	0.03	0.02	0.02
	(0.09)	(0.09)	(0.03)	(0.03)	(0.03)	(0.03)
Degree Centrality of Focal Firm	-0.00**	-0.00**	0.00**	0.00**	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Degree Centrality of Partner	-0.02	-0.02	-0.00	-0.01	-0.00	-0.00
	(0.02)	(0.02)	(0.00)	(0.00)	(0.00)	(0.00)
Size of Focal Firm	0.00*	0.00*	-0.00***	-0.00***	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Patent Counts of Focal Firm	0.00	0.00	-0.00*	-0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Patent Count of Partner	-0.00**	-0.00**	-0.00	-0.00	0.00*	0.00*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Cluster Size	-0.00*	-0.00*	0.00	0.00	0.00	0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Distance	-0.00	-0.00	0.00	0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Technology Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Therapeutic Area Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Phase Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Constant	-1.40***	-1.40***	-5.81***	-5.80***	-0.01	-0.01
	(0.40)	(0.40)	(0.29)	(0.29)	(0.28)	(0.28)
Log Pseudolikelihood	-124.94	-124.49	-203.66	-203.21	-371.29	-371.14
Wald Chi-squared	290.17	302.58	2333.96	2479.21	452.50	451.97
Pseudo R^2	0.2200	0.2228	0.2467	0.2484	0.1582	0.1585
Observations	639	639	639	639	639	639

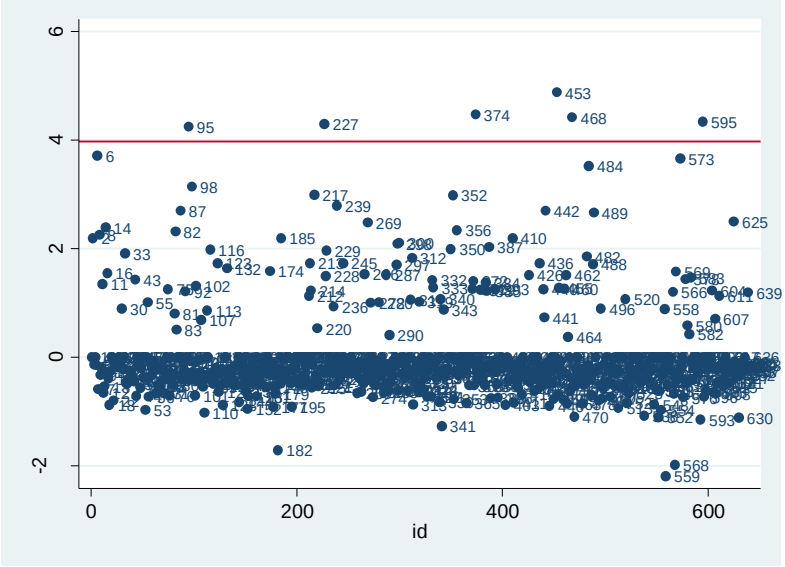
Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Finally, we also used a couple of multivariate approaches based on studentized residuals and Cook's Distance to investigate the possible impact of outliers and influential points. First, we visually inspected studentized residuals because studentized residulas have been recommended as more appropriate than the standardized residuals for detecting outliers, and then re-tested the hypotheses excluding the observations with studentized residuals greater than the suggested threshold (i.e., $t_{n-p-1}(1-\alpha/2n)=3.978$ when $\alpha = 0.05$) (Kutner, Nachtsheim, & Neter, 1996). As can be seen in the below graphs and table, there were 6, 6, and 1 observations that exceeded the threshold for H1, H2, and H3 models respectively and our results remained robust in this estimation excluding those outliers.

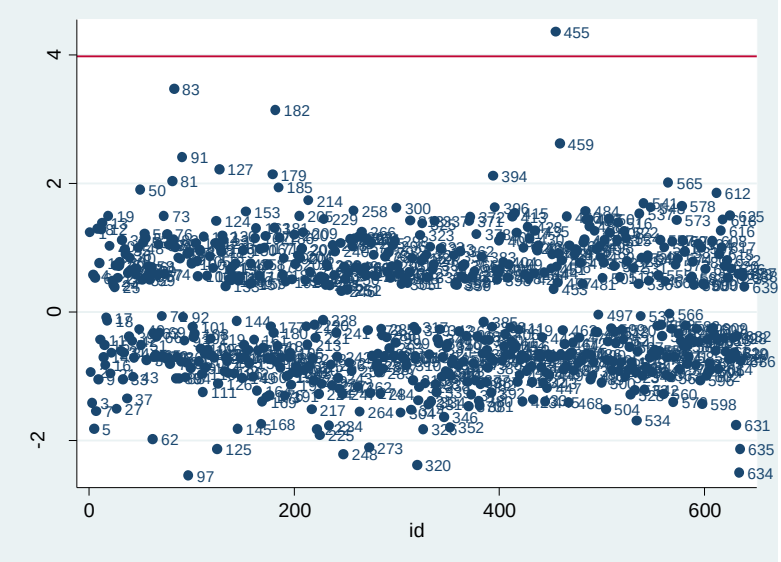
Studentized Pearson Residuals - Equity Alliance



Studentized Pearson Residuals - Scope



Studentized Pearson Residuals – Reciprocal Interdependence



Probit results excluding observations with studentized residuals greater than the threshold

	Model		
	(1)	(2)	(3)
	H1	H2	H3
Variables	Equity Alliance	Scope	Reciprocal Interdependence
Risk from Partner-Rival Co-location	4.585***	-3.512**	-2.610**
(based on MSAs)	(1.459)	(1.412)	(1.202)
Direct Ties	-0.698	-0.162	-0.315**
	(0.666)	(0.206)	(0.148)
Indirect Ties	0.217***	0.008	0.023
	(0.071)	(0.032)	(0.029)
Degree Centrality of Focal Firm	-0.006***	0.004**	0.000
	(0.002)	(0.002)	(0.001)
Degree Centrality of Partner	-0.089***	-0.005	-0.001
	(0.021)	(0.003)	(0.003)
Size of Focal Firm	0.000**	-0.000***	-0.000
	(0.000)	(0.000)	(0.000)
Patent Counts of Focal Firm	0.000	-0.001**	0.000
	(0.000)	(0.000)	(0.000)
Patent Count of Partner	-0.002	-0.000	0.000*
	(0.002)	(0.000)	(0.000)
Cluster Size	-0.003*	0.003*	0.001
	(0.002)	(0.001)	(0.001)
Distance	-0.000**	0.000	-0.000
	(0.000)	(0.000)	(0.000)
Technology Fixed Effects	Yes	Yes	Yes

Therapeutic Area Fixed Effects	Yes	Yes	Yes
Phase Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Constant	-1.276**	-6.382***	0.004
	(0.519)	(0.327)	(0.281)
Log Pseudolikelihood	-94.95	-181.30	-367.93
Wald Chi-squared	314.42	3370.29	475.46
Pseudo R^2	0.3391	0.2995	0.1581
Observations	632	633	633

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Second, we calculated Cook's Distance for further investigation of possible influential points and found that all Cook's Distance values were below one as reported in the below table (Cook & Weisberg, 1982). Thus, we could conclude that influences of outliers were not a serious concern at least based on Cook's Distance.

Summary statistics for Cook's Distance

Variable	Mean	S.D.	Min	Max
Cook's D - Equity Alliance	0.002116	0.008853	0	0.100152
Cook's D – Scope	0.002317	0.013849	1.52E-22	0.328907
Cook's D - Reciprocal Interdependence	0.002184	0.005962	6.63E-08	0.07866

Other issues

R2C4. *On p. 10, you cite Narula and Santangelo (2009) yet may also acknowledge Reuer and Lahiri (2014 OS) on the role of geographic distance in the formation of R&D alliances.*

Response: In the revised paper, we added the suggested citation as a prior study that also investigated the effects of geographic distance on the formation of R&D alliances (page 9).

R2C5. *Your key measure based on the location of first inventors might be argued to be somewhat noisy given that the name order on USPTO patents has no clear legal implications. It may be worthwhile noting that such noise would work against you and thus give conservative results, by decreasing precision of the coefficient estimates.*

Response: Following this comment, we added a footnote explaining the possible issue of identifying the locations of R&D activities using the first inventors' locations on page 22.

R2C6. *Thank you for showing clustered SEs. Preferably and if possible, please report standard errors clustered jointly by both the focal firm and the biotech partner. Stata's 'clus_nway' allows such estimation.*

Response: As per this request, we re-estimated the probit models with two-way clustered errors using focal pharmaceutical firms and biotechnology partners. For this estimation, we used the suggested 'clus_nway' command in Stata. As can be seen in the below table, this specification

still supports our hypotheses. In the revised paper, we briefly mentioned this point in a footnote in the Statistical Techniques (page 25).

Probit results with two-way clustered errors

	Model		
	(1)	(2)	(3)
	H1	H2	H3
Variables	Equity Alliance	Scope	Reciprocal Interdependence
Risk from Partner-Rival Co-location	3.795***	-3.981**	-2.602**
(based on MSAs)	(1.355)	(1.610)	(1.255)
Direct Ties	-0.128	-0.229	-0.300**
	(0.385)	(0.199)	(0.146)
Indirect Ties	0.052	0.028	0.018
	(0.087)	(0.033)	(0.033)
Degree Centrality of Focal Firm	-0.004**	0.003*	0.000
	(0.002)	(0.002)	(0.001)
Degree Centrality of Partner	-0.024	-0.005	-0.001
	(0.023)	(0.003)	(0.005)
Size of Focal Firm	0.000*	-0.000***	-0.000
	(0.000)	(0.000)	(0.000)
Patent Counts of Focal Firm	-0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)
Patent Count of Partner	-0.002*	-0.000	0.000
	(0.001)	(0.000)	(0.000)
Cluster Size	-0.002*	0.002	0.000
	(0.001)	(0.002)	(0.001)
Distance	-0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)
Technology Fixed Effects	Yes	Yes	Yes
Therapeutic Area Fixed Effects	Yes	Yes	Yes
Phase Fixed Effects	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Constant	-1.411***	-5.791***	-0.015
	(0.411)	(0.300)	(0.280)
Log likelihood	-124.559	-203.055	-370.699
Pseudo R^2	0.2224	0.2490	0.1595
Observations	639	639	639

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Chi-square values for model fit are not reported in the suggested 'clus_nway' command in Stata.

R2C7. *The "equity alliance" DV has a low average and so a check on the consistency between probit and rare events logit estimates may be useful.*

Response: To mitigate the concern about rare event bias, we used logistic regression for rare events data (King & Zeng, 2001) and obtained consistent results. In addition, given that some

scholars recently recommended to use Firth logit models rather than rare events logit models (Allison, 2012; Leitgöb, 2013), we also reran the models using the former. Firth logit models are based on penalized likelihood maximization which is a general approach to reducing small-sample bias in maximum likelihood estimation (Firth, 1993). As a result, we obtained consistent results even with this alternative model specification as well. We included a footnote explaining the summary of these results in the robustness analyses section on page 18 in the revised paper. The full results are reported below:

Rare event logit results

	Model	
	(1)	(2)
	H1	
Variables	Equity Alliance	
Risk from Partner-Rival Co-location		5.924**
(based on MSAs)		(2.327)
Direct Ties	-0.408	-0.322
	(0.932)	(0.914)
Indirect Ties	0.166	0.143
	(0.187)	(0.216)
Degree Centrality of Focal Firm	-0.00636**	-0.00660**
	(0.00309)	(0.00335)
Degree Centrality of Partner	-0.0489	-0.0489
	(0.0548)	(0.0589)
Size of Focal Firm	1.99e-08	2.16e-08
	(1.37e-08)	(1.43e-08)
Patent Counts of Focal Firm	0.000255	0.000185
	(0.000712)	(0.000832)
Patent Count of Partner	0.00144	0.00183
	(0.00226)	(0.00215)
Cluster Size	0.000318	-0.00382
	(0.00234)	(0.00322)
Distance	-0.000166	-0.000120
	(0.000146)	(0.000152)
Technology Fixed Effects	Yes	Yes
Therapeutic Area Fixed Effects	Yes	Yes
Phase Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
Constant	-2.153**	-2.132**
	(0.859)	(0.888)
Observations	639	639

Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Model fit statistics such as log likelihood, chi-square values, and pseudo R^2 are not reported in the 'relogit' command in Stata.

Firth logit results using penalized maximum likelihood.

	Model

	(1)	(2)
	H1	
Variables	Equity Alliance	
Risk from Partner-Rival Co-location		6.140**
(based on MSAs)		(2.634)
Direct Ties	-0.385	-0.288
	(0.742)	(0.746)
Indirect Ties	0.143	0.124
	(0.162)	(0.169)
Degree Centrality of Focal Firm	-0.006*	-0.007*
	(0.004)	(0.004)
Degree Centrality of Partner	-0.053	-0.051
	(0.037)	(0.038)
Size of Focal Firm	0.000	0.000
	(0.000)	(0.000)
Patent Counts of Focal Firm	0.000	0.000
	(0.001)	(0.001)
Patent Count of Partner	0.000	0.000
	(0.000)	(0.000)
Cluster Size	0.000	-0.004
	(0.003)	(0.004)
Distance	-0.000	-0.000
	(0.000)	(0.000)
Technology Fixed Effects	Yes	Yes
Therapeutic Area Fixed Effects	Yes	Yes
Phase Fixed Effects	Yes	Yes
Year Fixed Effects	Yes	Yes
Constant	-2.204***	-2.196***
	(0.733)	(0.743)
Penalized log likelihood	-53.799	-52.258
Wald Chi-squared	43.37	48.49
Observations	639	639

Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

R2C8. *Thank you for explaining the two-stage Heckman procedure in greater detail. The validity of your approach cannot really be shown in its current form, and the choice of a one-year window for alliance formations, while certainly one possibility, is inconsistent with most tie-formation studies in the literature (starting with Gulati 1995 ASQ). More broadly, your theory concerns variance in partner-rival co-location given a sample of pharma-biotech alliances. It concerns treatment of the treated, so to speak, and so I do not see the need for extensive discussion on the difference between the treated and others. Overall, I believe this analysis takes a disproportionate amount of space for the information it generates; perhaps there is a more efficient way to communicate its essence?*

Response: We appreciate the concern that this analysis may take a disproportionate amount of space for the information it generates. As such, we have shortened this discussion to more efficiently communicate the essence of the approach (page 27).

Thank you, again, for addressing previous comments so extensively. I hope you find the above additional comments useful in further developing your paper.

Response to Reviewer 3

I enjoyed reading this new version of the paper. The prior version was well-crafted but was generally less interesting (and had a weaker contribution) than it could have had. My previous concerns centered on your study's motivation/contributions, mechanisms, and measures. My read of this newly revised paper is that it has substantially improved on just about every dimension. I was particularly pleased by the level of thought, care, and effort that went into the response document as well as the paper itself. Below, I lay out the aspects that I have appreciated about this revision. I also raise a few minor issues that, in my view, warrant some additional attention or explanation.

R3C1. *As for the good news, the authors have upgraded the motivation of the paper substantially to make it more interesting and compelling for scholars of alliances, R&D, and competitive strategy. They have also foreshadowed their contribution to these literatures. This is very helpful. The only minor point here is that there is a significant nod to Oxley and Sampson (2004) (and a few other foundational alliance studies) as intellectual predecessors of your paper. I would encourage you to not only cite how your work is consistent with theirs but also where (importantly), it departs from (and improves upon) these great prior studies. You might also have a look at some of the alliance literature that could help you make the case that your study is timely and important. I am thinking of the work by Davis and colleagues who have done in-depth fieldwork on the structure and processes of effective R&D alliances between large firms (see Davis 2016 ASQ and Davis and Eisenhardt 2011 ASQ).*

Response: In order to incorporate the comment that we need to better illuminate the difference between our paper and the prior alliance studies (including Oxley and Sampson (2004)) that have examined knowledge protection concern in alliances between rivals, we highlighted in the revised Introduction that we move beyond the dyadic focus of the prior studies to indirect linkage and exposure that partner-rival co-location causes. In addition, we rewrote the Introduction to reinforce the motivation of our paper by using and citing the suggested prior studies that have focused on the R&D alliances between large firms.

R3C2. *You have also improved the discussion of mechanisms by citing prior work about what types of information might get leaked to competitors. Great job! One minor point: While I understand that your research design does not allow you to closely observe (and therefore, reconcile among) these overlapping mechanisms, having a better understanding of them must surely be beneficial to those designing R&D alliances to mitigate knowledge leakage to competitors. Is this something that could be of interest for future researchers?*

Response: In the Limitations and Future Research section of the revised paper, we added that when different mechanisms of knowledge leakage become more salient than others or whether some certain types of information are more likely to be leaked through some specific pathways will be interesting topics for future research (page 33).

R3C3. *Finally, you have done a much better job justifying (and adding to) the measures you have used in your study. I appreciate that you are now using standard measures for core constructs and justifying why you are using binary rather than continuous measures in those instances. One minor point here: You discuss your use of equity structures in R&D alliances noting that they provide for greater monitoring and control. You also note that they provide enhanced incentive alignment. Then you mention that the use of equity as a tool to prevent misappropriation has been discussed significantly by both scholars and practitioners (Deloitte Consulting report). This makes sense and supports your decision to use it as a key measure in your study. Then, in your response about binary variables, you note that "the trend in the biopharma industry has actually been moving fairly strongly to non-equity arrangements." How can this be? Specifically, how can a tool like equity arrangements be logically (and theoretically) compelling and receive significant recent discussion by both scholars and practitioners and yet the biopharma industry (which you study) seems to be following a trend of moving away from it? Are they misguided? Please provide better explanation.*

Response: According to Hagedoorn (2002: 484), firms not only in the biopharmaceutical industry but also in other high-technology industries such as information technology and aerospace and defense tend to choose equity-based governance structures less and less, and his recent research also bears this out. This trend can be explained by several factors. Prior studies have suggested that rapid technological change (Harrigan, 1985; 1988) or technological instability (Osborn & Baughn, 1990; Osborn et al, 1998; Yu & Tang, 1992) induce the formation of non-equity partnerships. Therefore, the heightened degrees of technological sophistication and change in the biopharmaceutical sector might explain the increasing prevalence of non-equity alliances at least partially. In addition, firms can develop their contract design capabilities by accumulating contracting experiences (e.g., Mayer & Argyres, 2004). Although equity alliances are more costly to form and terminate than non-equity alliances, firms choose the former over the latter when they think they cannot write complete and enforceable contracts and therefore need extra protection from partner opportunism that equity arrangements can provide (Pisano, 1989). Firms in the biopharmaceutical industry have been very active in partnering with other firms for R&D activities for last decades and thus tend to have accumulated extensive experiences in writing contractual agreements for alliances. Therefore, their enhanced contract-writing capabilities also might help them to govern R&D alliances without resorting to equity arrangements.

Overall, great job on the revision and best of luck as you continue to improve the paper.

REFERENCES (if not provided in paper)

Allison, P. D. 2012. ***Logistic Regression for Rare Events.*** Retrieved from http://www.statisticalhorizons.com/logistic-regression-for-rare-events.

Cook, R. D., & Weisberg, S. 1982. ***Residuals and Influence in Regression***. New York: Chapman & Hall.

Crossland, C., Zyung, J., Hiller, N. J., & Hambrick, D. C. 2014. CEO career variety: Effects on firm-level strategic and social novelty. ***Academy of Management Journal***, 57(3): 652–674.

Gomulya, D., & Mishina, Y. 2017. Signaler credibility, signal susceptibility, and relative reliance on signals: How stakeholders change their evaluative processes after violation of expectations and rehabilitative efforts. ***Academy of Management Journal***, 60(2): 554–583.

Harrigan, K. R. 1985. ***Strategies for Joint Ventures. Lexington***, MA: Lexington Books.

Harrigan, K. R. 1988. Joint ventures and competitive strategy. ***Strategic Management Journal***, 9: 141–158.

Inoue, C. F., Lazzarini, S. G., & Musacchio, A. 2013. Leviathan as a minority shareholder: Firm-level implications of state equity purchases. ***Academy of Management Journal***, 56(6): 1775–1801.

Leitgöb, H. 2013. ***The problem of rare events in maximum likelihood logistic regression-assessing potential remedies.*** Paper presented at the European Survey Research Association, Lisbon, Portugal.

Martin, G. P., Gomez-Mejia, L. R., & Wiseman, R. M. 2013. Executive stock options as mixed gambles: Revisiting the behavioral agency model. ***Academy of Management Journal***, 56(2): 451–472.

Mayer, K. J., & Argyres, N. S. 2004. Learning to contract: Evidence from the personal computer industry. ***Organization Science***, 15(4): 394–410.

McNamara, G. M., Haleblian, J. J., & Dykes, B. J. 2008. The performance implications of participating in an acquisition wave: Early mover advantages, bandwagon effects, and the moderating influence of industry characteristics and acquirer tactics. ***Academy of Management Journal***, 51(1): 113–130.

Neter, J., Kutner, M. H., Nachtsheim, C. J., & Wasserman, W. 1996. ***Applied Linear Statistical Models***. Chicago: Irwin.

Osborn, R. N., Hagedoorn, J., Denekamp, J. G., Baughn, C. C., Duysters, G. 1998. Embedded patterns of international alliance formation. ***Organization Studies***, 19: 617–638

Reuer, J. J., & Devarakonda, S. V. 2016. Mechanisms of hybrid governance: Administrative committees in non-equity alliances. ***Academy of Management Journal***, 59(2): 510–533.

Titus, V., Parker, O., & Bass, A. E. Ripping off the band-aid: Scrutiny-bundling in the wake of social disapproval. ***Academy of Management Journal***, amj.2016.0435; published ahead of print April 21, 2017, doi:10.5465/amj.2016.0435

Yu, C-M. J., & Tang, M-J., 1992. International joint ventures: Theoretical considerations. ***Managerial and Decisions Economics***, 13: 331–342.

Zhang, Y., & Qu, H. 2016. The impact of CEO succession with gender change on firm performance and successor early departure: Evidence from China's publicly listed companies in 1997–2010. ***Academy of Management Journal***, 59(5): 1845–1868.