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## Article

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# A contingency view of alliance management capabilities for innovation in the biotech industry

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## Abstract

In this research, we analyze the influence of two alliance management capabilities, coordination and interorganizational learning, on the performance of alliances for innovation. By adopting a contingency view, we explore whether the effectiveness of these capabilities depends on certain features of the alliance portfolio configuration (partner and geographic diversity). Based on a sample of Spanish companies belonging to the five leading biotech clusters, our results demonstrate that alliance management capabilities are not equally effective across different contexts. Alliance coordination capabilities become more effective when partner diversity is low and geographic diversity is high. By contrast, interorganizational learning capabilities have a positive effect on alliance portfolio performance when partner diversity is high and geographic diversity is low. These results also have useful implications for managers involved in alliances for innovation, who can direct the organizational efforts towards the most effective alliance capabilities, depending on the features of their alliance portfolio.

## JEL CLASSIFICATION M19

## Keywords

Alliance management capabilities, Innovation, Coordination, Learning, Partner diversity, Geographic diversity

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## Introduction

Managing cooperation for innovation is a complex process, with a varied number of challenges and drawbacks: different cultures and routines, diverging views and interests, appropriation issues, and lack of adaptability and knowledge spillovers, among many others (Antolin-Lopez et al., 2015). Firms are not equally effective when anticipating and managing this complexity, due to both the vast array of managerial resources that is required (Iturrioz et al., 2015), and the existence of great interfirm differences in terms of their ability to create value through cooperation (Anand and Khanna, 2000; Draulans et al., 2003; Schreiner et al., 2009; Sluyts et al., 2011). As a consequence, and having demonstrated the benefits of interfirm

cooperation, researchers have become increasingly interested in understanding how management capabilities may improve the alliances performance.

To address this issue, recent research has proposed the concept of alliance management capability, defined as a “the capacity to purposefully create, extend, or modify the firm’s resource base, augmented to include the resources of its alliance partners” (Helfat et al., 2007, p. 66). In other

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words, it refers to a firm's ability to effectively manage multiple alliances.

The literature on alliance management capabilities is relatively new (see the recent review by Wang and Rajagopalan, 2015; Kohtamäki et al., 2018). Wang and Rajagopalan (2015) provide a review of prior empirical research on alliance capabilities, in which they distinguish (1) three levels of analysis (individual alliance, portfolio, and dyad), and (2) two stages of the alliance (preformation versus postformation). Likewise, Kohtamäki et al. (2018) provide a systematic review of 94 articles from top-tier journals focused on alliance capabilities not only to present the open questions related to their conceptualization and dimensions, but also to summarize their antecedents, processes, and outcomes. Traditionally, researchers concerned with explaining alliance success mainly focused on inter-firm antecedents of alliance performance (Heimeriks and Duysters, 2007), while devoting considerably less attention to intrafirm antecedents, such as the ability to manage alliances. However, it is indeed these abilities that may better explain alliance success and may be critical for survival in a changing environment (Draulans et al., 2003; DeMan, 2005; Heimeriks et al., 2007, 2009; Kale and Singh, 2007; Schilke and Goerzen, 2010; Paradkar et al., 2015; Sluyts et al., 2011).

In line with the above, Schreiner et al. (2009) propose coordination, communication and bonding as the three main aspects when managing alliances. Schilke and Goerzen (2010), in turn, identify four types of routines that underlie the alliance management capability of the firm (coordination, learning, sensing and transformation). Given that analysing all of them would be beyond the scope of one single article, we limit our analysis to coordination and learning capabilities, which have been emphasized as essential skills for the success of the alliance (Kale et al., 2002; Draulans et al., 2003; Schreiner et al., 2009; Wang and Rajagopalan, 2015).

While it is true that the relevance and effectiveness of alliance management capabilities is generally acknowledged, such capabilities may not be equally effective under every circumstance. Indeed, it seems that some alliance management capabilities are more likely to contribute to alliance success than others depending on certain factors, from a contingency perspective of the topic (Draulans et al., 2003; Heimeriks et al., 2009; Sarkar et al., 2009; Wang and Rajagopalan, 2015).

Regarding those contingency variables, it has been argued that the diversity of alliance partners can affect the relationship between management capabilities and performance. Indeed, the increasingly complex and fast-changing technology that companies have to face make a single partner type be unlikely to provide all the necessary resources. Thus, firms are gradually increasing the number and types of partners, including customers, suppliers, research institutions, and so on. This is the so-called alliance partner

diversity. At the same time, such diversity may come from either the same or a different region, also named geographic diversity (Terjesen et al., 2011). Beyond the potential impact of diversity on performance, having diverse partners entails a number of transaction, coordination and learning costs that may strengthen or weaken the potential benefits of alliance management capabilities (Sarkar et al., 2009; Oerlemans et al., 2013). This is what Duysters and Lokshin (2011) call the complexity of the alliance portfolio, which places a burden upon managing the portfolio skilfully; thus the more the diversity, the more the management attention that will be needed.

Except for very few studies (Sarkar et al., 2009; Duyster et al., 2012; Oerlemans et al., 2013), the two paths of research mentioned above (alliance management capabilities and diversity of partners) have been examined in isolation. Recently, however, the need to bring them together in order to reach a better understanding of the interplay between alliance capabilities, diversity and performance is self-evident (Duyster et al., 2012). Furthermore, previous studies consider neither the multidimensional nature of alliance capabilities, as Schilke and Goerzen (2010) proposed, nor the different types of diversity that coexist in the portfolio (Terjesen et al., 2011; Duyster et al., 2012). In an attempt to bridge these gaps, our study brings together both alliances management capabilities and alliance diversity, so as to gain insight into how alliances for innovation can be more effective. With this aim, we propose two research questions: (1) how do coordination and learning alliance capabilities influence the performance of alliances for innovation? and (2) are these relationships moderated by partner and geographic diversity?

We are aware that an alternative approach regarding the interplay between alliance management capabilities and diversity is possible. In line with this, Duyster et al. (2012) and Oerlemans et al. (2013) focus on the direct effects of diversity on performance, while the capabilities of the firm for managing their alliances are considered as the moderating variable. Although this perspective is also plausible, we try to be consistent with our basic assumptions: first, the capabilities of the firm in managing alliances may be a more important success factor than the characteristics of the alliances (Draulans et al., 2003); and second, these capabilities are not equally effective under every circumstance and, therefore, a contingency view of the topic must be adopted (Draulans et al., 2003; Heimeriks et al., 2009; Sarkar et al., 2009; Wang and Rajagopalan, 2015).

In this study, we will apply the above-mentioned issues to the biotechnology sector, given its characteristics; specifically, most high technology firms are involved in multiple and simultaneous strategic alliances with different types of partners (Gay, 2005; Al-Laham et al., 2008; Shin et al., 2016), so that their challenge is to manage an entire alliance portfolio rather than an individual alliance (Wassmer, 2010). Thus, the unit of analysis in this research

is the firm's innovation alliance portfolio, which could be defined, from an additive perspective, as the aggregate of all the alliances for innovation of a focal firm (Marino et al., 2002; Hoffmann, 2005).

This paper is structured as follows: first, we explain the theoretical background on alliance management capabilities, and partner and geographic diversity, which will lead to the formulation of our hypotheses; second, we describe our empirical research and results; and finally, we present the main conclusions of our study.

## Theoretical background

The literature on R&D alliances is extensive and has addressed a large variety of issues from governance choice decisions, motives for collaboration, partner selection decisions and so on (see for a review Martínez-Noya and Narula, 2018). Within the literature of alliance for innovation, one of the most important trends in terms of scholarly contribution is the learning/knowledge transfer approach (Guardo and Harrigan, 2012). From this perspective, we assume that having certain capabilities for managing alliances for innovation will facilitate knowledge transfer and learning, and will explain differences in the alliance performance. Following Helfat et al. (2007), alliance management capabilities allow firms to create, extend, or modify their resource base through collaboration with partners. In this research, we focus on two of these capabilities: (1) coordination capabilities that aim to allocate resources assign tasks and synchronize activities, and (2) learning capabilities that lead to generate new knowledge and build new ways of thinking (Teece et al., 1997). Companies that hold alliance portfolio coordination and interorganizational learning capabilities will achieve a higher positive impact on the alliance portfolio performance than those that have not invested in developing such capabilities (Rothaermel and Deeds, 2006; Schilke and Goerzen, 2010; Sluyts et al., 2011). In this study, alliance portfolio performance refers to the performance of alliances established for innovation purposes (including R&D alliances), measured through different facets (e.g. improvement of competitive position), and not just innovation performance (e.g. new product development).

### *Alliance portfolio coordination capabilities*

Draulans et al. (2003) suggest that the coordination of activities between two independent organizations implies dealing with differences in terms of structure, culture and planning, as well as reconciling partners' interests. Apart from this interorganizational coordination, Goerzen (2005, 2007) and Koka and Prescott (2002) highlight the importance of the governance of the entire alliance portfolio, that is, alliance portfolio coordination. This aims to identify the interdependences among single alliances, and involves

specifying the roles and responsibilities of each participant in task execution, in a way that their specific activities are linked to each other, and regular mutual adjustments can be made (Schreiner et al., 2009).

Moreover, it is worth noting that interdependencies in alliance portfolios can create both synergies and conflict (Wassmer, 2010). Baum et al. (2000) suggest that the potential for conflict depends on how many partners perform similar functions or take on duplicate roles, and this may lead to increasing the risk of intra-alliance rivalry. Consequently, coordination among partners is a key issue to consider when trying to explain the performance of alliances (Wuyts et al., 2004; Goerzen and Beamish, 2005; Jiang et al., 2010).

On the other hand, Zollo et al. (2002) also analyze the beneficial effects of interorganizational routines developed through prior collaborations with the partner firm, and support the role of interfirm coordination and cooperation routines in enhancing the effectiveness of collaborative agreements. Belderbos et al. (2015) also provide evidence that collaboration with partners improves performance but once firms have been persistently engaged in collaborating with that type of partner. Thus, it seems as though persistent collaborations might benefit from reputational effects of the firm (that had previously established as a reliable partner itself), as well as from previous coordination experience since firms are likely to have refined their (inter)organizational routines for collaboration. As Dyer and Nobeoka (2000) suggest, alliance portfolio coordination should lead to make an alliance portfolio more than the sum of its parts. This explains why a firm's alliance portfolio coordination capability would be positively related to alliance portfolio performance. Based on this argument, we propose our first hypothesis:

**H1.** Alliance portfolio coordination capabilities have a positive effect on alliance portfolio performance.

### *Interorganizational learning capabilities*

One of the main reasons why firms participate in alliances is to learn or absorb the know-how, skills and capabilities from their partners (Hamel, 1991; Khanna et al., 1998; Al-Laham et al., 2010). Thus, routines that allow collaborating firms to systematically absorb external knowledge are key to make interorganizational learning successful (Cohen and Levinthal, 1990; Dyer and Singh, 1998; Van den Bosch et al., 1999). These routines or set of organizational processes designed to integrate and facilitate knowledge transfer from R&D alliance partners are the so-called interorganizational learning capabilities (Dyer and Nobeoka, 2000; Inkpen and Crossan, 1995; Schilke and Goerzen, 2010).

These capabilities have been identified as critical for competitive success. To name but a few examples, Powell

et al.'s (1996) study in the biotech industry conclude that firms showing learning capabilities in their networks are likely to become industry leaders. Dyer and Nobeoka (2000) concluded that Toyota's knowledge-sharing routines with partners result in improved competitive advantage. García-Muiña and González-Sánchez (2017) and Nieto and Santamaría (2017) provide empirical evidence of the role that assimilation routines have, making cooperation agreements an efficient source of external knowledge. Schilke and Goerzen (2010) also highlight that interorganizational learning capabilities represent a key advantage in alliances and have a positive impact on the amount of resources obtained from them.

Based on the statements above, we propose the following hypothesis:

- H2.** Interorganizational learning capabilities in alliances have a positive effect on alliance portfolio performance.

### *A contingency view of alliance management capabilities*

Within the innovation literature, there is a line of research focused on identifying the contingencies under which alliance portfolios can increase or decrease innovative performance (Gomes et al., 2016). The contingency theory assumes that there is no "best" way to organize, but just the opposite: the management style and organizational structure are contingent upon conditions that are both internal and external to the firm (Pennings, 1992). In the early days of research on this contingency view, different studies acknowledged that appropriate organizational design depends on the organization's technology, its task interdependence, its information processing requirements, its organizational strategy, and its environment (Burns and Stalker, 1961; Chandler, 1962; Woodward, 1965; Lawrence and Lorsch, 1967). The contingency view, therefore, broke from the universally applicable set of management principles assumed by Weber's bureaucracy or Taylor's scientific management. There is no good or bad strategy in itself, but it rather depends on the situation or context in which it is used (Pennings, 1992).

In this diverse literature, one proposition has gained widespread acceptance: the formal and informal structures, systems and processes that make up an organization's design affect each other to form complete configurations (Khandwalla, 1973). Organizations are typically seen as "highly integrated system(s) whose performance is determined by the degree of alignment among the major elements" (Nadler and Tushman, 1997, p. 3). The design of a specific element depends on the configuration of others. So, within the innovation literature, Ju et al. (2005) analyze a variety of contingent factors (such as the firm absorption orientation, risk reduction orientation, R&D scale economy

orientation or top management team experiences) that influence the choice of alliance model (i.e. either contract-based form or in equity-based model), and finally determine the competitive advantage.

Following this stream, we adopt the contingency view, rather than the universalistic one, to explain the role of alliance management capabilities (Heimeriks et al., 2009; Duyster et al., 2012; Oerlemans et al., 2013). Thus, the effectiveness of alliance management capabilities would depend on certain features of the alliance portfolio configuration (Wassmer, 2010). Among these features, we focus on the diversity of partners in alliances for innovation, identified by Sarkar et al. (2009) as a relevant moderating factor that determines the effect of alliance management capabilities on performance. This construct is, by nature, multidimensional, with different types of diversity, each with a different potential impact on performance (Jiang et al., 2010). Of special interest in this study is Terjesen et al. (2011)'s proposal, which distinguishes two types of alliance diversity, with relevant managerial challenges: partner diversity, regarding the heterogeneity of partners' activities, and geographic diversity, regarding the heterogeneity of their locations. Having diverse types of partners from diverse geographic settings represents a great challenge to effectively manage the network of relationships and the transference of valuable knowledge among them.

In the following sections, we explore how the relationship between alliance management capabilities (portfolio coordination and interorganizational learning) depends on both partner and geographic diversity.

*The moderating role of partner diversity.* Partner diversity refers to the degree of heterogeneity in the types of partners with which a firm allies, including suppliers and customers, as well as other firms and organizations within the same industry (Oerlemans and Knobens, 2010; Terjesen et al., 2011). On the one hand, this diversity encourages creativity and novel solutions to existing problems. On the other, it creates learning opportunities that allow the firm to create and recombine knowledge (Cohen and Levinthal, 1990; Sampson, 2007), and to contribute to innovation (Luo and Deng, 2009; Cui and O'Connor, 2012; Sarpong and Teirlinck, 2018).

According to Baum et al. (2000), biotechnology firms learn about scientific knowledge in collaboration with some of their partners (universities, research institutes, government labs, and so on), and about operational knowledge with others (pharmaceutical firms, suppliers, and so on), while alliances with potential competitors (i.e., other biotech firms) may also provide access to experience with regard to how to operate and grow in the biotechnology industry.

However, diversity implies complexity, and therefore, significant management challenges in terms of coordination and interorganizational learning capabilities (Marhold et al.,



2017). This is especially true in technologically intense industries, in which diverse partners may have competencies in very different knowledge and technological fields, as well as different perspectives and cultures. This cognitive distance may result in problems of communication (Boschma, 2005) and lack of understanding and empathy among partners. Consequently, it may be the case that partners might be unwilling to work jointly, make concessions or meet on a middle ground for cooperation. This lack of mutual support could hinder the achievements of the alliance (Lakpetch and Lorsuwanarat, 2012). Hsiao et al. (2017) also point out that, as organizational distance increases in terms of business practices, operational mechanisms, corporate culture, and management style, interaction problems become more complicated and costly. Under these circumstances, interorganizational coordination capabilities, which include dedicated managerial hierarchy, joint work teams, the transfer of managerial and technical personnel, and so on (Pollard, 2001; Colombo, 2003; Cui and O'Connor, 2012), become critical when it comes to managing interactions among these diverse partners, and may have an impact on performance.

Regarding learning capabilities, the benefit of partner diversity in an innovation-related context can only be realized through effective sharing of information and resources (Cui and O'Connor, 2012). In this sense, the study of Oerlemans et al. (2013) demonstrate that the role of learning routines designed to enable capture, share and leverage information and knowledge across an alliance portfolio will vary depending on the level of partner diversity. That is, the learning capabilities of the firm will have an impact on the performance of the alliance when partner diversity is relatively high.

Based on the above-mentioned literature, we propose the following hypotheses:

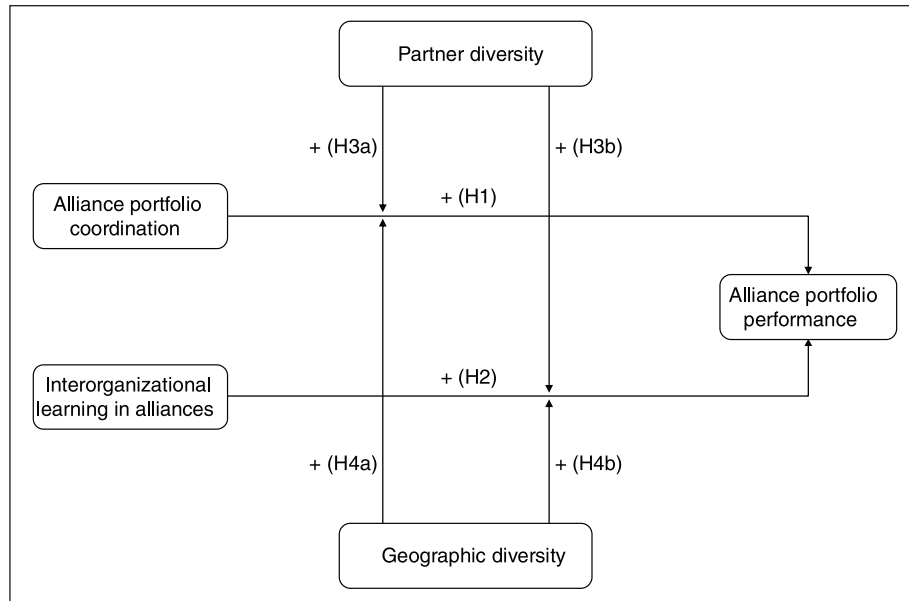
**H3a.** The relationship between alliance portfolio coordination capabilities and alliance portfolio performance will be moderated by partner diversity, so that the relationship will be positive when partner diversity is high.

**H3b.** The relationship between interorganizational learning capabilities and alliance portfolio performance will be moderated by partner diversity, so that the relationship will be positive when partner diversity is high.

*The moderating role of geographic diversity.* Geographic diversity refers to the degree to which a firm's alliance partners are located in geographically diverse settings (Terjesen et al., 2011). Although some authors defend the relevance of geographical proximity in fostering radical innovations (Hinzmann et al., 2018), the literature clearly supports the potential offered by geographic diversity, rather than proximity, among partners. The reasons are manifold. First, although proximity facilitates interaction

among companies, it is not a prerequisite for effective interorganizational learning, because other forms of proximity could act as a substitute (Boschma, 2005). For example, when partners share the same cognitive experience, or when social networks exist (regardless their geographic location), tacit knowledge can be transmitted effectively across long distances. Second, in technology intensive industries, no geographic region is likely to have the monopoly of knowledge (Zaheer and George, 2004). Indeed, the main risk of geographic proximity is the creation of overlapping networks between firms and common suppliers and customers, who share membership in common regional institutions. The consequence would be the access to the same redundant knowledge in repeated cycles (Pouder and St John, 1996; Zaheer and George, 2004; Sarpompong and Teirlinck, 2018). Thus, some firms will need to seek relationships with distant firms in order to obtain sources of new knowledge and innovation unavailable within their region (Rosenkopf and Almeida, 2003; Bell and Zaheer, 2007; Arikan, 2009; Capaldo and Messeni Petruzzelli, 2015; Ardito et al., 2018; Pucci et al., 2018).

However, the potential benefits that geographic diversity provides may be undermined by some difficulties and requirements that the distance imposes. Specifically, technical, complex and tacit knowledge (which is essential in the R&D process) is less easily transferred when it comes from distant partners. Therefore, certain coordination mechanisms, which may include formal collaboration (based on contractual assurances, prescheduled visits and exchanges, etc.) (Whittington et al., 2009) are required to facilitate inter-firm knowledge transfer (Mason and Leek, 2008; Ardito et al., 2018). It is under these circumstances that coordination capabilities can make a great impact on the performance of alliances (Sarkar et al., 2009). Accordingly, Capaldo and Messeni Petruzzelli (2015) highlight the importance of considering the characteristics of innovative activities to be performed by the different alliance partners, that is, the coordination of the specific alliance task of each partner, especially to integrate and take advantage of geographically distant knowledge. These authors introduced the concept of search span to capture "the extent to which allied firms jointly search across different knowledge domains" (Capaldo and Messeni Petruzzelli, 2015, p. 466), which is, in turn, related to the notion of innovation complexity and different types of competencies. Their results show that partner selection and coordination, based on how broadly the allied organizations are expected to search, are critical when geographical distant partners are involved in R&D alliances. By contrast, we expect a different role of coordination capabilities when geographic diversity is low. The collaboration with local partners can be easily maintained thanks to informal social channels and a normative context that observes and sanctions poor partnership behaviour, and enforces reputational effects (Singh, 2005; Whittington et al., 2009). Hence, in



**Figure 1.** Theoretical model.

this context, formal coordination capabilities of the focal firm are not as relevant as in the case of distant partners, as their effects may be neutralized or replaced with social channels (Owen-Smith and Powell, 2004).

Similar to coordination capabilities, we expect interorganizational learning capabilities to play a key role in terms of improving the performance in a context of high geographic diversity. As Pucci et al. (2018) suggest, developing trust-based relationships and communication channels with distant partners is more difficult and complex, and it takes longer than with local partners. When the firm has to manage networks with distant partners, a high endowment of human capital, skills and capabilities facilitate the transfer and exchange of information among actors, and contribute to the success of the collaboration. On the contrary, when partners are located in the same region and the firm is exposed to redundant knowledge, the opportunities for learning are reduced and, consequently, the impact of learning capabilities on the performance of the alliance is weakened.

Based on the statements above, we propose the following hypotheses:

**H4a.** The relationship between alliance portfolio coordination capabilities and alliance portfolio performance will be moderated by geographic diversity, so that the relationship will be positive when geographic diversity is high.

**H4b.** The relationship between interorganizational learning capabilities and alliance portfolio performance will be moderated by geographic diversity, so that the relationship will be positive when geographic diversity is high.

Fig. 1 summarizes the proposed model and the hypotheses that have been formulated.

## Method

### *An overview of Spanish biotech industry and clusters*

Spain is the 3rd country in the OCDE region with a significant number of biotech companies. In 2016, 651 companies included biotechnology as their main activity, which represents an increase of 37% in comparison with 2009 (475 companies) (Asebio, 2018). The sector is mainly composed of micro-enterprises and SMEs: 59% are micro-enterprises (less than 10 employees) and 39% are SMEs (less than 250), while only 2% are large companies (more than 250 employees) (Asebio, 2017).

The economic impact of Spanish biotech companies is 0.7% of GPD and 0.6% of employment. When the overall industry is considered (not only companies mainly dedicated to biotechnology but also those for which biotech is a secondary activity or use biotechnology as a tool), it accounts for 7.8% of GPD, 4.9% of employment and 3% of R&D expenditure (Asebio, 2017).

Spanish Bioregion Network triggered the creation of a number of biotech clusters with the purpose of “encouraging all the stakeholders of the Bioregion (companies, research entities, hospitals and innovations support structures) to transform knowledge and technology into economic growth and to create a social impact” (Asebio, 2018, p. 15). In 2017, the 5 clusters considered in our research account for the largest number of biotech companies (76.8%) (Asebio, 2017).

**Table 1.** Main figures of biotech clusters.

	Andalusia BioRegion	BioBasque	BioCat	Madrid Biocluster	BioVal
Year of creation	2008	2002	2006	2007	2006
Dedicated biotech firms (DBF)	64	45	83	51	42
Employees in DBFs	769	777	1830	1531	435
Researchers in DBFs	431	531	1099	1045	247
Number of alliances	30	17	50	26	14
Number of alliances with partners in other regions	19	15	40	15	12

Source: Vlasisavljevic (2015).

The main figures related to each of these clusters are shown in Table 1. The data are for the years the data were collected (2012–2013).

### Sample and data collection

The population for this study is composed of 285 biotechnology firms that fulfilled the following requirements: (1) they are located in one out of the five biotechnology clusters in Spain: BioRegion (Andalusia), BioBasque (The Basque Country), BioCat (Catalonia), Madrid Biocluster (Madrid), and BioVal (Valencian Community); (2) they perform R&D in biotechnology as the main activity; and (3) they are not subsidiary companies with headquarters or R&D activity outside the cluster.

The motivation to focus on the biotechnology sector is based on the fact that both alliances and innovation are very common. A database of biotechnology firms of the above clusters was created by matching ASEBIO's (Spanish Association of Biotechnology Companies) database and the information found on the websites of the cluster agencies.

Data were collected through a personal survey during 2012 and 2013. An interviewer in each cluster asked CEO or R&D managers (usually, in small biotech companies, it is the same person) to fulfil the questionnaire, as we consider they have the required knowledge of the alliances for innovation and their performance. The most common profile corresponded to male respondents (more than 2/3 of the sample), aged between 35 and 44 years old (more than 1/3), and with postgraduate studies (about 2/3). Most of them had an academic degree in Biology, Chemistry or Engineering (but there were also respondents with Biotechnology or Pharmacology degrees), and around half of the respondents had a PhD in Biology, Chemistry, Medicine or Biotechnology.

Out of the 101 companies that answered the questionnaire, and after removing those cases with missing data, 91 valid responses were obtained, resulting in a response rate of almost 32% (91/285). However, given that our unit of analysis is the alliance portfolio, at least two alliances are required, and so five cases with just one alliance were removed. Therefore, the data analysis finally included 86

cases. Similar or even lower sample sizes have been reported in other innovation studies (Ettlie and Rosenthal, 2011; Kock et al., 2011; Carmona-Lavado et al., 2013; Hsiao et al., 2017).

Table 2 shows the characteristics of the companies included in the sample. These had an average of 69 permanent employees and an average age of 9.45 years. Therefore, most of them were small and young firms, as is often the case with the biotechnology industry. The companies in the sample operate in one or more fields within the biotech activity; among them, the most frequent was (human and animal) health, followed at a distance by agri-food. Andalusia and Catalonia were the regions providing the greatest number of firms to the sample. Lastly, the companies had an average of 13 alliances (with a standard deviation of 20), ranging between 2 and 150. The most common partners were universities, research institutes and centres, which are present in almost all the alliances, and as expected in a science-based and knowledge intensive industry, such a biotechnology. Customers/clients are also a common partner for more than half of the firms.

### Measures

Measures have been selected for this research after a wide literature review on innovation and alliances, and the questionnaire has been pretested with a small sample of companies in order to ensure that questions were well understood by managers and relevant to the biotechnology industry.

**Alliance management capabilities.** The two dimensions of alliance management capabilities involved in this study were measured with the alliance management capability scale developed by Schilke and Goerzen (2010), including R&D and innovation alliances.<sup>1</sup> The response scale was a seven-point Likert scale ranging from “totally disagree” (1) to “totally agree” (7).

**Alliance portfolio coordination** The four items for this dimension of alliance management capability were: APC1: We ensure an appropriate coordination among the activities of our different R&D and innovation alliances, APC2: We determine areas of synergy in our R&D and innovation



**Table 2.** Sample of companies.

	Number of companies	Proportion
<i>Number of permanent employees</i>		
Until 9	42	48.8%
10–49	34	39.5%
50–249	6	7.0%
250 or more	4	4.7%
<i>Firm age (years)</i>		
Until 5	27	31.4%
6–10	37	43.0%
11–20	17	19.8%
More than 20	5	5.8%
<i>Fields of biotech activity<sup>a</sup></i>		
Industrial/environmental	21	24.4%
Agri-food	31	36.0%
(Human and animal) health	63	73.3%
Bioinformatics	10	11.6%
Services and others	30	34.9%
<i>Location of the biotechnology cluster</i>		
Andalusia	32	37.2%
The Basque Country	24	12.8%
Catalonia	10	27.9%
Madrid Community	9	10.5%
Valencian Community	11	11.6%
<i>Types of partners in the alliance portfolio<sup>b</sup></i>		
Universities, research institutes and centres	82	95.3%
Customers/clients	50	58.1%
Providers	35	40.7%
Competitors	19	22.1%
Others	36	41.9%

<sup>a</sup>Firms can have more than one field of biotech activity.

<sup>b</sup>Alliances can be composed from 1 to 5 types of partners.

alliance portfolio, APC3: We ensure that interdependencies between our R&D and innovation alliances are identified, APC4: We determine if there are overlaps between our different R&D and innovation alliances.

**Interorganizational learning in alliances.** This dimension of alliance management capability also has four items: ILA1: We have the capability to learn from our R&D and innovation alliance partners. ILA2: We have the managerial competence to absorb new knowledge from our R&D and innovation alliance partners. ILA3: We have adequate routines to analyze the information obtained from our R&D and innovation alliance partners. ILA4: We can successfully integrate our existing knowledge with new information acquired from our R&D and innovation alliance partners.

#### Characteristics of alliances

Two types of diversity of partners are analyzed, which are measured through objective indicators.

**Partner diversity.** It was measured with an index calculated as the number of different types of partners using several categories: (1) Universities, Research Institutes and Centres, (2) Customers/clients, (3) Providers, (4) Competitors, and (5) Others. Each type of partner is coded as a binary variable: 1 when the partner is in the alliance portfolio and 0 when it is not. The index ranges from 0 (any type of partner) to 5 (all the five types of partners). A similar methodology (addition of the types of partners) have been used for measuring *breath* in the context of open innovation research (Laursen and Salter, 2006; Gimenez-Fernandez and Sandulli, 2017).

**Geographic diversity.** It was measured as one minus the ratio between the number of alliances with organizations that belong to the same regional cluster and the total number of alliances of the firm. Organizations outside a regional cluster can be in Spain or wherever in a foreign country.

**Alliance portfolio performance.** R&D and innovation alliance portfolio performance in the last five years was measured by adapting Thorgren et al.'s (2009) five-item scale, and in line also with Wincent et al. (2010). Managers assessed the results obtained by the firm from its portfolio of R&D and innovation alliances with the following five items: APP1: Competitive position was improved; APP2: Costs were reduced; APP3: Existing products or services were improved; APP4: New products were developed; and APP5: R&D effectiveness was improved. The response scale was a seven-point Likert scale ranging from “totally disagree” (1) to “totally agree” (7).

#### Control variables

**Firm size.** It was measured by the natural logarithmic transformation of the number of permanent employees as reported by firm's respondents (Cheng and Huizingh, 2014). **Age.** Following Sørensen and Stuart (2000), we also controlled for firm age (2013 – company foundation date).

**Number of firm alliances.** Since higher partner and geographic diversity can entail a greater amount of alliances, we need to control for the number of firm alliances. Given the high dispersion in this variable, we used the natural logarithmic transformation of the number of firm alliances.

Considering that the selected measurement scales were based on an exhaustive review of the relevant literature concerning the constructs under study and the result of the pretest, we can confirm their content validity.

An exploratory factor analysis (EFA) was performed separately for each construct, using principal component analysis, and selecting factors with eigenvalues greater than one. All the items of each construct loaded in only one factor (unidimensionality). Another EFA was conducted with the items of three measurement scales (alliance portfolio performance, alliance portfolio coordination, and

**Table 3.** Exploratory factor analysis and Cronbach's alpha.

Items	Factor 1 Alliance portfolio performance	Factor 2 Interorganizational learning in alliances	Factor 3 Alliance portfolio coordination	Factor 4 Partner diversity	Factor 5 Geographic diversity
APP1	.809	.182	-.012	.081	.006
APP3	.868	.043	.105	.077	-.189
APP4	.789	.034	.179	-.051	.005
APP5	.836	.075	.101	.003	.031
APC2	.104	.161	.851	-.082	.191
APC3	.363	.317	.762	.039	.043
APC4	.014	.260	.804	.067	-.143
ILA1	.091	.805	.360	.043	-.005
ILA2	.078	.821	.224	.199	.068
ILA3	.060	.748	.155	-.110	.221
ILA4	.142	.829	.089	-.175	.059
PD	.073	-.050	.008	.973	.032
GD	-.101	.219	.048	.039	.941
Eigenvalues	4.524	2.438	1.238	1.055	.843
% of variation	34.800	18.750	9.522	8.114	6.484
% of cumulative variance	34.800	53.551	63.073	71.187	77.671
Cronbach's alpha	0.857	0.846	0.825	—	—

Note: Factor loadings above .7 are in *italics*.

interorganizational learning in alliances), extracting components with eigenvalues greater than one, and using a varimax rotation. The results showed a three-factor solution, but the item APC1 of alliance portfolio coordination had a high factorial loading in the component of interorganizational learning in alliances, and APP2 of alliance portfolio performance had a relatively low one, so both items were removed. After this refinement, in a new EFA including also the measures of partner and geographic diversity, five components were extracted, resulting in a five-factor solution, in which items measuring each construct had high loadings just in one factor, and low ones in the other factors (see Table 3). Thus, convergent and discriminant validity of the measures was verified.

Common method variance bias (Podsakoff and Organ, 1986) does not seem to be a problem in our study (the first factor accounted by less than 50% of the total variance), as can be seen in Table 3.

With regard to reliability, Cronbach's alpha exceeded the minimum value of 0.7 recommended by Nunnally and Bernstein (1994) for all the constructs with more than one item (see last row in Table 3). Therefore, these measures appear to be reliable and valid. Table 4 shows the mean, standard deviation and Pearson's correlations for the study variables.

## Results

The hypotheses were tested using hierarchical regression analyses, given that we have control variables and interaction terms, and also all the variables in the study were

standardized following Cohen et al. (2003). Four models were tested, in which the variance inflation factors (VIF) and the condition indexes (CI) did not indicate a multicollinearity problem: the highest VIF was 1.127, and the highest condition index was 3.205, as the former is recommended to be lower than 10 and the later lower than 30 (Hair et al., 1998; Gujarati, 2003).

Model 1 was a base model that only includes control variables: firm size, age and number of firm alliances (see Table 5). As can be observed, only the number of firm alliances affected alliance portfolio performance positively. When independent and moderating variables were introduced in model 2, alliance portfolio coordination had a positive and significant effect at 5% level on alliance portfolio performance (geographic diversity had a negative effect, but is statistically significant at 10% level). Model 2 made a significant contribution over and above model 1 (increase of explained variance of 12.4%). Therefore, H1 was supported, while H2 was rejected.

In model 3 we tested the moderating effect of partner diversity. All the two interaction effects were statistically significant, increasing explained variance 7.6%. To interpret these interactions, we plotted the effect of the two independent variables on alliance portfolio performance separately for values of partner diversity at the mean and one standard deviation above and below the mean, following Cohen et al. (2003).

The plot in Fig. 2 shows that the relationship between alliance portfolio coordination and alliance portfolio performance is positive when partner diversity is low. However, portfolio coordination has a slightly negative

**Table 4.** Descriptive statistics and correlations.<sup>a</sup>

Constructs	Mean	SD	1	2	3	4	5
1. Alliance portfolio coordination	5.535	1.115	1.000				
2. Interorganizational learning in alliances	5.862	0.840	0.518	1.000			
3. Partner diversity	2.580	0.988	0.024	-0.049	1.000		
4. Geographic diversity	0.508	0.300	0.119	0.301	0.021	1.000	
5. Alliance portfolio performance	5.914	0.981	0.320	0.223	0.093	-0.105	1.000

<sup>a</sup>Correlations equal or greater than .213 are significant at  $p < .05$ .

**Table 5.** Hierarchical regression on alliance portfolio performance.

	Model 1	Model 2	Model 3	Model 4
<i>Control variables</i>				
Firm size	-0.208 (0.165) <sup>a</sup>	-0.122 (0.161)	-0.064 (0.159)	-0.058 (0.152)
Age	0.055 (0.162)	0.030 (0.156)	-0.040 (0.155)	-0.005 (0.147)
Number of firm alliances	0.268* (0.109)	0.280* (0.118)	0.260* (0.114)	0.252* (0.111)
<i>Main effects</i>				
H1: Alliance portfolio coordination (APC)		0.243* (0.119)	0.261* (0.115)	0.238* (0.111)
H2: Interorganizational learning in alliances (ILA)		0.141 (0.125)	0.118 (0.121)	0.133 (0.120)
Partner diversity (PD)		-0.020 (0.113)	-0.045 (0.111)	-0.037 (0.107)
Geographic diversity (GD)		-0.209† (0.110)	-0.163 (0.108)	-0.211* (0.104)
<i>Interactions</i>				
H3a: APC × PD			-0.366** (0.135)	
H3b: ILA × PD			0.412* (0.168)	
H4a: APC × GD				0.349** (0.117)
H4b: ILA × GD				-0.294** (0.106)
Intercept	0.000 (0.000)	0.000 (0.000)	0.029 (0.097)	0.041 (0.098)
R <sup>2</sup>	0.084	0.208	0.284	0.318
Adjusted R <sup>2</sup>	0.051	0.137	0.199	0.237
F	2.509†	2.923**	3.343**	3.936***
Change in R <sup>2</sup>	0.084	0.124	0.076	0.110
F for the change in R <sup>2</sup>	2.509†	3.046*	4.020*	6.134**

<sup>a</sup>Standard errors in parentheses.

\* $p < .05$ .

\*\* $p < .01$ .

\*\*\* $p < .001$ .

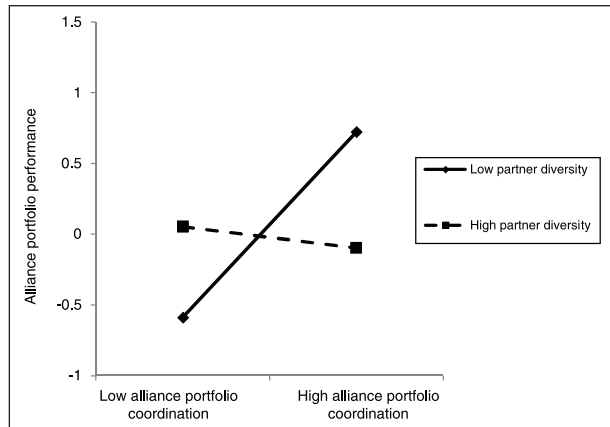
† $p < .10$ .

effect on alliance portfolio performance when partner diversity is high. Hence, H3a was rejected.

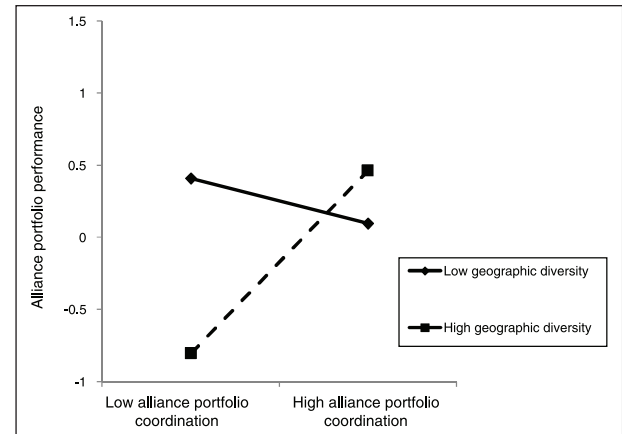
Fig. 3 shows that interorganizational learning in alliances has a positive effect on alliance portfolio performance when partner diversity is high, but it has a negative

effect when partner diversity is low. Thus, H3b was supported.

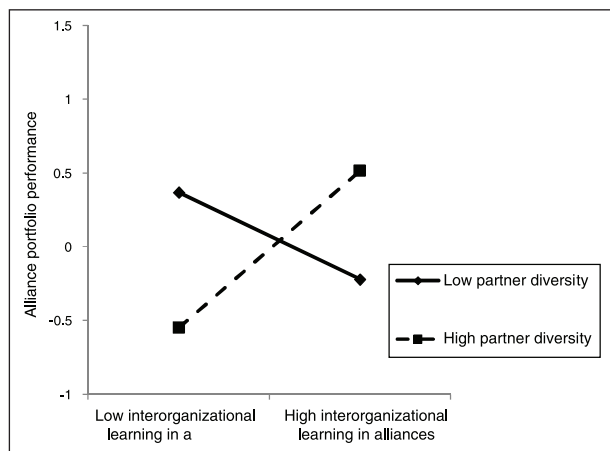
In model 4 we tested the moderating effect of geographic diversity (see Table 5). Both interaction effects were statistically significant, with an increase of 11% in



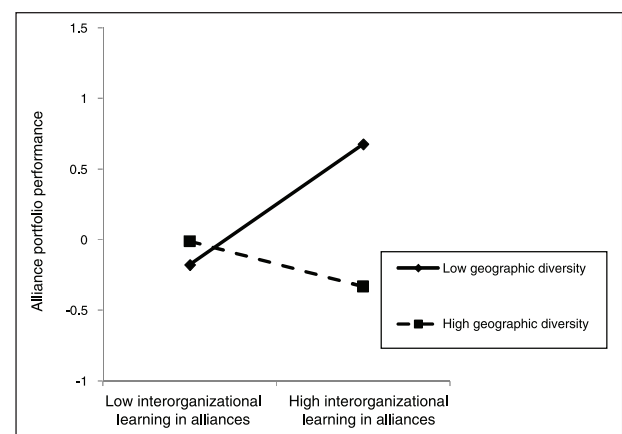
**Figure 2.** Interaction plot for the moderating effect of partner diversity on the relationship between alliance portfolio coordination and alliance portfolio performance.



**Figure 4.** Interaction plot for the moderating effect of geographic diversity on the relationship between alliance portfolio coordination and alliance portfolio performance.



**Figure 3.** Interaction plot for the moderating effect of partner diversity on the relationship between interorganizational learning in alliances and alliance portfolio performance.



**Figure 5.** Interaction plot for the moderating effect of the geographic diversity on the relationship between interorganizational learning in alliances and alliance portfolio performance.

the explained variance. As for partner diversity, to interpret the two inter-actions, we plotted, separately again, the effect of both alliance management capabilities on alliance portfolio performance for values of geographic diversity at the mean and one standard deviation above and below the mean.

In Fig. 4 it can be observed that the relationship between alliance portfolio coordination and alliance portfolio performance is positive when geographic diversity is high, but it is negative when geographic diversity is low. Besides, the alliance portfolio performance is similar in cases of both low and high alliance portfolio coordination and geographic diversity. Consequently, H4a was accepted.

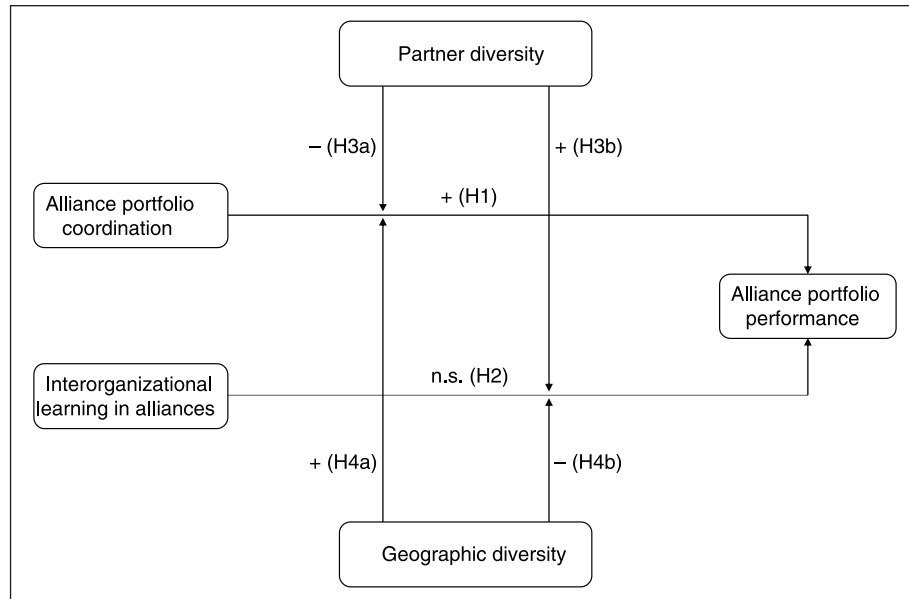
Lastly, Fig. 5 reveals that when geographic diversity is low, interorganizational learning in alliances has a positive effect on alliance portfolio performance. By contrast, it has a negative effect when geographic diversity is high. Thus, H4b was rejected.

Fig. 6 summarizes the empirical model (including the results of hypotheses testing).

## Discussion and conclusions

By adopting a contingency view, our research has examined, on the one hand, whether coordination and learning alliance management capabilities can improve the performance of alliances for innovation; on the other, the moderating role of two features of the alliance portfolio configuration (partner and geographic diversity).

Previous literature had already addressed the relevance of alliance management capabilities to achieve higher alliance performance (DeMan, 2005; Kale and Singh, 2007; Schreiner et al., 2009; Schilke and Goerzen, 2010; Paradkar et al., 2015; Sluys et al., 2011). However, most of the research in the field has overlooked the fact that the value of alliance management capabilities can vary across



**Figure 6.** Empirical model.

different contexts, that these contexts may represent different challenges and opportunities, and that, consequently, alliance capabilities that are very effective in one setting may be less successful in another (Wang and Rajagopalan, 2015). In fact, Schilke and Goerzen (2010) claim that potential moderators such as alliance portfolio characteristics should be considered when it comes to exploring alliance management capabilities. To the best of our knowledge, only Sarkar et al. (2009) have addressed the context-dependent nature of alliance management capabilities, and demonstrate that the value created by the said capabilities is contingent on both structure (alliance function) and strategy (diversity of the portfolio).

Our findings provide mixed support for our predictions. Alliance coordination capabilities have a positive effect on the performance of the alliances (Hypothesis 1), as suggested in studies that aim to explain the success of alliances (Wuyts et al., 2004; Goerzen and Beamish, 2005; Jiang et al., 2010). In this sense, through coordination routines, a focal firm can adapt and recombine knowledge from a number of external sources, create greater value for the portfolio, and have a number of advantages over firms without such coordination capabilities (Parise and Casher, 2003; Dyer and Hatch, 2006). Our findings also indicate that this relationship is contingent on both partner and geographic diversity in the way described below.

On the one hand, and contrary to our predictions, alliance coordination capabilities have a slightly negative effect on performance when partner diversity is high (Hypothesis 3a). This finding counters our assumption that a context of complex interdependencies among diverse partners, where knowledge and activities from different specialized organizations have to be integrated, is what

makes coordination capabilities really valuable, with an impact on alliance portfolio performance. Although this result would require further research to better understand how coordination capabilities create value, a plausible explanation is the one provided by Sarkar et al. (2009). They state that “the benefits of coordination will depend on the degree of diversity of partners or alliances within the portfolio” (p. 590), which represents one of our core assumptions.

Nevertheless, notions from an absorptive capacity framework tip the balance towards a following reasoning that contradict our hypothesis: when the portfolio includes very diverse partners or alliances with widely different competences and resource bases, lack of knowledge overlap may diffuse the possibility of synergy, and may reduce the impact of coordination capabilities on performance. Therefore, from this perspective, homogeneous rather than diverse portfolios are what make coordination capabilities create value.

On the other hand, and as we predicted, we find that alliance coordination capabilities have a positive effect on performance when geographic diversity is high (Hypothesis 4a). It seems that when partners are geographically distant (and, as a consequence, active informal interactions are infrequent), investment and practices to improve communication and coordination are expected to help partners better understand each other’s culture and management systems (Heiman and Nickerson, 2004). This will facilitate knowledge transfer. Thus, in the case of distant partners, coordination capabilities are crucial in that they contribute to enhancing the performance of the alliance. We also argued that when partners are closely located (low geographic diversity), their interactions could be easily



**Table 6.** Conditions for a positive effect of alliance management capabilities on performance.

Alliance management capabilities	Partner diversity	Geographic diversity
Alliance portfolio coordination	Low partner diversity (H3a rejected)	High geographical partner diversity (H4a supported)
Interorganizational learning in alliances	High partner diversity (H3b supported)	Low geographical partner diversity (H4b rejected)

managed without significant formal coordination efforts. Indeed, selecting geographically close partners has the advantage of facilitating control (Martínez-Noya and Narula, 2018). In this context, the contribution of alliance coordination capabilities to the alliance performance might be irrelevant. Our results go beyond this fact, and suggest that a context of low geographic diversity may even make alliance coordination capabilities have a negative effect on performance. Therefore, it seems that when partners are geographically close, formal procedures and explicit mechanisms designed for coordinating the interactions among them will be underused and ineffective. These routines may even result in rigidity in the partnership and, consequently, inhibit the performance of the alliance. Interestingly, the impact on alliance portfolio performance with high coordination and distant partners is almost equivalent to the performance achieved with low coordination and close partners.

Regarding interorganizational learning capabilities, our study did not reveal significant results with regard to its main effect on alliance portfolio performance (H2). This contradicts an assumption taken for granted in the literature of alliance management capabilities. One possible explanation is provided by Sluyts et al. (2011). Their study demonstrates that the different kinds of learning mechanisms involved in interorganizational learning capabilities are not equally beneficial for alliances outcome. Our measure of learning capabilities may be overlooking their internal heterogeneity as well as the different effects on performance of different learning mechanisms. A second explanation for this non-significant relationship between interorganizational learning capabilities and alliance performance points to its context-dependent nature, as it has been proposed in our hypotheses about the interaction effects. In this sense, our results suggest that the benefits of these capabilities are contingent on both partner and geographic diversity in two different ways.

On the one hand, and as expected, interorganizational learning capabilities have a positive effect on performance when partner diversity is high (Hypothesis 3b). This finding goes in line with Oerlemans et al. (2013), who state that those activities designed to enable, capture, share and leverage information and knowledge across multiple alliances are more valuable when partner diversity is high, because it is in this context that complementarities between internal and external knowledge bases can be fully exploited. Our research also indicates that when partner

diversity is low, the effect of interorganizational learning capabilities on alliance performance becomes negative. One possible interpretation is that interorganizational learning capabilities are valuable when applied to suitable partners, those that provide what the firm requires to accomplish the goals of the alliances. This is more likely when partners are heterogeneous (e.g. universities, research institutes, customers, providers, competitors, and so on). If what partners offer is not what the firm needs, because all of them have similar knowledge and resources that prove to be incomplete, the performance of the alliances will be poor. A second interpretation could be that in a context of partners with similar characteristics, the routines designed to analyze information, as well as to integrate and absorb knowledge from alliance partners (i.e. interorganizational learning capabilities), may be redundant and provoke some inefficiencies that reduce the performance of the alliances.

On the other hand, and contrary to our predictions, the effect of interorganizational learning capabilities on performance is negative when geographic diversity is high (Hypothesis 4b). In our theoretical discussion, we argued that alliances with distant partners contribute to avoiding excessive knowledge overlap and may widen the base of knowledge of the firm. This exposure to new knowledge was expected to enhance the value of interorganizational learning capabilities. As it is concluded by Dooley et al. (2016), when partners are geographically distant, managers should make a greater effort to develop learning capabilities. Nevertheless, it seems that the benefits of acquiring knowledge from distant partners may be hampered by the difficulties of geographic distance. Indeed, literature had already pointed out the advantages of proximity for learning (e.g. Bell and Zaheer, 2007). In this sense, the opportunities to communicate face to face, to build trust among collocated firms, and to promote labour mobility among close organizations, as well as the possibilities for sharing a common language, culture, norms and values, among others, seem to leverage the effectiveness of interorganizational learning more than when reaching new knowledge from distant partners. A summary of the main results is presented in Table 6.

Our study contributes to the alliance for innovation literature in two ways. First, we ascertain the impact of alliance management capabilities on alliance portfolio performance. Indeed, academics are increasingly attributing a large part of alliance success to the firm's ability to

manage them (Sluyts et al., 2011), and empirical studies testing this influence will contribute to this growing body of research. In fact, by providing evidence that learning capabilities do not directly affect alliance performance, we question taken for granted statements in the literature on interorganizational learning. Second, our research contributes to a better understanding of the context-dependent nature of alliance management capabilities and expands on existing theoretical grounds on the topic in the direction proposed by Schilke and Goerzen (2010) and Wang and Rajagopalan (2015). They support a contingent view in the research on alliance management capabilities, which has been scarcely examined to date. More recently, Kohtamäki et al. (2018) highlight the fact that relationships in alliances do vary in their exchange context (e.g. a context of partner or geographic diversity), which is relevant concerning how the alliance should be managed and how learning processes should be deployed. Consequently, they claim that more studies should address contextual variables that interplay with alliance capabilities, as well as test potential interactions among them. Our research, in line with those proposals, provides a fine-grained analysis of certain contexts that emphasize the role of interorganizational coordination and learning capabilities, and strengthen their impact on alliance performance. When a firm has to manage very diverse alliances, the role of their capabilities clearly depends on the type of diversity: while coordination capability seems to successfully manage geographic distance (geographic diversity), learning capability seems to better manage knowledge distance (partner diversity). We also provide evidence that the context dependent nature of alliance management capabilities may be more complex and intriguing than expected, and some of our findings may be fertile ground for future research (e.g., certain contexts of diversity even make alliance management capabilities harmful for the success of the alliance).

Relevant managerial implications can be derived from this study. Managers expect that alliances provide access to knowledge and resources that are necessary for innovation activities. This is especially true in knowledge intensive industries, as it is the case of biotech. The nature of biotech activities, as result of cross-industrial and cross-disciplinary scientific synergies, leads biotechnology companies to an extensive reliance on external collaborations. Consequently, biotech firms are engaging in an increasingly large number of alliances with different types of partners who provide access to diverse information, knowledge and capabilities. Nevertheless, the benefits of the alliances cannot be taken for granted. Without a full understanding of how the alliance portfolio must be managed, biotech firms could miss the rich opportunity that alliances potentially offer. Alliance management capabilities matter, and managers should invest in tools, routines and procedures that guarantee the effective coordination among partners, as well as the successful exploitation of learning opportunities. Although

sometimes coordination and learning from partners in the portfolio may occur spontaneously, alliance management capabilities should be purposefully developed by the firm. However, these capabilities are not likely to be equally effective across different scenarios. A certain degree of partner diversity or distance among partners can make coordination and learning capabilities ineffective and even harmful for the alliance portfolio performance. Thus, managers should carefully monitor the configuration of their alliance portfolio in order to make informed decisions regarding the deployment of coordination and learning routines. If the portfolio is composed of diverse partners (including suppliers, customers, competitors and research institutions), managers could make the most of this knowledge diversity by setting up learning routines and procedures that facilitate knowledge transfer and absorption, and lead to substantial improvement in alliance performance. A portfolio composed of similar partners does not require such learning effort, and managers should refrain from investing heavily in such mechanisms. Regarding geographic diversity, if the firm keeps alliances with distant partners, the effort should be directed towards coordination capabilities, which can really contribute to the improvement of their performance. As long as the portfolio is mainly composed of closely located partners, coordination may happen without the need of formal mechanisms and procedures, which in turn may even result in rigidities that harm the goals of the alliance. As such, firms with low levels of geographic diversity in their portfolio should constrain investment with regard to coordination routines.

We acknowledge the limitations of our research, which also provide opportunities for future research. First, our study only addresses two alliance management capabilities, so others, such as sensing and transformation (Schilke and Goerzen, 2010) should be considered in future research. Second, although we have theoretically discussed processes and activities related to coordination and learning capabilities, we do not provide evidence of the impact of specific routines on performance. Future research efforts should be made to shed light on the type of activities that are needed to improve the effectiveness of coordination and learning in the alliance relationships. Third, our operationalization of partner diversity overlooks features of the alliance portfolio that may influence the efficacy of coordination and learning capabilities to create value (e.g., the existence of competitors and tractor firms in the alliance portfolio, the role of specific partners or combinations of different types of partners). Some of these nuances could be incorporated in future analyses. Fourth, the sample size is small with firms located in just five clusters of only one country. Larger multi-country samples should be collected in order to confirm our findings. Finally, we focus on only one industry. Biotechnology is a science-based and knowledge-intensive industry where alliances are especially relevant, with a majority of

small young firms characterized by long times-to-market. Consequently, we recommend caution in generalizing our results to other contexts. Further research should replicate this study in industries with different knowledge intensity, firms' size, age or time-to-market.

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## Note

1. In the questionnaire, we use the expression "R&D and innovation alliances" in order to make clear for the respondents that this research encompasses innovation coming from not only the R&D activities but other innovation activities.

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