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The Influence of Multinational Corporations on International Alliance Formation Behavior of Colocated Start-Ups

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Abstract. We theorize that vicarious learning theory provides a framework for understanding how small- and medium-sized start-ups can learn from the activity of a variety of regional actors, not just from the activity of colocated peer firms (i.e., other start-ups). Furthermore, we suggest that the magnitude of the impact of vicarious learning is influenced by a firm's own specific experience with a variety of actors. We use longitudinal data of the population of German biotechnology start-ups and pharmaceutical multinational corporations (MNCs) between 1996 and 2015 across 19 German biotechnology regions. We show that colocated start-ups' international expansion is positively impacted by the regional network centrality of colocated MNCs and that this relationship is moderated by a start-up's direct alliance experience with these entities. Our results highlight how important it is for researchers to differentiate the distinct and separate influences a wide variety of actors have on vicarious learning to more clearly identify outcomes of this influence. We also provide evidence that the influence of MNCs is heterogeneous and depends on whether MNCs are domestic or foreign and on their R&D intensity, yet find that country of origin has no significant influence. Our study makes a number of contributions, one of which is research on alliances, supporting conflicting arguments on the subsequent impacts of experience. We further find that certain types of alliance experience may not be transferrable to induce start-ups' future international expansion, and in some cases may even hinder it.

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Keywords: start-ups • multinational corporations • MNCs • internationalization • regional clusters • interorganizational networks

Introduction

Vicarious learning—learning by observing and imitating other firms—is a key mechanism by which small- and medium-sized start-ups (hereafter, "start-ups") benefit from their local environment (e.g., Liebeskind et al. 1996, Al-Laham and Souitaris 2008). Research on vicarious learning suggests that the greater the perceived similarity between a focal firm and potential role models, the more likely a focal firm observes and learns from these firm. For example, scholars such as Al-Laham and Souitaris (2008) explain that start-ups learn about international opportunities from peer firms (i.e., other start-ups in their industry), a learning process that facilitates these start-ups' own internationalization activity. An important element of this

learning process is that only a select set of firms—for example, those within the same industry that are better performing or that experience rapid growth (Fernhaber and Li 2010)—serve as role models for learning and imitation. Since multinational corporations (MNCs) have a multimarket presence, they have been viewed as potential role models with a repository of knowledge about opportunities in foreign markets (Aitken et al. 1997). Therefore, they may be as important as internationally active peer firms in influencing colocated start-ups' international activity. Even though this argument may be true, the significant differences between MNCs and start-ups could diminish their fit as role models. The influence of MNCs, and particularly their fit as an appropriate role model for start-ups, remains unclear.

While studies on vicarious learning, as they relate to start-ups' internationalization, have argued that start-ups learn from observing domestic peer firms, they have neglected to consider that MNCs might also be a source of vicarious learning and could influence the strategic behavior of colocated firms. In addition, when explaining which types of firms serve as potential role models, existing research has failed to differentiate and compare the role of large domestic MNCs and peer firms (i.e., other start-ups) (e.g., Al-Laham and Souitaris 2008, Fernhaber et al. 2009, Fernhaber and Li 2010), nor has it considered how the potential impact of MNCs may differ depending on whether the MNC has domestic or foreign headquarters (i.e., domestic versus foreign MNCs¹). Examining the potential distinct and separate impacts of these differentiations is important. First, because start-ups and MNCs are significantly different, start-ups may not imitate MNCs; nevertheless, MNCs may influence the subsequent actions of start-ups via vicarious learning. Second, cultural differences among MNCs may influence whether and how a start-up examines and learns from the activity of MNCs. Third, prior alliance and network research has not examined how differences in a firm's specific experience with certain types of actors could contribute to the magnitude of impact of vicarious learning, an examination that could uncover important differences. Finally, prior work has not differentiated between international alliance formation and alliances formed with foreign entities within a host country.

In this paper, we seek to understand under what conditions MNCs can serve as sources of vicarious learning and whether and how MNCs influence the international alliance formation behavior of colocated start-ups. We examine two important elements of MNC activities in the local environment. First, we examine the degree to which MNCs are engaged in the regional network. We suggest that the greater the regional network centrality of the MNCs, the greater the potential for disseminating knowledge about international opportunities and the greater the potential for a local start-up manager's attention to be directed toward international expansion possibilities. Second, we examine direct alliances between MNCs and a colocated start-up, since these alliances provide relatively easy access to knowledge of international opportunities. The literature provides conflicting reasoning for the potential influence of direct alliances. On the one hand, researchers argue that a colocated start-up can benefit from the experience and knowledge flows of its international alliance partners. These benefits can subsequently induce the start-up's international alliances formation (e.g., Fernhaber et al. 2009). As in the case of alliances with entities located outside the country, it can thus be suggested that a

firm's alliances with colocated MNCs may enhance its resources and capability development yielding greater subsequent international alliance formation. On the other hand, as start-ups often suffer from resource constraints, and as local partners are often preferred over more distant ones (e.g., Shan 1990), direct alliances with MNCs may serve as a substitute for international alliances, hindering a start-up's future international alliance formation. In the theoretical model we suggest that the positive benefits are likely to exceed the negative ones, leading to greater international alliance formations. Moreover, we suggest that direct alliance experience can also have a positive indirect contribution to a start-up's international alliance formation by increasing its vicarious learning stemming from the MNCs' engagement in the regional network. Finally, we propose that the influence of the MNCs' activities may vary depending on whether the MNCs are domestic or foreign.

To investigate these arguments, we examined the international alliance formation activity (defined as alliances with partner organizations located outside Germany) of the complete population of biotechnology start-ups within 19 regions in Germany from 1996 to 2015. We also conducted several interviews with experts and entrepreneurs from the biotechnology industry to gain a better understanding of the processes that drive the internationalization activities of these start-ups. The German setting is ideal for examining how MNCs' activities influence the international alliance activity of start-ups for several reasons. First, compared with other, more mature markets such as the United States, the German biotechnology industry is still in a relatively early development stage² (Biotechnologie.de Report 2017). By contrast, the majority of German-based (for our purposes, domestic) pharmaceutical MNCs have been globally active for many years or even decades. Some of these companies grew to become global players, such as Bayer, Hoechst, Schering, Merck, Knoll, Heyden Pharmaceuticals, and Boehringer (Cramer 2015). This knowledge setting provides an excellent opportunity to examine how MNCs' activities influence the international alliance activity of start-ups while at the same time limiting the possibility of reverse causality (i.e., that international activity influenced the location choices of the MNCs). Therefore, we can analyze the MNCs' influence on the evolution of the industry from its inception. Second, our research setting is also ideal because forming international alliances is an important means for start-ups to grow (Inkpen 1998, Narula and Hagedoorn 1999, Zahra et al. 2009) and expand their international activities (Leiblein and Reuer 2004). For start-ups in knowledge-intensive industries such as biotechnology, research has shown that international alliances are the preferred mode of internationalization (Shan 1990, Sharma and Blomstermo 2003,

Al-Laham and Souitaris 2008, Oehme and Bort 2015), since these alliances enable firms to overcome their resource constraints and meet the resource demands associated with international expansion (e.g., Lavie and Miller 2008). The current state of the biotechnology industry in Germany, which is still very young and continues to evolve, underscores the importance of alliances for start-up survival, growth, and expansion. Considering the industry's development stage and the colocation of domestic and foreign MNCs, our setting is an optimal one for testing our research questions, since it is one where start-ups' internationalization activities are pursued as an attempt to seek resources by establishing R&D alliances or by collaborative market-seeking activities, such as establishing M&D agreements.

Our study contributes in several ways. First, we contribute to the literature on vicarious learning as it relates to start-ups' internationalization. Our study illustrates that start-ups can use the experience and knowledge of colocated organizations (not just peer firms) to facilitate their international alliance formation behavior. We highlight the importance of differentiating between domestic MNCs and other peer firms (i.e., start-ups), showing that the influence of each is distinct. The importance of this differentiation can be seen in our results, which suggest that firms can vicariously learn from and be influenced by foreign firms that have a domestic presence. Our study goes even further than just underscoring this important differentiation. We examine the factors that may cause variation in vicarious learning. In particular, we show that the influence of vicarious learning depends on whether an MNC is domestic or foreign, and on the research intensity of MNCs. We further find that the heterogeneity of MNCs' headquarter countries has no influence on international alliance formation. A second contribution of our study is to the literature on a firm's learning from its own alliance experience. We reiterate prior work that argues that inherent differences among alliance partner types determine the accessible knowledge, the transferability of knowledge, and the appropriation of knowledge and information (Rothaermel and Deeds 2006, Lavie 2007, Yang et al. 2014, Yu et al., 2011). Yet, we highlight the importance of differentiating between alliances with foreign firms that have a domestic presence and those that do not. A third contribution of our study is to work on geographical regions by examining the duality of benefits and constraints for start-ups considering expanding into foreign markets. Finally, we contribute to research examining how MNCs shape their host environment by investigating the potentially differentiated influence that foreign versus domestic MNCs have on regional development, and identifying several MNC-related contingency factors (e.g., the research intensity of the colocated MNCs) that need to be

considered when studying the impact of MNCs in a region on the development of colocated start-ups.

Theoretical Background

International alliances are "inter-firm cooperative arrangements, involving cross-border flows and linkages that utilize resources and/or governance structures from autonomous organizations headquartered in two or more countries" (Parkhe 1991, p. 581). Start-ups and small firms benefit from forming international alliances because these alliances provide them with access to new knowledge (Inkpen 1998), increase their innovativeness (Zahra et al. 2009), and help them expand their international activities (Leiblein and Reuer 2004). Prior work suggests that international alliances are the preferred mode of internationalization for start-ups (e.g., Zahra et al. 2000, Sharma and Blomstermo 2003, Al-Laham and Souitaris 2008), since they allow firms to overcome their resource constraints and to meet the resource demands international expansion requires (Fernhaber et al. 2009). Whereas, although international alliances offer potential benefits for start-ups, forming and maintaining them may be more challenging and possibly less enduring than alliances with domestic partners (Meschi 1997).

An important mechanism that facilitates alliance formation is organization learning. Research on organization learning has long acknowledged that organizations learn from their own experience and from the experience and knowledge of other organizations (e.g., Levitt and March 1988). Vicarious learning has been defined as the process by which "an observer learns from the behavior and consequences experienced by a model rather than from outcomes stemming from his or her own performance attempts" (Gioia and Manz 1985, p. 528). A vital factor in vicarious learning is the choice of the observed model, which affects how an observer may react, often seeking to imitate the modeled behavior (Manz and Sims 1981, p. 107). Hence, examining the localized actors that may serve as role models and their influence on a local firm's foreign expansion may help start-up managers derive more informed choices.

Vicarious learning helps start-ups gain knowledge and recognize opportunities from the experience of other organizations. Prior research on vicarious learning in small-firm internationalization mainly emphasizes that small firms learn from similar organizations they are in contact with and from similar organizations that are in close proximity (Fernhaber et al. 2009, Fernhaber and Li 2010). Al-Laham and Souitaris (2008) argue that the local international alliance activity of peer firms potentially generates knowledge spillovers, which facilitates greater international alliance formation. Other studies suggest that the higher the number of firms with international

sales within a region, the higher the potential international sales of colocated start-ups (Fernhaber et al. 2008, Fernhaber et al. 2009). The similarity argument emphasizes that it is easier for a focal firm to learn from and adapt the gained knowledge if the source of that knowledge comes from a similar firm. Recent work, such as Fernhaber and Li (2010) suggests that firms learn and imitate the actions of a selected few of their peers—those that perform better within their industry—rather than learning and imitating the actions of all peer firms. However, Manz and Sims (1981, p. 107) claim that “a model who is seen as possessing substantially greater abilities may not be considered a reasonable reference point for the observer.” These contradictory arguments suggest that it is unclear whether MNCs active in regional networks serve as role models and influence the internationalization of start-ups.

MNC Regional Network Position and Start-Up International Alliance Formation

Networks play a pivotal role in a firm’s internationalization process (Holmlund and Kock 1998, Chetty and Holm 2000, Johanson and Vahlne 2009). Interorganizational relationships facilitate the flow of knowledge and as a result influence entrepreneurs’ recognition and realization of international opportunities (Coviello and Munro 1995, 1997, Ellis 2011). Coviello and Munro (1997) suggest (based on four case studies) that formal (i.e., business-related) and informal (i.e., family or friends) network relationships have a strong impact on the internationalization decisions of small software firms in terms of foreign market selection, mode of entry, product development, and market-diversification activities. Chetty and Holm (2000) argue that networks expose managers to new opportunities and they explain that managers can “obtain knowledge, learn from experiences, and benefit from the synergistic effect of pooled resources” (p. 77). Yli-Renko et al. (2001) suggest that from their networks, start-ups can access information about foreign customers, competitors, and potential alliance partners. Oehme and Bort (2015) report that networks influence a small and medium sized enterprises (SMEs) internationalization mode decision (i.e., research or marketing alliances, licensing).

Examining the influence of actors, network studies show that the magnitude of an actor’s impact in a network depends on this actor’s position within this network (e.g., Gulati and Gargiulo 1999). Specifically, studies explain that the more central an organization’s position (in terms of connections) in a network, the greater the chance that its knowledge is disseminated to the rest of the network (e.g., Freeman 1979; Powell et al. 1996). Building on this finding, it seems

reasonable to expect that enhanced MNC centrality within a regional network may facilitate increased knowledge exchange, thereby providing a greater opportunity for colocated start-ups to learn and benefit from MNCs’ international knowledge. Furthermore, studies posit that organizations that occupy a more central network position are more visible to other organizations throughout the network (e.g., Gulati and Gargiulo 1999), and that this visibility influences these organizations’ perceived status (Stuart et al. 1999). Considering that higher-status firms have a greater influence on other firms (Haunschild and Miner 1997), a more central position in the network may entail a greater likelihood of attracting the attention of managers of other organizations in the network and influence their managerial actions. Following this reasoning, it seems reasonable to expect that centrally located MNCs are more likely to serve as role models for colocated start-ups and/or serve as repositories of knowledge that a local start-up can vicariously learn from. Therefore, we posit that the more central the positions of MNCs within a regional network, the greater the likelihood they will influence the strategic actions of colocated start-ups, especially the start-ups’ internationalization activities (such as international alliances). We hypothesize the following.

Hypothesis 1. *The higher the centrality of the MNCs in the regional network, the higher the international alliance formation rate of the regionally colocated start-ups.*

Direct Alliances Between MNCs and Colocated Start-Ups

The benefits of collaborations for start-ups have long been acknowledged. Researchers highlight that collaborations enhance financial returns (Vapola 2011), network attractiveness (Aharonson et al. 2016), and innovation performance (Shan et al. 1994). Start-ups can also profit from alliances by leveraging the brand and reputation of their alliance partners and from the access an alliance provides to technological competencies (Prashantham and Birkinshaw 2008). By forming an alliance with a colocated MNC, a start-up can gain access to information about opportunities in international markets, which it can use to help develop the resources and capabilities it needs to form subsequent international alliances. In a recent case study of partnerships between start-ups and MNCs in India, Prashantham and Dhanaraj (2015) suggest that the knowledge start-ups derive from MNCs may help them to evaluate the opportunities and challenges of internationalization. Although this study provides exploratory insights from software firms in India, the authors studied a firm’s internationalization intentions and not its international activities.

Further, prior studies that examined the likelihood of a firm's internationalization have often bundled the alliances with MNCs and other peers (i.e., start-ups) in the calculations of the international alliance experience of the firm (e.g., Sharma and Blomstermo 2003). Such studies have generally shown a positive influence of the firm's alliance experience on the likelihood of forming additional international alliances (e.g., Al-Laham and Souitaris 2008). Although we think that alliance experience matters, we believe that the effects of a start-up's previous alliance experiences with peers should be separated from previous alliance experiences with MNCs since the latter could be potentially more important in our context. Following these arguments, we suggest that the more direct alliances a start-up has with colocated MNCs, the higher its subsequent international alliance formation rate.

Despite the positive benefits of alliances, studies also highlight the potential downfalls (high costs and risk), explaining that the disproportionate resources and power a larger firm has compared with a start-up may result in the resources of the start-up being exploited by the larger firm (e.g., Diestre and Rajagopalan 2012, Yang et al. 2014). Katila et al. (2008) argue that start-ups accept the risk of partnering with large corporate investors (such as large pharmaceutical firms) when they need resources (i.e., financial and manufacturing) and when they have defense mechanisms in place to protect their own resources. Vandaie and Zaheer (2014) suggest that alliances with large partners may decrease the value smaller firms can derive from their internal capability and explain that the large and more powerful partners intervene in the strategy of the start-up in such a way that it limits the number of new projects the start-up forms. Similarly, Singh and Mitchell (2005) claim that partnerships with larger incumbent industry partners may result in lower sales volumes for the start-up. Diestre and Rajagopalan (2012) argue that start-ups avoid forming alliances with large firms because they fear that the larger firms will appropriate and use the start-up's knowledge for activities not related to the alliance. Start-ups' partnerships with MNCs can also be very demanding and potentially resource-consuming. Prashantham and Birkinshaw (2008) identify three potential problems that arise when MNCs and start-ups collaborate: (1) communication difficulties between partners, (2) differing objectives, and (3) asymmetry in the distribution of resources. Studies further suggest that the long-term success of start-ups may suffer as a result of alliances with MNCs, since much of the start-up firm's value is appropriated by the larger partner (Alvarez and Barney 2001). Yang et al. (2014) reason that large firms exploit smaller firms to a point where the latter's performance (market value) diminishes. In

addition to these costs and risks, cultural distance, uncertainties, misunderstandings, and hidden agendas enhance the complexities of partnerships between large and small firms (Doz 1987).

Given the collaboration challenges between MNCs and start-ups, taking into account the high costs and complexity associated with international collaborations (Child 2001), and considering the resource constraints of start-ups (e.g., Shan 1990), it may be concluded that firms that are already collaborating with MNCs are less likely to form additional international alliances. Shan (1990) explains that a start-up very often has the choice between forming a domestic alliance to achieve its strategic purpose and forming a similar arrangement in foreign markets. He explains that

the difficulties of operating in a foreign environment, as compared to the domestic one, are compounded, and the time it takes to build internal capabilities in a foreign market may well be longer. In this game where time is of the essence, cooperation with a local partner may be perceived as a low-cost strategy of gaining access to foreign markets as well as to complementary assets. (p. 134)

Hence, it seems reasonable to expect that if a start-up chooses to form alliances with colocated MNCs it did so as a substitute to forming international alliances directly.

Although the literature supports conflicting arguments, we posit that the knowledge benefits start-ups gain from their experience of alliances with MNCs is likely to enhance their international alliance formation rate and that the benefits of this knowledge outweigh the costs and result in a substitution effect. We further tilt toward the positive side as prior studies examining the likelihood of a firm's internationalization have shown a positive influence of a firm's alliance experience (treating all alliances with MNCs as international alliance) (e.g., Al-Laham and Souitaris 2008). In line with these arguments, we suggest that the more direct alliances a start-up has with colocated MNCs, the higher its subsequent international alliance formation activity. We propose the following hypothesis.

Hypothesis 2. *The more direct alliances a start-up has with MNCs in the region, the higher the international alliance formation rate of the colocated start-up.*

The Moderating Impact of Start-Ups' Direct Alliance Experience

Studies that follow Cohen and Levinthal's (1990) absorptive-capacity argument suggest that a firm's experience enhances its ability to learn. Organizations are better able to absorb external knowledge when they have a prior knowledge that helps them to decode and recombine the external knowledge. The greater a start-up's alliance experience, the greater its ability to

vicariously learn from and act on information about foreign opportunities (e.g., Al-Laham and Souitaris 2008). Milanov and Fernhaber (2014) also argue that alliance experience with foreign-headquartered partners may strengthen a firm's potential learning from its alliances with domestic-headquartered partners. Hence, we suggest that a start-up's alliance experience with MNCs can enhance its ability to absorb and learn from MNCs' regional network activity. Further, the more a firm engages in alliances with MNCs, the more it may see these firms as a potential source of learning. Such start-ups may pay greater attention to and more actively engage in seeking network knowledge flows stemming from the activity of the colocated MNCs. Thus, we argue the following.

Hypothesis 3. *A start-up's alliance experience with MNCs positively moderates the relationship between the centrality of the MNCs in the regional network and the international alliance formation rate of the colocated start-ups.*

Differentiating Between Foreign and Domestic MNCs

While MNCs may impact the focal start-up's international alliance formation via local networks and direct alliances, not all MNCs are likely to have the same influence. One potential meaningful difference in influence can be traced back to the MNCs' country of origin (Ferner 1997, Harzing and Sorge 2003, Noorderhaven and Harzing 2003). The cultural and institutional settings of organizations' home countries have a strong influence on organizations' behavior and the way knowledge and practices are implemented. For example, Bloom and Van Reenen (2007) report that there are significant variations in MNCs' management practices depending on where the MNCs are headquartered. The authors provide evidence that U.S. MNCs located in the United Kingdom have higher returns from management practices than UK domestic firms. Wang et al. (2009) report that MNCs from different countries have different motivations for entering China. They find that market size and technological capability is a more important motivation for foreign direct investments by firms from non-Chinese Western countries (United States, European Union, and Japan) than they are for firms from Chinese countries (Hong Kong, Macao, and Taiwan). Another area of variability can be seen in cultural differences. Child (2001) explains that because of historical experiences and current institutional conditions, societies vary substantially in how they define and understand trust and how it impacts the establishment and management of global collaborations. Aharonson et al. (2016) suggest that, compared with their domestic counterparts, foreign MNCs bring with them a set of foreign norms, values, views, and

processes to their host country that are strongly influenced by the headquarters of MNCs.

As noted earlier, research on vicarious learning emphasizes that a peer group consists of similar organizations. Yet, research on vicarious learning often ignores the actions of foreign firms in the same industry that have operations in a host country and does not consider them part of the peer group category (e.g., Fernhaber and Li 2010). Yet, because of their presence in the host country, the actions of foreign firms could have as much of an effect on the focal firm as the actions of its domestic counterparts. Furthermore, differences in knowledge, norms, and routines of foreign MNCs compared with domestic MNCs means that the knowledge that disseminates from the network activity of foreign MNCs may be more valuable for the focal firm's internationalization activity. For example, knowledge stemming from foreign MNCs may not only help start-ups identify and recognize opportunities in foreign markets, but also help the regional start-ups better understand the standards and capabilities needed to form international alliances. Hence, whereas all MNCs increase "the entrepreneur's consciousness" of the opportunities that are available in international markets (Vernon 1966, p. 192), foreign MNCs—to a greater degree than their domestic counterparts—may provide the proximate start-ups with the opportunity to learn about the challenges they may face in forming international alliances and how to deal with them. This additional knowledge may enhance a start-up managers' perceptions of the feasibility of forming and managing international alliances. Therefore, it may be the case that the centrality of foreign MNCs will have a greater impact on the international alliance formation of colocated start-ups than the centrality of domestic MNCs.

A counterargument may be that domestic MNCs are more similar to the colocated start-ups (same country of origin) than foreign MNCs, and that because of this similarity, start-up managers are able to better understand and learn how to operate internationally from domestic MNCs than they are from foreign MNCs. Using social categorization theory to examine the interaction between alliance partners, Kwon et al. (2016) explain that the impact of social categories weakens as the familiarity between the alliance partners increases. Start-up managers may gain more confidence in their own internationalization possibilities when knowledge of operating internationally comes from domestic MNCs. Whether a firm is foreign or domestic may therefore be a critical characteristic when evaluating firm similarities³ as they relate to internationalization, especially when it comes to vicarious learning. Hence, it may be more difficult for foreign MNCs to be considered a peer than it is for domestic MNCs.

Whereas the literature supports conflicting views, we believe that all else being equal, the advantages stemming from the similarity with domestic MNCs outweigh the potential additional knowledge from foreign MNCs. In addition, it may be harder to access and absorb the knowledge of foreign MNCs given cultural distance, reducing the potential a firm has to benefit from this knowledge (Lane and Beamish 1990). Therefore, we suggest that a domestic firm's similarity intensifies the regional dissemination of potential knowledge of international opportunities from the network activity. We propose the following.

Hypothesis 4(a). *The centrality of domestic MNCs in the regional network has a greater positive impact on the international alliance formation rate of regionally colocated start-ups than does the centrality of foreign MNCs.*

Prior work suggests that having a foreign partner may be more challenging because of differences, such as cultural ones (e.g., Lane and Beamish 1990). These differences may hinder learning and negatively influence the time and resources a firm will devote to forming subsequent international ties. Lane and Beamish (1990) explain that because of cultural barriers, the time needed to learn from an alliance with a foreign entity is often greater than the time needed to learn from an alliance with a domestic entity. The more time spent learning, the lower the potential rate of establishing subsequent alliances. Further, forming alliances with foreign MNCs—compared with domestic MNCs—may involve more complex and perhaps more binding contractual agreements (Prashantham and Birkinshaw 2008). Thus, it can be argued that collaborative ties with domestic MNCs may induce (or be less hindering to) start-ups' international alliance-formation rate more than collaborative ties with foreign MNCs. We hypothesize the following.

Hypothesis 4(b). *The number of direct alliances a colocated start-up has with domestic MNCs increases its international alliance formation rate to a greater extent than the number of direct alliances with foreign MNCs in the region.*

We summarize our theoretical framework in Figure 1.

Data and Method

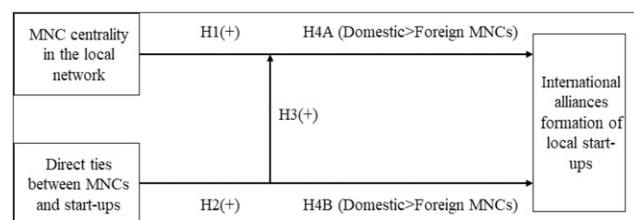
To assess our hypotheses, we examine the German biotechnology industry and the international activities

of the population of 960 German biotechnology start-ups located in 19 German biotechnology regions.⁴ Although it started late compared with other countries, the German biotechnology industry has benefited from changing regulations, social norms, and values that have led to the rise of biotechnology in Germany since the early 1990s (Casper et al. 1999, Dohse 2000, Kaiser and Prange 2004). Nevertheless, compared with the United States, the German biotechnology industry still lags behind. For example, in 2014 the revenues in the German biotechnology industry were around €3.03 billion, and the United States had revenues of around US\$93.1 billion (equivalent to about €81.9 billion) (Biotechnologie.de Report 2015, Ernst & Young 2015). In 2015, there were 593 active biotechnology firms in Germany, whereas in the United States there were 436 public and 2,336 private companies (Biotechnologie.de Report 2016, Ernst & Young 2016).

We used several sources to compile the data. First, we used the *Yearbooks of the German Biotechnology Industry*, an annual directory published by BIOCOM AG, to identify the active biotechnology firms (see also Al-Laham and Souitaris 2008) as well as the foreign and domestic MNCs located in Germany. We also matched these results with the list provided by the Association of Research-Based Pharmaceutical Companies (Vfa). As of 2015, the Vfa consists of 45 leading research-based large pharmaceutical companies that operate in multiple countries. These firms are domestic (i.e., of German origin with headquarters in Germany, such as Bayer AG with headquarters in Leverkusen) and foreign (i.e., of international origin, such as Pfizer, Inc., with headquarters in New York and four regional locations in Germany: Berlin, Freiburg, Illertissen, and Karlsruhe). In addition, we used the German Commercial Register to identify the start-ups' firm-level events such as founding, Mergers and Acquisitions (M&As), potential exit date, location, and other legal issues. We augmented this information with (1) data from the European Patent Office to search for start-ups' patents, and (2) information on the alliance and network activities using archival data coded from the monthly *Transkript* newsmagazine (which reports on the German biotechnology industry) and daily press releases published on the respective companies' webpages. We also conducted several interviews with industry experts and entrepreneurs to gain a better understanding of the motivations and challenges start-ups face when internationalizing.

Using data collected from Compustat, Amadeus, the company filings, and Lexis-Nexis, we were able to compile additional data about the characteristics of the MNCs in the regions: research and development (R&D) intensity (measured as the amount of R&D expenditure per year), age (measured as the number

Figure 1. Theoretical Framework



of years since incorporation), and size (measured in terms of number of employees per year). We identified all contract-based marketing and distribution (M&D) and R&D alliance events between 1996 and 2015 and coded all alliances with partners located in a foreign country as international alliances (excluding those with foreign MNCs located in Germany). Our observations start in 1996, the year the industry emerged in Germany (e.g., Casper et al. 1999, Dohse 2000, Kaiser and Prange 2004).

To identify which region an organization belongs to, we used the regional cluster membership lists that we received from the 19 biotechnology regions and looked for the first two-digits of each members' German postal code. The German postal code consists of five digits, the first of which reflects the state (e.g., Bavaria) and the second representing a smaller area or city within the state. As a result, all biotechnology firms and alliance partners that belonged to the same first two postal code digits as the focal biotechnology firm contained in the membership list of the biotechnology regional cluster were coded as belonging to the respective region and thus became potential constituents of the regional network.

Dependent Variable

The dependent variable is a start-up's international alliance-formation rate $\lambda(t)$, defined as

$$\lambda(t) = \lim_{\Delta t \rightarrow 0} \left[\frac{q(t, t + \Delta t)}{\Delta t} \right] \Delta t \rightarrow 0,$$

with q representing the discrete probability of forming another international alliance between time t and $(t + \Delta t)$, conditional on the history of the process up to time t . This rate provides information on the time span between successive events. Higher values of the rate correspond to shorter times between events.

Independent Variables

Regional Network Centrality of MNCs. We constructed a network using all the alliances in a region over a five-year window prior to year t . We constructed the industry network by applying methods similar to those used in prior alliance and network studies in the field of biotechnology (e.g., Powell et al. 1996, Milanov and Fernhaber 2009). To construct the regional networks, we identified all direct cooperative agreements between the MNCs and their alliance partners in a particular region. Although we carefully coded all announced terminations of collaborative events, we were not able to account for all firms that terminated alliances. Following prior research (e.g., Phene and Tallman 2012, Yang et al. 2014), we considered the observed alliances as active network links for a period of five years unless we had information on a prior termination or an extension of the respective

interorganizational agreement that fell below or exceeded this five-year window. This assumption is based on prior research in the field of biotechnology in Germany showing that network characteristics are relatively stable over time.⁵ Using UCINET 6 (Borgatti et al. 2002), we calculated the centrality variables by using all the degree centralities from Freeman's measure of degree centrality (Freeman 1979) for all the actors in the network. We then calculated the MNC's average network centrality as the ratio of the cumulative degree centrality of all the MNCs in the region divided by the number of MNCs active within this region in that period. Next, we divided the MNCs into foreign and domestic categories and calculated separate average network centrality scores—*Regional network centrality foreign MNCs* and *Regional network centrality domestic MNCs*. Higher values suggest greater MNC regional network activity.

Alliance Experience with MNCs in the Region. To measure this variable, we created a count variable: the number of alliances with MNCs in the region prior to the time of the international alliance event. As with the network variables, we used a five-year window prior to the year of the event for the count. As the impact of an additional tie may have diminishing returns, we used a natural log of the counts. Similar to the network measures, we distinguish between foreign and domestic MNCs to construct the *Alliances with foreign MNCs in region* and *Alliances with domestic MNCs in region*.

Control Variables

We included several control variables at the firm and regional level that may affect start-ups' international alliance-formation rate. First, in line with previous research (e.g., Al-Laham and Souitaris 2008; Yenyurt et al. 2009), we controlled for a *Start-up's international alliance experience* (*Intern. alliance-formation experience*) over the five-year period prior to the year of an event. The experience was measured by the cumulative number of previous international alliances by the respective start-up. The more experience and knowhow a firm has about forming international alliances, the more it may continue to add additional alliances in the future. We lagged this variable by one year, since we assume a time lag between the initial international alliance and the integration of the subsequently gained experience into the organizational routines. We used a natural log to normalize the distribution of the variable. Second, we controlled for the stocks of intellectual property held by the start-up (*Number of prior patent applications*). Following earlier research (e.g., Milanov and Fernhaber 2009), we calculated the cumulative number of a start-up's patent applications to control for its innovative output.

The number of patent applications is important since it increases the attractiveness of the start-up as an international cooperation partner as well as increases a start-up's possibilities for developing an international market base (Al-Laham and Souitaris 2008). We assigned a patent to a biotech start-up on the date of application. We lagged this variable by one year and used a natural log to normalize the distribution of the variable. Third, we controlled for *firm size* (measured by the number of employees), as it may influence a start-up's internationalization activities (Bloodgood et al. 1996). We applied the natural log to normalize the distribution of this variable. Fourth, we controlled for grants a firm received from the German Federal Ministry of Education and Research (BMBF) (*Amount of prior grants*). Prior work suggests that the funds received and the knowledge gained from taking part in this funding framework may have an effect on the firms' success (e.g., Fornahl et al. 2011), and as such may influence the internationalization patterns of firms. Receiving grants from a government agency may also signal a start-up's success and proficiency, which would likely increase its attractiveness to potential alliance partners. To account for the funds available to the firm from this grant in each period, we distributed the amounts over the funding period. We updated this variable at the starting date of the respective funding period. We lagged this variable by one year and used a natural log to normalize the distribution. Finally, we controlled for the type of biotech firm (*Biotech type*). Following prior work (Oehme and Bort 2015), we differentiated based on the firm's focus within the field. We used a binary variable, with "1" indicating that a biotechnology firm is mainly active in the area of diagnostic and medical applications and "0" if the firm is active in another area (e.g., green biotechnology, which focuses on using plants or animals to produce more environmentally friendly products and services). On the regional level, we have several controls: (1) The *Number of prior international alliances in region*, measured as the number of all international ties formed in a region in the five-year window prior to the year of the event. Prior research has found that a higher number of internationally active firms in a new venture's region has a positive impact on a new venture's internationalization success (e.g., Al-Laham and Souitaris 2008, Fernhaber et al. 2009). We used a natural log for this variable. (2) The density of colocated MNCs, measured as a count of the number of MNCs located in the respective German biotechnology region. We separated this variable into two counts: foreign and domestic MNCs. Population ecology research suggests that the impact of density is linked in complex ways to both legitimization of an organizational form

and competition intensity. The combined effect of density should increase at a decreasing rate (Hannan and Freeman 1977), hence we used a natural log in our variable operationalization to account for this possibility. (3) *Density biotech firms in region*, measured as the number of biotechnology firms in a region. A denser regional biotech firm population may facilitate the internationalization of this region (e.g., Fernhaber et al. 2008). We used a natural log for this variable. (4) *Density universities and research institutes in region*, measured as the natural log of the cumulative number of universities and research institutes in existence in a region per year. Researchers of geographic agglomerations have long argued that universities play a significant role in the development of regions and clusters in general (Aharonson et al. 2004, 2007, 2008, 2014), and in the field of biotechnology in particular (Owen-Smith et al. 2002). (5) Three measures of organizational characteristics of the regional MNCs. We followed previous research (e.g., Al-Laham and Souitaris 2008) and constructed a Blau index (inverse Herfindahl) (Blau 1977). We categorized each MNC in a region according to its organizational characteristics (i.e., R&D spending, age, and size) in two categories: above and below the mean value of all MNCs in our sample. We then calculated three Blau index variables: (a) *Heterogeneity MNCs' R&D spending in region*; (b) *Heterogeneity MNCs' age in region*; and (c) *Heterogeneity MNCs' size in region*; (6) *Wage level in region*, measured by the growth rate in the wages in a region. MNCs' investments may stimulate the growth of a region but may also drive away local business by pushing up the wage level in the region. According to the German Statistic Departments of the Federation and the Federal States' classification of economic activities, edition 2008, WZ 2008, the pharmaceutical industry is part of the manufacturing sector. Therefore, we used the annual growth rate in gross wages in the manufacturing sector in percent (compared with the previous year) according to the German Statistic Departments of the Federation and the Federal states (i.e., <https://www.statistik-bw.de/VGRdL/>). We matched the regional manufacturing data provided by the Statistic Department with the regions in our sample by the postal two digits.

Model Specification

A start-up's international alliance activity can be viewed as an outcome of a series of events. Hence, we use an event-history analysis (Amburgey 1986). The data structure of an event-history analysis includes information on the number, timing, and sequential order of the events under investigation. In our context, the event-history analysis is an appropriate analytical technique (Blossfeld et al. 2007) and has already

been used to study international alliance formation (e.g., Yeniyurt et al. 2009, Oehme and Bort 2015). The history of each firm begins at the time of its founding and ends as soon as a firm exits (via acquisition or failure) or at the end of the observation period (December 31, 2015). If no international alliance events occurred during a certain quarter, we coded the international alliance event variable as zero. Since we see no evidence that the hazard rate is constant over time, this study parameterizes the international alliance-formation rate as a Weibull distribution function. We used the Stata 2015 (StataCorp. 2017) program to estimate our results.

Findings

Table 1 reports descriptive statistics including means, standard deviations, and correlation matrices for all the variables used in the analysis of MNCs' impact on the international alliance-formation rate of the start-ups in a region. Table 2 presents the results of the event-history analysis. It provides parameter estimates and robust standard errors. In the first model, we included only the control variables. In the next models, we added the independent variables. The size of the coefficients in the model shows the magnitude of the covariate's impact on the dependent variable (i.e., international alliance formation rate). In addition to the coefficients we also report the standard errors and the hazard ratios (HR).⁶

In Hypothesis 1, we proposed that the centrality of the MNCs in the regional network has a positive impact on the international alliance-formation rate of the start-ups in the region. Model 5 (Table 2) shows that the coefficient of the centrality of the MNCs in the regional network is positive and significant (1.593 (HR = 4.92), $p \leq 0.01$), supporting Hypothesis 1. In Hypothesis 2, we posited that the number of direct alliances between MNCs and colocated start-ups increases the international alliance-formation rate of the regional start-ups. Contrary to our expectations, we find that the opposite is true, which we believe is an interesting finding and which we elaborate in greater detail in the discussion section. The coefficient of the number of alliances between MNCs and start-ups in the region (Model 5 (Table 2)), is negative and significant (−2.026 (HR = 0.13), $p \leq 0.001$). In Hypothesis 3, we suggested that a start-up's alliance experience with MNCs positively moderates the relationship between the centrality of the MNCs in the regional network and the international alliance formation of the colocated start-ups. The estimate of the interaction in Model 5 (Table 2) is positive and significant, supporting Hypothesis 3 (1.638 (HR = 5.15), $p \leq 0.001$). In Hypothesis 4(a), we posited that the centrality of domestic MNCs has a greater positive impact on the international alliance formation of the

colocated start-ups than the centrality of foreign MNCs. In Model 5(b) (Table 2), we find support for this hypothesis. The coefficient of the centrality of the foreign MNCs is negative (−0.17) but not significant ($p \leq 0.05$) and the coefficient of the centrality of domestic MNCs is positive and significant (1.098 (HR = 2.998), $p \leq 0.001$). In Hypothesis 4(b), we suggested that a start-up's number of direct alliances with domestic MNCs increases international alliance formation to a greater extent than the number of direct alliances it has with foreign MNCs in the region. Contrary to our expectations, in Model 5(b) (Table 2), the coefficient of the number of direct alliances with domestic MNCs is negative and significant (−0.615 (HR = 0.54), $p \leq 0.05$), whereas the coefficient of the number of direct alliances with foreign MNCs is also negative and significant (−2.506 (HR = 0.082), $p \leq 0.05$).

Figure 2(a) depicts the results of Model 5 (Table 2), highlighting the importance of the MNCs' regional network behavior. The greater the regional network centrality of the MNCs, the higher a colocated start-up's subsequent international alliance formation. This suggests that when the MNCs are highly active in a regional network, local start-ups seek more international alliances. Figure 2(b) compares the impact of one alliance with foreign versus domestic MNCs. This figure highlights that an alliance with a domestic MNC will tend to improve the likelihood of forming subsequent international alliances to a greater degree than an alliance with a foreign MNC. Figure 2, (c) and (d) depict the influence of additional alliance experiences based on whether the MNC is foreign or domestic. Though in the case of domestic MNCs, the subsequent rate of an international alliance formation of a colocated start-up diminishes with alliance experience, in the case of foreign MNCs, the impact of alliances depends on the network behavior of the foreign MNCs.

Some of the control variables across Models 5 and 5(b) (Table 2) also show significant effects on the rate of the start-ups' formation of international alliances. Of the firm-level controls, the start-ups' international alliance-formation experience is significant and positive, indicating that the more experience a start-up has in forming international alliances, the more it will tend to do so in the future. The size of the start-ups as well as the biotechnology type are also significant and positive, which implies that larger firms and those active in the field of diagnostics have a higher rate of international alliance formation than others. The age of a start-up is negative and significant, which might indicate that as firms age, the likelihood that they search for international alliances is reduced. On the regional level, the estimate of the number of regional foreign MNCs is positive and significant, suggesting that the

Table 1. Statistics and Correlations

No.	Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
1	Dependent variable: <i>International alliances</i>	0.043	0.202	1.00																					
2	<i>Regional network centrality MNCs</i>	0.192	0.512	0.18	1.00																				
3	<i>Regional network centrality foreign MNCs</i>	0.070	0.277	0.15	0.74	1.00																			
4	<i>Regional network centrality domestic MNCs</i>	0.150	0.451	0.17	0.94	0.50	1.00																		
5	<i>Alliances with MNCs in region</i>	1.097	0.308	0.05	0.10	0.07	0.08	1.00																	
6	<i>Alliances with foreign MNCs in region</i>	0.991	0.303	0.03	0.09	0.07	0.07	0.75	1.00																
7	<i>Alliances with domestic MNCs in region</i>	1.124	0.563	0.06	0.13	0.08	0.12	0.76	0.49	1.00															
8	<i>Start-ups international alliance formation experience</i>	0.361	0.688	0.20	0.64	0.52	0.59	0.14	0.14	0.16	1.00														
9	<i>Number of prior patent applications</i>	1.273	1.469	0.15	0.44	0.38	0.39	0.12	0.16	0.13	0.53	1.00													
10	<i>Firm size (number of employees)</i>	2.717	1.442	0.18	0.47	0.40	0.42	0.08	0.07	0.07	0.52	0.53	1.00												
11	<i>Firm age</i>	1.936	0.737	0.01	0.22	0.17	0.20	0.17	0.22	0.08	0.27	0.40	0.39	1.00											
12	<i>Amount of prior grants</i>	5.132	7.295	0.07	0.27	0.18	0.27	0.05	0.10	0.03	0.32	0.41	0.27	0.32	1.00										
13	<i>Biotech type</i>	0.750	0.433	0.05	0.12	0.11	0.10	0.05	0.03	0.08	0.12	0.18	0.15	0.05	−0.05	1.00									
14	<i>Number of prior international alliances in region</i>	2.735	1.270	0.05	0.15	0.10	0.13	0.68	0.61	0.77	0.22	0.17	0.09	0.19	0.07	0.06	1.00								
15	<i>Density of colocated foreign MNCs</i>	6.718	4.295	0.05	0.11	0.05	0.10	0.45	0.34	0.61	0.12	0.12	0.08	0.06	0.06	0.07	0.65	1.00							
16	<i>Density of colocated domestic MNCs</i>	4.129	2.482	0.02	−0.01	−0.02	−0.01	−0.06	−0.07	0.08	−0.01	0.06	0.01	0.06	−0.08	0.06	0.00	0.21	1.00						

Table 1. (Continued)

No.	Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
17	Density biotech firms in region	0.016	0.068	-0.01	-0.01	-0.01	-0.01	0.01	0.04	-0.01	0.01	0.01	0.01	0.00	0.01	0.01	0.06	0.01	0.21	1.00					
18	Density universities and research institutes in region	5.389	3.533	-0.01	-0.03	-0.06	-0.02	0.32	0.32	0.45	0.01	0.04	-0.05	0.04	-0.01	0.01	0.54	0.36	-0.09	-0.04	1.00				
19	Heterogeneity MNCs' R&D spending in region	0.427	0.129	0.04	0.10	-0.07	-0.09	0.24	0.19	0.33	0.10	0.12	0.11	0.04	0.05	0.09	0.29	0.35	0.39	0.06	0.16	1.00			
20	Heterogeneity MNCs' age in region	0.404	0.140	0.06	0.12	0.09	0.11	0.13	0.19	0.18	0.01	0.12	0.09	0.14	-0.03	0.05	0.08	0.24	0.47	0.36	0.08	0.05	0.71	1.00	
21	Heterogeneity MNCs' size in region	0.377	0.122	0.00	0.00	-0.02	0.01	0.18	0.21	0.20	0.05	0.07	0.04	0.19	0.08	0.02	0.20	0.13	0.26	0.05	-0.01	0.27	0.024	1.00	
22	Wage level in region	1.349	3.479	-0.03	0.05	0.05	0.04	0.08	0.15	0.06	0.04	0.11	0.02	0.25	0.14	-0.05	0.10	0.27	-0.17	-0.07	0.02	-0.04	-0.01	0.01	1.00

Notes. Number of observations 14,036. S.D., standard deviation.

mere presence of foreign MNCs has a positive influence on a start-up's international alliance formation, which is not the case for other organizational types in the region. We find that the number of universities and research institutes in the region is significant and negative, indicating that the more universities there are in a region, the lower the start-ups' rate of forming international alliances. A strong regional academic base might lower the need for start-ups to engage in international collaborations since necessary research, development, and production knowhow can be found in the region at satisfying levels. Contrary to our expectations, we find that an increasing wage level in the region decreases the rate of international alliance formation activity of the local start-ups. The estimates for the heterogeneity of the MNCs in terms of R&D spending in the region and the heterogeneity of the MNCs' size in the region are all negative and significant, suggesting that a diverse number of MNC types in a region and an increase in regional wages reduce a start-up's international alliance-formation behavior. By contrast, we find that the heterogeneity in terms of the MNCs' ages in the region is positively related to a start-up's international alliance-formation behavior.

Additional Analyses

We tested the robustness of our results for several possible alternative explanations. First, as evident from Table 2, the correlations between the regional international alliances and network variables are comparatively high. In line with previous network research (e.g., Yu et. al. 2011, Milanov and Fernhaber 2014), we omitted the number of the prior international alliances in the region from our models and found consistent results. Thus, we are confident that multicollinearity does not bias our parameter estimates. Second, since variance in the R&D intensity of the MNCs may provide a differentiated experience for start-ups, we distinguished between high- and low-R&D intensity of the MNC. An MNC is categorized as high-R&D intensity if in the prior year it had more than the average R&D expenditures compared with other MNCs. Using this categorization, we then created four counts for the alliance experience: (1) Alliance experience with high R&D intensive foreign MNCs in region, (2) Alliance experience with high R&D intensive domestic MNCs in region, (3) Alliance experience with low R&D intensive foreign MNCs in region, and (4) Alliance experience with low R&D intensive domestic MNCs in region. We reran the regressions for Models 5 and 5(b) (Table 2) using this differentiation. The results are reported in Table 3. Alliance experience with low-R&D intensive MNCs reduces the rate of a start-up's subsequent international alliance formation. In the case of alliance experience

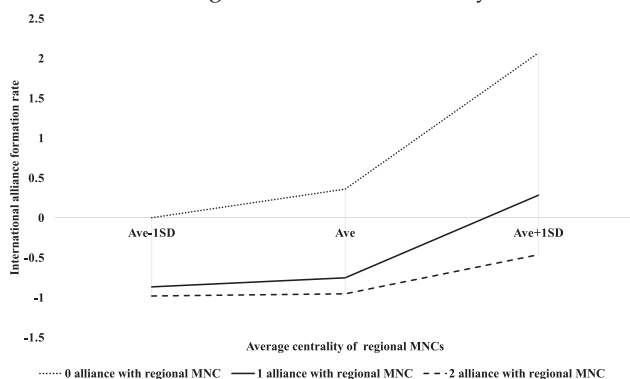
Table 2. Impact of MNCs on Start-Ups International Alliance Formation

Variable	Model 1	Model 2	Model 3	Model 4	Model 5	Model 5(b)
<i>Regional network centrality of MNCs</i>		2.263*** (0.473)		2.256*** (0.477)	1.593** (0.570)	
<i>Regional network centrality foreign MNCs</i>						−0.170 (0.240)
<i>Regional network centrality domestic MNCs</i>						1.098*** (0.206)
<i>Alliances with MNCs in region</i>			−0.159+ (0.086)	−0.141+ (0.086)	−2.026*** (0.360)	
<i>Alliances with foreign MNCs in region</i>						−2.506* (1.192)
<i>Alliances with domestic MNCs in region</i>						−0.615* (0.254)
<i>Regional network centrality of MNCs</i>					1.638*** (0.302)	
<i>Alliances with MNCs in region</i>						
<i>Regional network centrality foreign MNCs</i>						2.064* (1.056)
<i>Alliances with foreign MNCs in region</i>						0.422* (0.167)
<i>Regional network centrality domestic MNCs</i>						
<i>Alliances with domestic MNCs in region</i>						
<i>Start-ups international alliance formation experience</i>	0.477*** (0.064)	0.480*** (0.062)	0.551*** (0.075)	0.546*** (0.073)	0.489*** (0.073)	0.558*** (0.071)
<i>Number of prior patent applications</i>	0.012 (0.038)	0.021 (0.038)	0.014 (0.038)	0.021 (0.037)	0.050 (0.037)	0.022 (0.038)
<i>Firm size (number of employees)</i>	0.701*** (0.044)	0.703*** (0.044)	0.723*** (0.045)	0.723*** (0.015)	0.745*** (0.046)	0.739*** (0.045)
<i>Firm age</i>	−1.447*** (0.064)	−1.441*** (0.066)	−1.454*** (0.064)	−1.447*** (0.066)	−1.465*** (0.068)	−1.446*** (0.066)
<i>Amount of poor grants</i>	0.003 (0.007)	0.005 (0.007)	0.004 (0.007)	0.006 (0.007)	0.006 (0.007)	0.005 (0.007)
<i>Biotech type</i>	0.304* (0.122)	0.302* (0.123)	0.306* (0.122)	0.307* (0.123)	0.282* (0.123)	0.286* (0.123)
<i>Number of poor international alliance in region</i>	0.062 (0.080)	−0.133+ (0.074)	0.077 (0.081)	−0.123 (0.075)	−0.054 (0.083)	−0.153 (0.102)
<i>Density of colocated foreign MNCs</i>	0.101*** (0.020)	0.073*** (0.021)	0.098*** (0.020)	0.071*** (0.022)	0.045* (0.022)	0.044* (0.020)
<i>Density of colocated domestic MNCs</i>	0.005 (0.026)	0.037 (0.027)	0.003 (0.026)	0.035 (0.027)	0.033 (0.026)	−0.004 (0.026)
<i>Density biotech firms in region</i>	−0.325 (0.724)	−0.648 (0.736)	−0.424 (0.722)	−0.732 (0.736)	−0.931 (0.763)	−0.858 (0.728)
<i>Density universities and research institutes in region</i>	−0.02* (0.017)	−0.019 (0.016)	−0.038* (0.017)	−0.024 (0.017)	−0.030+ (0.017)	−0.046** (0.016)
<i>Heterogeneity MNCs' R&D spending in region</i>	−0.037 (0.788)	−1.380 (0.923)	−0.079 (0.792)	−1.374 (0.921)	−1.179 (0.881)	−1.367+ (0.795)
<i>Heterogeneity MNCs' age in region</i>	0.665 (0.631)	1.858* (0.788)	0.834 (0.640)	1.961* (0.785)	2.131* (0.731)	2.168*** (0.630)
<i>Heterogeneity MNCs' size in region</i>	−3.551*** (0.611)	−3.721*** (0.611)	−3.664*** (0.608)	−3.800*** (0.604)	−3.809*** (0.583)	−3.891*** (0.579)
<i>Wage level in region</i>	−0.198*** (0.014)	−0.201*** (0.014)	−0.195*** (0.014)	−0.19*** (0.014)	−0.195*** (0.014)	−0.200*** (0.015)
Constant	−126.1*** (2.768)	−134.5*** (3.950)	−126.9*** (2.819)	−135.1*** (3.980)	−137.9*** (3.888)	−136.8*** (3.369)
Log likelihood	−1018.5	−992.6	−1016.4	−991.0	−973.6	−975.4

Notes. Number of international alliance events: 601. Number of observations: 14,036. Robust standard error appear in parentheses.

+ $p \leq 0.1$; * $p \leq 0.05$; ** $p \leq 0.01$; *** $p \leq 0.001$.

Figure 2(a). Influence of Alliance Experience with MNCs and the MNCs' Regional Network Centrality



with high-R&D intensive MNCs, however, the experience with foreign MNCs reduces subsequent international alliance formation whereas experience with domestic MNCs increases subsequent international alliance formation. The combined results reiterate that regardless of whether the alliance experience is with low- or high-R&D intensive MNCs, alliance experience with domestic MNCs has a greater overall positive influence on a start-up's rate of subsequent international alliance formation than alliance experience with foreign MNCs. Figure 3(a) demonstrates the results using a comparison of alliance experience with a low-R&D intensive foreign MNC and alliance experience with a high-R&D intensive foreign MNC, given three different network centrality measures (the mean of the variable ± 1 SD). Similarly, Figure 3(b) illustrates the impact of alliance experience with a domestic MNC. In a region where there is above-average MNC network activity, having alliance experience with MNCs increases the rate of subsequent international alliances of a start-up except in the case of alliances with foreign MNCs with high-R&D intensity (however, we found no significant

Figure 2(b). Comparing the Influence of One Alliance with a MNC

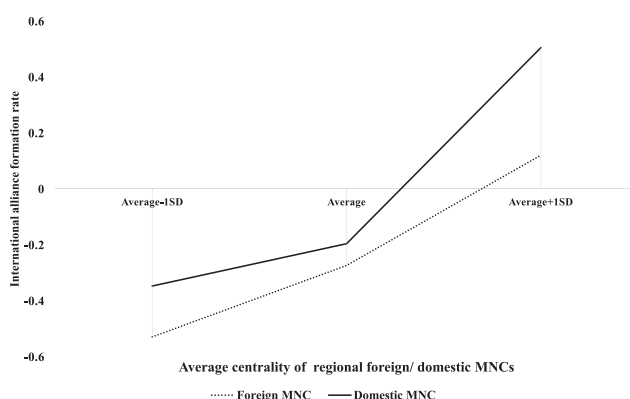
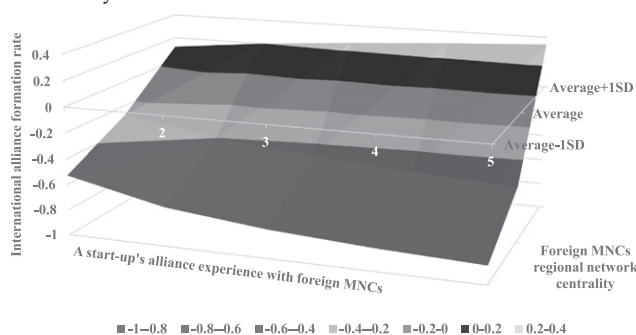


Figure 2(c). Influence of Alliance Experience with Foreign MNCs and the Foreign MNCs' Regional Network Centrality



effect of the estimate for the interaction). In the case of foreign MNCs, in regions where the MNCs have average and above-average network activity, a start-up may be more likely to form an international alliance if it has prior alliance experience with a low-R&D intensive MNC than with a high-R&D intensive MNC. In the case of domestic MNCs, this is true only for regions where the MNCs have above-average network activity.

Because previous research shows that MNCs move to clusters to get access to location-specific knowledge (e.g., Almeida and Phene 2004), we conducted a third additional analysis. Our longitudinal research setting allows us to test for potential endogeneity concerns because we were able to observe start-ups from their formation until the point where a firm exits the data, either because of dissolution or M&A. Our detailed data also enabled us to determine different event timings. In the case of the German biotechnology industry, the location decisions of the much older pharmaceutical and chemical MNCs proceeded in almost all cases the location and internationalization decisions of the start-ups and small SMEs in the biotechnology industry. Therefore, we believe that endogeneity between the international alliance

Figure 2(d). Influence of Alliance Experience with Domestic MNCs and the Domestic MNCs Regional Network Centrality

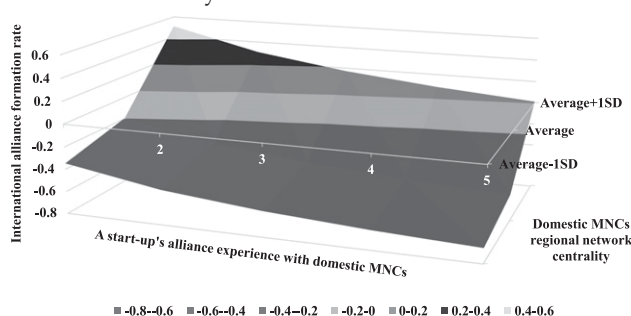


Table 3. Impact of MNCs on Start-Ups International Alliance Formation MNCs' High Versus Low-R&D Intensity

Variable	Replicated Model 5	Replicated Model 5(b)	Augmentation Model 5(b)
<i>Regional network centrality of MNCs</i>	1.599** (0.566)		
<i>Regional network centrality foreign MNCs</i>		−0.190 (0.245)	−0.182 (0.244)
<i>Regional network centrality domestic MNC</i>		1.072*** (0.207)	1.077*** (0.206)
<i>Alliance experience with high RD intensive MNCs in region</i>	−0.647 (1.031)		
<i>Alliance experience with high RD intensive foreign MNCs in region</i>		−3.254 (2.362)	−0.974*** (0.267)
<i>Alliance experience with high RD intensive domestic MNCs in region</i>		2.008** (0.702)	1.976** (0.707)
<i>Alliance experience with low RD intensive MNCs in region</i>	−2.129*** (0.448)		
<i>Alliance experience with low RD intensive foreign MNCs in region</i>		−2.968* (1.364)	−3.159* (1.352)
<i>Alliance experience with low RD intensive domestic MNCs in region</i>		−0.655+ (0.351)	−0.667+ (0.352)
<i>Regional network centrality of MNCs</i>	0.161 (0.862)		
<i>Alliance experience with high RD intensive MNCs in region</i>			
<i>Regional network centrality foreign MNCs</i>		2.137 (2.202)	
<i>Alliance experience with high RD intensive foreign MNCs in region</i>			
<i>Regional network centrality domestic MNCs</i>		−1.226* (0.496)	−1.217* (0.497)
<i>Alliance experience with high RD intensive domestic MNCs in region</i>			
<i>Regional network centrality of MNCs</i>	1.803*** (0.395)		
<i>Alliance experience with low RD intensive MNCs in region</i>			
<i>Regional network centrality foreign MNCs</i>		2.617* (1.224)	2.806* (1.204)
<i>Alliance experience with low RD intensive foreign MNCs in region</i>			
<i>Regional network centrality domestic MNCs</i>		0.478+ (0.256)	0.485+ (0.256)
<i>Alliance experience with low RD intensive domestic MNCs in region</i>			
<i>Start-ups international alliance formation experience</i>	0.493 (0.037)	0.559*** (0.070)	0.555*** (0.070)
<i>Number of prior patent applications</i>	0.052 (0.037)	0.027 (0.038)	0.029 (0.038)
<i>Firm size (number of employees)</i>	0.745*** (0.046)	0.741*** (0.045)	0.739*** (0.045)
<i>Firm age</i>	−1.464*** (0.068)	−1.434*** (0.067)	−1.433*** (0.067)
<i>Amount of prior grants</i>	0.004 (0.007)	0.003 (0.007)	0.004 (0.007)
<i>Biotech type</i>	0.285* (0.124)	0.324* (0.128)	0.328** (0.128)
<i>Number of prior international alliance in region</i>	−0.050 (0.083)	−0.124 (0.105)	0.125 (0.106)
<i>Density of colocated foreign MNCs</i>	0.042* (0.021)	0.040* (0.020)	0.040+ (0.020)
<i>Density of colocated domestic MNCs</i>	0.034 (0.026)	−0.008 (0.026)	−0.008 (0.026)
<i>Density biotech firms in region</i>	−1.003 (0.774)	−0.913 (0.742)	−0.921 (0.743)
<i>Density universities and research institutes in region</i>	−0.030+ (0.017)	−0.051** (0.016)	−0.052** (0.016)
<i>Heterogeneity MNCs' R&D spending in region</i>	−1.237 (0.877)	−1.285 (0.806)	−1.313 (0.803)
<i>Heterogeneity MNCs' age in region</i>	2.238** (0.733)	2.119*** (0.630)	2.140*** (0.631)

Table 3. (Continued)

Variable	Replicated Model 5	Replicated Model 5(b)	Augmentation Model 5(b)
<i>Heterogeneity MNCs' size in region</i>	−3.896*** (0.586)	−3.901*** (0.574)	−3.846*** (0.566)
<i>Wage level in region</i>	−0.195*** (0.014)	−0.203*** (0.016)	−0.203*** (0.016)
Constant	−137.9*** (3.904)	−137.6*** (3.474)	−137.6*** (3.476)
Log likelihood	−971.6	−967.6	−967.9

Notes. Number of observations: 14,036. Robust standard errors appear in parentheses.

⁺ $p < 0.1$; $*p < 0.05$; $**p < 0.01$; $***p < 0.001$.

formation rate and MNCs location decisions is not an issue here. Figure 4 depicts the average number of different organizational types located across regions across time. Ninety percent of the MNCs in our setting were founded or entered the German market (i.e., foreign MNCs) prior to 1996; in other words, before the biotechnology industry in Germany emerged and before our analysis began. Hence, our setting gives us the opportunity to study the MNCs' influence on the development of the industry from its origin.

We conducted a fourth analysis because prior research has consistently found that a firm's age plays a critical role in its strategic decisions and performance (e.g., Sørensen and Stuart 2000). Since we look at the firms from their founding, we refer to them as start-ups. Over time these start-ups age, which makes it likely that they would not suffer from the same resource constraints that younger firms do. The firms in our sample are relatively young (mean age of 5.9 years). The average age of the firms in our population when they form their first international alliance is 4.75 years. By the age of 10, about 74.5% of start-ups in this population have at least one international alliance. As one of the start-up founders we interviewed explained,

Yes, definitely, [international alliances] are important for us—even in the very early stage of a start-up. (Interview with Biotech entrepreneur, January 24, 2017, Mannheim)

Following prior work that has defined new ventures as 10 years old and younger (e.g., Milanov and Fernhaber 2009), we ran Models 5 and 5(b) in Table 2 for firms of six, seven, eight, nine, and 10 years of age (for firms six years and younger, we were left with 310 international alliance events). The results in Model 5 are relatively similar; however, the main effect of a firm's alliance experience with MNCs gains significance at age nine and above. Replication of Model 5(b)

revealed more differences. Specifically, we find that up to the age of eight, young firms are more influenced by domestic MNCs, and from ages nine and 10 on, they are more impacted by foreign MNCs. Overall, we believe that our results apply to young technology-oriented start-ups as well as to more mature ones.

Prior research has suggested that different types of alliances (i.e., research versus marketing alliances) may yield different outcomes, since they relate to different resources, information, and skills shared (e.g., Yu et al. 2011, Yang et al. 2014), so we conducted a fifth additional analysis to address this issue. We split the dependent variable and the alliance experience variables into two (R&D and M&D) and ran Models 5 and 5(b). Although the results are similar in the case of Model 5, in Model 5(b) the main difference was in the analysis of the influence of marketing-alliance experience on subsequent international marketing alliances. Marketing-alliance experience with domestic MNCs has a positive influence and the interaction of this experience with domestic MNCs' network centrality is positive. These results suggest that such alliances might be valuable for a

Figure 3(a). Comparing One Alliance Experience with a Foreign MNC

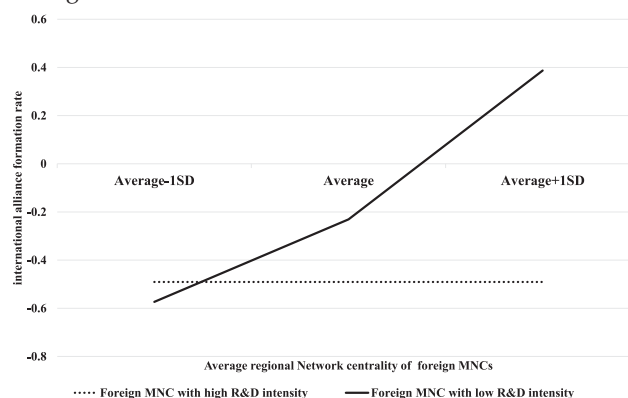
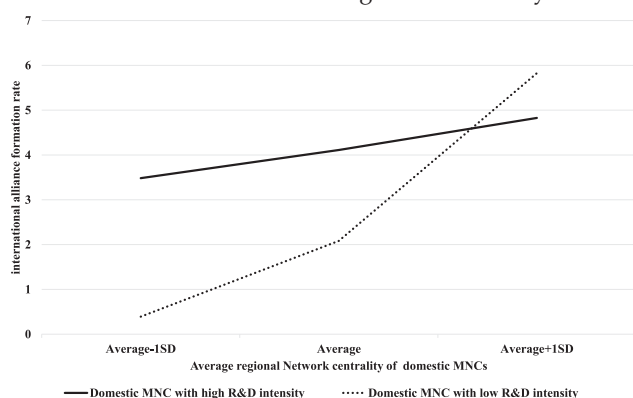


Figure 3(b). Comparing One Alliance Experience with a Domestic MNC with Low vs. High R&D Intensity

start-up that seeks to advance its international marketing activity.

As a sixth additional analysis, to examine the sensitivity of our results as they relate to the headquarters location, we coded the international alliances by geographic distance (e.g., Boeh and Beamish 2012). We split the variable *Alliances with foreign MNCs in region* into two new categories: those with MNCs whose headquarters are located within and outside the European Union. The findings (Table 4) suggest that alliance

experience with foreign MNCs whose headquarters are located outside the European Union has a significantly greater negative effect on a start-up's formation of its international alliances and in particular the formation of alliances outside the European Union. However, this experience effect is not significant, compared with alliances within the European Union, when it comes to forming alliances in Europe (excluding Germany). We further find that the estimates for alliance experience with European-headquartered MNCs are only significant and negative in influencing a start-up's formation of future international alliances within Europe. The interactions of the alliance experience of MNCs headquartered outside the European Union were significant and positive across all models. Finally, the estimates for alliance experience with domestic MNCs (including the interaction) on a start-up's alliance formation within the European Union were not significant.

Discussion

For start-ups, international expansion is an important means to grow and develop. To overcome the resource demands international expansion requires, start-ups—especially those in the life sciences industry—tend to form international alliances (e.g., Al-Laham and

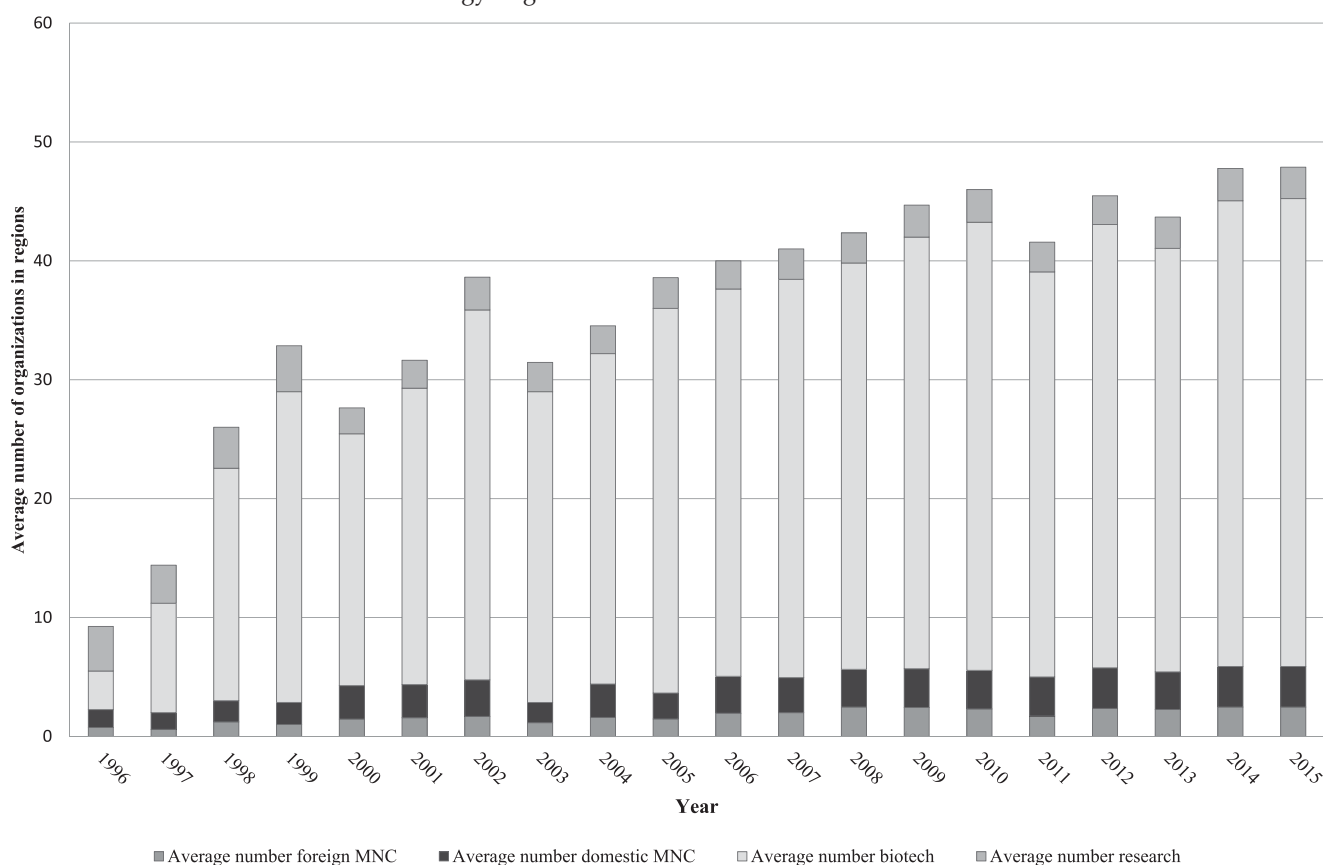
Figure 4. Development of the Average Number of Foreign and Domestic MNCs, Biotech Firms, Research Institutes, and Universities in the 19 German Biotechnology Regions

Table 4. Impact of MNCs on Start-Ups' International Alliance Formation in Europe and Outside Europe

Variable	All international alliances			International alliances in Europe			International alliances outside Europe		
	Original variables		By MNC location	Original variables		By MNC location	Original Model 5(b)		By MNC location
	Original variables			Original variables			Original Model 5(b)		
Regional network centrality foreign MNCs	-0.170 (0.240)		-0.084 (0.241)	0.015 (0.368)		0.049 (0.369)	-0.282 (0.305)		-0.162 (0.308)
Regional network centrality domestic MNCs	1.098*** (0.206)		1.089*** (0.205)	1.307*** (0.339)		1.306*** (0.338)	0.971*** (0.256)		0.957*** (0.254)
Alliances with foreign MNC in region	-2.506* (1.192)			-4.264* (1.941)			-1.580 (1.433)		
Alliances with foreign European MNCs in region			-1.540 (1.110)			-3.625* (2.113)			-0.645 (1.200)
Alliances with other foreign MNCs in region			-15.04*** (3.599)			-8.492* (4.533)			-22.654*** (4.316)
Alliances with domestic MNCs in region	-0.615* (0.254)		-0.803** (0.254)	-0.092 (0.388)		-0.169 (0.403)	-0.914** (0.325)		-1.159*** (0.328)
Regional network centrality foreign MNCs Alliances	2.064* (1.056)			3.323* (1.704)			1.432 (1.277)		
with foreign MNC in region									
Regional network centrality foreign MNCs Alliances			1.256 (0.992)			2.770 (1.869)			0.672 (1.078)
with foreign European MNCs in region									
Regional network centrality foreign MNCs Alliances			12.544*** (3.062)			7.108* (3.895)			18.883*** (3.536)
with other foreign MNCs in region									
Regional network centrality domestic MNCs Alliances			0.511** (0.167)	0.088 (0.255)		0.128 (0.259)	0.611** (0.215)		0.722*** (0.216)
with domestic MNCs in region									
Start-ups international alliance formation experience	0.558*** (0.071)		0.592*** (0.072)	0.610*** (0.114)		0.604*** (0.116)	0.519*** (0.092)		0.477*** (0.093)
Number of prior patent applications	0.022 (0.038)		0.047 (0.039)	0.036 (0.056)		0.039 (0.057)	0.014 (0.051)		0.054 (0.052)
Firm size (number of employees)	0.739*** (0.045)		0.775*** (0.047)	0.713*** (0.064)		0.723*** (0.067)	0.759*** (0.058)		0.810*** (0.060)
Firm age	-1.446*** (0.066)		-1.436*** (0.067)	-1.479*** (0.097)		-1.479*** (0.097)	-1.414*** (0.083)		-1.393*** (0.084)
Amount of prior grants	0.005 (0.007)		0.001 (0.007)	-0.008 (0.011)		-0.009 (0.012)	0.014 (0.009)		0.007 (0.009)
Biotech type	0.286* (0.123)		0.272* (0.123)	0.301 (0.190)		0.295 (0.190)	0.271* (0.159)		0.251 (0.160)
Number of prior international alliance in region	-0.153 (0.102)		0.179* (0.101)	-0.073 (0.150)		-0.085 (0.151)	-0.202 (0.132)		-0.236* (0.132)
Density of collocated foreign MNCs	0.044* (0.020)		0.053** (0.020)	0.006 (0.028)		0.009 (0.029)	0.070** (0.027)		0.081** (0.027)
Density of collocated domestic MNCs	-0.004 (0.026)		-0.007 (0.026)	0.000 (0.041)		-0.001 (0.041)	-0.006 (0.033)		-0.009 (0.032)
Density biotech in region	-0.858 (0.728)		-0.968 (0.746)	-1.707 (1.159)		-1.733 (1.175)	-0.261 (0.931)		-0.499 (0.966)
Density universities and research institutes in region	-0.046** (0.016)		-0.051** (0.016)	-0.083*** (0.026)		-0.085*** (0.026)	-0.018 (0.021)		-0.025 (0.021)
Heterogeneity MNCs' R&D spending in region	-1.367* (0.795)		-1.387* (0.789)	-0.737 (1.418)		-0.735 (1.415)	-1.643* (0.981)		-1.709* (0.975)
Heterogeneity MNCs' age in region	2.168*** (0.630)		2.011*** (0.6633)	2.733** (0.978)		2.675** (0.975)	1.839* (0.794)		1.661* (0.799)
Heterogeneity MNCs' size in region	-3.891*** (0.579)		-3.809*** (0.573)	-2.959** (0.953)		-2.937** (0.950)	-4.461*** (0.738)		-4.325*** (0.728)
Wage level in region	-0.200*** (0.015)		-0.207*** (0.016)	-0.194*** (0.024)		-0.197*** (0.024)	-0.205*** (0.020)		-0.215*** (0.021)
Constant	-136.793 *** (3.369)		-137.987 *** (3.413)	-143.117*** (5.359)		-143.386*** (5.389)	-134.192*** (4.191)		-135.880*** (4.273)
Number of international alliances	601	601	601	251	251	251	350	350	350
Log likelihood	-968.767	-968.767	-968.767	-607.855	-607.855	-607.946	-760.738	-760.738	-758.354

Notes. Number of observations: 14,036. Robust standard errors appear in parentheses.

* $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$; **** $p < 0.001$.

Souitaris 2008). This study assesses the extent to which nonpeer actors can serve as points of reference and influence a local start-up's behavior. Specifically, we examine whether foreign and domestic multinational entities, which are not part of a local start-up's peer group, can become a source of learning. We explain that in forming more educated internationalization choices a start-up can use knowledge it acquires vicariously—examining the actions of others (in our case knowledge derived from regional network activity of the MNCs) and knowledge it acquires from its own prior experience. We further posit that the degree to which a start-up can use the vicariously acquired knowledge is influenced by its own specific prior experience with these entities.

Overall, our findings illustrate the importance of a vicarious learning theoretical framework for explaining the internationalization activity of start-ups. We show how nuanced differentiations of the actions of the actors in a firm's local environment provide a clearer resolution of the determinants of a firm's behavior (international alliance formation). While research on vicarious learning often emphasizes the mimetic end results of learning from others, we show that learning from the activities of others can lead to nonmimetic actions—that is, a differentiated strategy. Our results further emphasize the need to examine vicarious learning in conjunction with the firm's own experience. Our study also contributes to the literature on a firm's own alliance experience. Our findings contradict prior work showing that the prior alliance experience a firm has with MNCs may not transform to subsequent future international alliance formation. We show the unique influence of each type of alliance and highlight the importance of disentangling them. Our results further provide evidence to support the existence of conflicting arguments regarding the influence of alliances on a firm's subsequent behavior. Evidence supporting these conflicting arguments is essential because it illustrates the need to better understand the context in which the experience have impact. Our findings further contribute to the discussion of how MNCs shape their host environment, and emphasize the significant effect of decoupling whether the MNC is foreign or domestic; yet, contrary to prior work, we find no added value of decoupling by country of origin. Finally, our study contributes to the discussion of the benefits and costs of agglomerations to technology-oriented start-ups as they relate to their future international growth.

Our study adds to the vicarious learning literature by emphasizing the importance of examining the potential influence of the activity of nonpeer firms and refining categorization of the different actors. Our findings show that a closer and more refined examination can more precisely clarify and identify the

actors that effect a firm's strategic behavior, which may—as in our case—provide a more accurate account of the determinants of a firm's behavior. By limiting their focus to the impact of peer firms, such as other similar start-ups, scholars using vicarious learning theory to study the international activity of start-ups (and SMEs) (such as Al-Laham and Souitaris 2008, Fernhaber and Li 2010) have failed to examine the potential for these start-ups to vicariously learn from other nonpeer organizations that take part in industry-related activity and that have a local presence in the region (for example both domestic and foreign MNCs'). Consequently, research so far has only a limited understanding of the types of firms that can serve as potential role models for start-ups and influence their behavior. Our study expands the potential sphere of influence and finds that start-ups' behaviors are influenced by the activity of MNCs. Contrary to prior findings, we find evidence to suggest that start-ups' international alliance formation activity is not influenced by the international alliance formation activity of proximate similar firms, but rather by the regional network activity of colocated MNCs. The results show that the more network-active colocated MNCs are in forming alliances with proximate similar start-ups, the more a focal start-up seeks international alliance partners. Furthermore, we show that the influence of MNC network activity is not equally similar across all MNCs. By differentiating between domestic and foreign MNCs, we are able to reveal a more nuanced understanding of the influential impact of these different actors. We find that the network activity of domestic MNCs is much more influential in motivating international alliance formations of colocated start-ups than the network activity of foreign MNCs. Our study goes beyond this important differentiation and further decouples the two types of MNCs by R&D intensity. These additional segmentation-analysis findings suggest that the greater the research intensity of the MNCs—particularly domestic MNCs—the more start-ups' attention is directed to international alliance formation. Hence, to understand the possible learning opportunities that a local firm has, and its subsequent response, it is not enough to look at peer firms and definitely not limit to successful peer firms. Researchers need to examine the diversity of local actors who interact with the peer firm, and then understand that a clearer picture can only be achieved via a more in-depth sub-categorization of the actors involved.

An additional important result of our study pertains to foreign MNCs, suggesting that cultural differences may inhibit a colocated start-up's ability to vicariously learn from these MNCs and subsequently influence its international alliances. Only once a firm has some experience with such entities can it vicariously

learn from their activity as it relates to future international expansion on their own. In addition, only at high levels of regional network engaged the foreign MNCs', there is a positive likelihood that start-ups would seek to form subsequent international alliances. Our findings also indicate that this likelihood is restricted to start-ups' alliance experience with foreign MNCs that have relatively lower R&D intensity. In all other cases, the combined influence of foreign MNCs on local start-ups' international alliance formations is negative. One possible reason for this finding may be that the activity of foreign MNCs helps start-up managers learn how to form and maintain alliances with these MNCs and that this knowledge steers start-up managers away from forming international alliances on their own. Another possible explanation is that foreign MNCs extract more value from their start-up alliance partners. This argument is in line with prior studies pointing to the potential downfalls of alliances with larger firms, as the latter may appropriate more of a start-ups' potential value (e.g., Doz 1987, Alvarez and Barney 2001, Singh and Mitchell 2005). These results emphasize the importance of studying vicarious learning from all the actors in a firm's local environment, including foreign entities.

Moreover, although vicarious learning theory often suggests a mimetic behavior from similar role models, learning about the activity of other actors can lead a firm to choose "what not to do" or to seek other alternatives. As one of the entrepreneurs we interviewed explains,

We look, of course, at other companies, companies which in the broadest sense are comparable to us—those that started in Germany—just to learn about it. We look at what worked well and what didn't work so well for them. How should I enter a market, when should I start to internationalize? (Interview with Biotech entrepreneur, January 24, 2017, Mannheim)

Just as firms can learn from their own failures, we believe that they can also learn from the mistakes of others. Vicarious learning work, thus, should focus on learning from the activities of all others, not only successful organizations. This claim fits with one potential interpretation of our findings—the differences in network effects of domestic and foreign MNCs—indicating that local firms may learn about the difficulties of forming alliances with foreign entities from their peers and choose not to form alliances or wait longer to internationalize. Hence, although mimetic behaviors can be a response to learning about processes that work well, a decision to delay, avoid, or choose altogether alternative ways to grow and expand could and should be studied as a response to learning about potentially challenging processes.

Another contribution of our study to the vicarious learning literature is highlighting the important role of a firm's own experience when examining from

whom a firm may learn and how it may be impacted from vicarious learning. Our results suggest that a firm's experience can enhance the impact of vicarious learning. Specifically, we show that a firm's alliance experience with a particular type of MNC (domestic or foreign) can enhance the influence of that type of MNC's regional network engagement on the firm's subsequent international formation. The more nuanced results we get by decoupling the different experiences a firm has (based on R&D intensity of the MNCs) further illustrate how future work on vicarious learning can benefit from examining the actions of the subcategorized actors in a firm's environment in conjunction with the firm's prior experience across these subcategories.

Our study also contributes to the literature on a firm's own alliance experience. Our findings contradict prior work, which shows that through collaboration with MNCs, small firms develop the resources and capabilities they need to internationalize (e.g., Prashantham and Dhanaraj 2015). There could be multiple reasons for such a discrepancy. First, Prashantham and Dhanaraj (2015) investigate the firms' internationalization intent, not the actual international activity (i.e., forming international alliances). Our results might also be explained by the power disparity between a start-up and the colocated MNCs: either the start-ups need to devote more resources to such alliances or the MNCs are absorbing more potential value, thus leaving the start-up with fewer resources or value needed to form subsequent international alliances. Another explanation could be that forming and maintaining alliances with colocated MNCs may seem less taxing to a start-up than forming international alliances with foreign entities. Finally, another possible explanation is that alliances, much like other organizational activities, lead to the formation of routines (e.g., Schilke and Goerzen 2010). In the process of learning, a start-up develops certain competencies and routines that lead to path dependence and lock-in. Alliances with proximate MNCs may lead to start-ups' forming specified or specialized routines that are not transferable to international alliance formation with partners located outside country borders. This finding contributes to recently emerging literature investigating the negative consequences of alliances and the challenges stemming from differences in power and resources between the collaborating firms (e.g., Diestre and Rajagopalan 2012, Vandaie and Zaheer 2014, Yang et al. 2014).

Our study illustrates that each type of alliance experience a firm has uniquely impacts its subsequent international alliance activity. Although international alliance experience has a positive impact, alliance experience with local MNCs has a negative impact,⁸

and significantly more so in the case of alliance experience with foreign MNCs. This differentiated outcome suggests that alliances with local MNCs may serve as a substitute to start-ups' forming their own international alliances (alliances with foreign entities outside the country's boundaries). One of the founders we interviewed shared his concerns:

We did not search explicitly and [spend our] whole [search] time to find a partner abroad, because, of course, this goes along with more travel expenses and certain language barriers and legal barriers and such issues. (Interview with Biotech entrepreneur, January 23, 2017, Mannheim)

Our finding that the impact of a start-up's alliances with foreign MNCs is even more negative (compared with that of alliances with domestic MNCs) points toward an even greater substitutive effect taking place. One possible explanation for this negative finding is that forming and managing alliances with foreign MNCs requires more time and resources (i.e., additional costs) than forming and maintaining alliances with domestic MNCs, even when the foreign MNCs are colocated. Zucker (1986) explains that cooperation will likely be easier between people with the same cultural norms, and individuals are more likely to trust those who share the same values, which fosters a common cognitive frame and promotes a sense of common social identity. Shared culture and values also entail presence in the same, or a similar, institutional environment, which further facilitates the development of trust-based relationships (Child 1998).

We further contribute to the literature on alliances by finding evidence to support the existence of conflicting streams of arguments. The overall influence of alliance experience with MNCs depends on the level of MNCs' engagement in the regional network. As we illustrate in Figure 2, (a) and (b), when colocated MNCs are extremely engaged in the regional network (i.e., average + 1 standard deviation and above), having an alliance experience with these MNCs induces a start-up to extend its international alliance activity. At other levels of MNC engagement, having an alliance experience diminishes a start-up's subsequent alliance formation rate. Two possible explanations could clarify this finding. First, a start-up may be able to capture and leverage more knowledge from its networks if it has a direct link to one specific source in the network. However, because of the resources and costs associated with forming the tie, to intensify the firm's international activities, a certain threshold of a particular type of knowledge should be available to justify the additional use of resources to form more international alliances. A second explanation may be that an increased level of MNC engagement in the local network increases competition

among MNCs, reducing the number of restrictions MNCs write into their contracts with local start-ups when forming ties, leaving start-ups with an increased number of options for working with other foreign entities.

Our findings also contribute to the discussion of how MNCs shape their host environment (Kwok and Tadesse 2006, Mariotti et al. 2015). Prior work, such as Almeida and Phene (2004), acknowledges the important role MNCs play in shaping the host region in which they are embedded. We add a dimension for the role of MNCs, yet highlight that MNCs may have both a positive and a negative influence. Our study also complements prior research (e.g., Aharonson et al. 2016) emphasizing the significant role of both domestic and foreign MNCs and the meaningful difference in their impact. However, when we examine in more detail the headquarters country of the MNCs (Ferner 1997, Harzing and Sorge, 2003, Noorderhaven and Harzing, 2003), we find no evidence to support a potential variance in the respective influence of headquarters countries on local firms' subsequent international alliance formation. In fact, we find that regardless of the country of origin, the impact of foreign MNCs on the international alliance formation is consistent, irrespective of the distance to the MNC's headquarters country. With this finding, our study shows that variation in vicarious learning is more greatly influenced by whether an MNC is domestic or foreign than by the heterogeneity of an MNC's country of origin. Social categorization research may provide a useful framework to explain this finding. Work in this theory assumes that individuals and groups use differences and similarities as the basis for categorizing themselves and others into in- and out-groups (Tajfel 1981, Turner et al. 1987). Individuals then tend to stereotype members of other categories and perceive their own category as superior (Williams and O'Reilly 1998). Yet, the impact of social categories weakens as a familiarity with the partner increases (Kwon et al. 2016).

Finally, our research contributes to the discussion of the benefits and cost of agglomerations to technology-oriented start-ups. Our work provides an additional dimension that helps to explain the potential impact of a firm's location decision and the degree to which its actions may enhance or impede the growth and international development in its location. MNCs not only benefit from the internationalization activity within their region but also influence the subsequent evolution of the internationalization activity of colocated start-ups. Our findings emphasize the significant impact that MNCs have on the development of the industry within a region and the potential international alliance behavior of the colocated start-ups. When considering the implications of attracting MNCs to

locate in a region, policymakers should carefully weigh the benefits and costs of devoting resources to increasing the engagement of the MNCs within a region, especially since doing so may reduce the incentives of the colocated start-ups to seek international alliances on their own. Policymakers should consider the positive implications of enhancing the regional activity of domestic MNCs and the benefits of encouraging already positioned MNCs to be more regionally active, to increase the odds that colocated start-ups benefit from the positioning and activity of the regional MNCs.

In sum, our paper makes several contributions to four streams of literature. First, it adds value to the literature on vicarious learning by highlighting the importance of (a) using a vicarious learning theoretical framework to explain the internationalization activity of start-ups; (b) using nuanced differentiations of the actions of the variety of actors—including nonpeers—in a firm's local environment; (c) recognizing the need for future studies to examine the potential influence of foreign entities that have a domestic presence; (d) examining the potential consequence of vicarious learning beyond mimetic behavior and recognizing the possibility of other alternative actions; and (e) examining the potential influence of vicarious learning in conjunction with a firm's own experience. Second, our study contributes to the literature on a firm's own alliance experience by providing evidence that (a) contradicts prior work and shows that a firm's prior alliance experience with MNCs may not be transferrable to subsequent future international alliance formation; (b) each type of alliance has a unique influence on the likelihood of forming another specific type of alliance, which highlights the importance of disentangling a firm's alliance experience by type; (c) supports the existence of conflicting arguments regarding the influence of alliances on a firm's subsequent behavior. Third, our findings contribute to the discussion of how MNCs shape their host environment, emphasizing the significant effect of decoupling the influence of foreign and domestic MNCs, with the added contribution that contrary to prior work, we find no added value of decoupling by country of origin. Fourth, our study contributes to the discussion of the benefits and costs of agglomerations to technology-oriented start-ups, as they relate to start-ups' future international growth.

Limitations and Future Research Directions

This study has several limitations. The first is its specific industry context. We examined the impact of MNCs on the international alliance behavior of colocated start-ups in the German biotechnology industry. While prior work has identified alliances as the preferred means for start-ups to internationalize, particularly in the life

sciences industries, this is not the only means by which start-ups and SMEs can internationalize (e.g., Laufs and Schwens 2014). Future work can explore the impact MNCs have on other local firms' internationalization activity. Second, even though we find overall consistent results for our main hypotheses across different age categories, we also find some differences. Specifically, we find that for younger start-ups, domestic MNCs have a greater influence on international activity, whereas older start-ups are more greatly impacted by foreign MNCs. Because we lose a significant number of international alliance events when we limit the sample by age, we are not certain to what degree this sample loss influences the outcomes. Future research may be able to disentangle the role of age in the context of international alliance formation. In addition, we examined a relatively young emerging industry with a population of young firms. Yet, we had variance in size and ages of the firms. Future work may be able to explore the potential differentiated impact of MNCs on the internationalization activity in a more nuanced manner to enhance our understanding of the potentially differentiated impact of MNCs on colocated firms across their life cycle. Third, because we had a relatively small sample of international alliance events, we could not explore in more depth the influence of the different types of alliances (e.g., R&D versus M&D), nor could we classify the international alliance formation by specific countries and examine the relation of each alliance to MNC country of origin. Future work may be able to do more finely grained analyses to assess the potentially differential impact that country of origin and alliance type experience has on sparking internationalization activity. Fourth, it might be possible that both the presence of MNCs and the international alliance formation of the local start-up can be explained by other underlying resources that make the region attractive. Further, although most of the MNCs in our setting were founded in or entered (in case of the foreign MNCs) the German market before the biotechnology industry in Germany emerged and before our analysis begins, we cannot completely rule out the possibility of endogeneity issues. We urge further research to investigate in detail the factors that make a region an attractive place for MNCs, and the effect MNCs' entry into established locations has on the internationalization behavior of regional start-ups. Finally, whereas we conducted several expert interviews to get a better understanding of our findings, we believe that more in-depth exploration is needed to understand the mechanisms that influence a start-up's internationalization decisions. For example, one explanation that we proposed is that the increase in MNCs' engagement in the regional network increases the competition

among MNCs and reduces the constraints they place on the local start-ups when forming ties, giving the start-ups greater possibilities for working with other foreign entities. Future research can explore this issue more in-depth to disentangle these potential explanations. As evident in our results, it may also be valuable to continue to explore the particular mechanisms and factors that lead to the differential influence that MNC and tie type has on a colocated firm's internationalization process, specifically on a start-up's international alliance behavior. Future work can also explore whether being a foreign firm has the same implications in terms of its being viewed as a foreigner, regardless of its country-of-origin, and irrespective of the German biotechnology industry and its international alliance behavior.

Conclusion

In conclusion, our study provides evidence that start-ups vicariously learn from the activity of nonpeer actors such as MNCs. Our research reveals that in order to have a clearer understanding of the impact of vicarious learning, an in-depth differentiation of the actors in a firm's environment is necessary. Moreover, it is essential to study the potential impact of vicarious learning in conjunction with a firm's own experience across this subcategorization of actors. Furthermore, vicarious learning does not always result in mimetic behavior. In the case of a firm's international alliance formation, it is imperative to differentiate peers from domestic MNCs, domestic MNCs from foreign MNCs, and alliances with foreign entities that have a domestic presence from those that do not. We show that MNCs play a vital role in influencing the international alliance behavior of colocated start-ups; we highlight that MNCs are not a homogenous group; and we reveal that for host start-ups, what matters more is whether the MNCs are domestic or foreign, not their country of origin. Finally, we highlight the need for agglomeration studies and studies on the influence of MNCs to examine the impact of MNCs on colocated start-ups in terms of their network activities and their direct alliances with the local start-up.

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Endnotes

¹MNCs with foreign headquarters are defined here as "any host-country operations controlled by a foreign parent firm, such as branch offices, manufacturing plants, or local headquarters" (Mezias 2002, p. 266). In this study, we follow Aharonson et al. (2016) and

classify a foreign MNC as one that was initially founded in a country other than Germany (i.e., its country of origin is any country outside Germany), whereas a domestic MNC is one that was initially founded in Germany.

²Changing regulations, social values, and preferences led to the emergence of biotechnology in Germany around 1996. Among these regulatory changes was the liberalization of genetic testing in 1993 and, beginning in 1995, the establishment of different support and funding programs designed to facilitate the development of the German biotechnology industry (Dohse 2000, Kaiser and Prange 2004).

³This study examines start-up biotechnology firms and pharmaceutical MNCs. The focus of a pharmaceutical firm is more on the production and distribution and less on R&D, whereas the focus of a start-up is mainly on R&D. Therefore, pharmaceutical firms are less likely to be considered a peer group for start-ups.

⁴We investigated firms located in 19 biotechnology regions in Germany. The German Federal Government initiated a contest in which leading biotechnology regions (the so-called "BioRegios") competed for public funding (Casper et al. 1999, Dohse 2000). The aim of initiating these "biotechnology regions" was to encourage the innovation and growth of the German biotechnology industry (Casper et al. 1999). As a result of the contest, 19 regions emerged (Dohse 2000, Dohse and Staehler 2008): 17 in 2000 and two additional regions around 2008.

⁵For example, Oehme and Bort (2015) show in their study on the German biotechnology industry that network-centrality figures measured based on a three-, four-, and six-year moving window are correlated with five-year-based variables.

⁶Hazard ratios (HRs) can be interpreted as the probability that a start-up experiences an international alliance event at a given point in time.

⁷Although in some industries, domestic MNCs might be considered peers, in our case they are significantly different. In cases where domestic MNCs are considered part of the peer group, we posit that there might be value in separating this group from the other peers.

⁸When we differentiate the alliance by the R&D intensity of the partners, we find a positive influence of a firm's alliance experience with high-R&D insensitive domestic MNCs. This type of alliance may provide the firm with added value that it can later utilize outside its home country to form international alliances.

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