R&D MANAGEMENT

Dancing with wolves: how R&D human capital can benefit from coopetition

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This research examines the impact of coopetition (i.e., competitor alliances) on the development of internal R&D human capital. The study was conducted using survey data from 111 biotech firms in Spain and United States. Results show a mediation relationship: coopetition increases a firm's internal R&D human capital via its proactiveness to pursue R&D partnerships. To further examine the link between competitor alliances and R&D partnerships, we also investigate the role of two moderators, alliance satisfaction and alliance coordination. We argue that the two factors exert opposite moderation effects on the relationship between coopetition and proactiveness to pursue R&D partnerships. Results demonstrate that when a firm and its alliance partners are satisfied with each other, the effect of coopetition on proactiveness decreases, but the moderation effect of alliance coordination, though predicted to be in the opposite direction, is not significant.

1. Introduction

Firms in knowledge-intensive industries are increasingly motivated to establish alliances with different types of partners. Among the many types of alliances, R&D alliances are recognized as a key source of knowledge and competitive advantage that have long-term effects on firm performance (Belderbos et al., 2004; Filiou and Massini, 2018). Knowledge-intensive firms need to combine unique resources and capabilities speedily and efficiently, and thus, they search for external support to facilitate their innovation activities (Vlaisavljevic et al., 2016).

Human capital, defined as the set of knowledge, skills, and abilities of individuals in a given organization, is one of the primary resources for innovation (Subramaniam and Youndt, 2005), and it has been shown to determine many businesses' strategic direction, survival, and growth (Bosma et al., 2004). In turn, human capital can be significantly leveraged as a result of inter-organizational relationships, since they create opportunities to connect, and

recombine ideas, thoughts, and knowledge of individuals (Subramaniam and Youndt, 2005). In the area of Research and Development (R&D), the focus of this study, alliances, and external connections are key to facilitating a firm's internal learning behavior, and R&D outcomes (Zhang et al., 2010).

Alliances with competitors, labeled as 'coopetition' (Brandenburger and Nalebuff, 1996), are increasingly discussed as a strategy for innovation (Bouncken et al., 2018; Wang et al., 2019), since they provide opportunities for partners to use joint markets and share technological knowledge (Ritala and Hurmelinna-Laukkanen, 2009). Examples of R&D alliances in the global auto industry (Tata and VW), in high-tech elevators (Kone and Toshiba), in LCD panels (Sony and Samsung), among others, illustrate the importance and relevance of this type of cooperation (Ritala and Hurmelinna-Laukkanen, 2009). In addition to these examples of large companies, coopetition is highly important for small and medium firms in knowledge-intensive industries, as it helps to share R&D costs, build economies of scale, use synergistic effects by pooling resources, search for complementary resources and distribute risks, among other advantages (Gopalakrishnan et al., 2008; Gnyawali and Park, 2009; Bouncken and Kraus, 2013). Thus, although 'dancing with wolves' (collaborating with competitors) forces firms to take significant risks, such creative collaboration may also be a great opportunity for survival and success.

Prior research suggests that cooperation with competitors involves unique characteristics, absent in other types of alliances, which might produce different (either better or worse) results for the concerned parties (Ritala and Hurmelinna-Laukkanen, 2009). For instance, regarding innovation, Quintana-García and Benavides-Velasco (Quintana-García and Benavides-Velasco, 2004) suggest that coopetition facilitates the creation of more new products than collaboration with other types of partners does, while Nieto and Santamaría (2007) argue that cooperation with competitors was the least likely to produce highly novel innovations. With respect to economic performance, Belderbos et al. (2004) demonstrate that cooperation with competitors may improve productivity and sales, while Ritala et al. (2008) report a negative impact of coopetition on economic performance. As Pekovic et al. (2020) suggest, coopetition can be visualized as a 'double-edged sword' with both opportunities and drawbacks, which may be the origin for this lack of conclusive results. We propose a more precise approach to the phenomena, by considering specific industries, alternative benefits rather than innovation or economic performance, and contingency factors that could help to shed more light about how and under what circumstances coopetition can be beneficial.

First, while most research does not differentiate the benefits of coopetition in different industries, industry really matters (Gast et al., 2015). Knowledge-intensive industries, on which our research is focused (specifically on biotechnology), are the ones that may benefit most from coopetition, since rival firms in these industries have to cooperate on R&D activities to create new products and share risks (Ritala, 2012).

Second, coopetition studies have mainly focused on their impact on innovation performance (Nieto and Santamaría, 2007; Ritala, 2012; Bouncken and Kraus, 2013) and economic performance (Belderbos et al., 2004; Hallikas and Sissonen, 2008). Even if firms fail to reach those expected outcomes, other internal benefits may stem from coopetition. On the one hand, coopetition itself becomes a learning process through which employees acquire knowledge about how to generate value from cooperation with competitors, as well as the capability to identify potentially valuable partnering opportunities (this is what Schilke and Goerzen (2010) label as alliance proactiveness). On the other hand, employees involved in coopetition agreements will also be able to accumulate, use, and extend their knowledge to improve innovation outcomes (Bouncken and Kraus, 2013). As a result, human capital of the firm can be significantly strengthened (Wu and Sivalogathasan, 2013). Thus, our research addresses the impact of coopetition on human capital through the mediating role of alliance proactiveness.

Third, the success of coopetition has proved to be contingent on a number of contextual factors: equity investment, portfolio density, social structure (Asgari et al., 2018); dominant operational control (Arslan, 2018); knowledge sharing, technological uncertainty (Bouncken and Kraus, 2013); market uncertainty, network externalities, and competitive intensity (Ritala, 2012). Each of these studies focuses on a particular aspect in the context of coopetition and contributes to describe the scenario in which coopetition works. We further clarify the picture, by proposing other contextual variables that can make collaboration with competitors more effective: the degree of alliance satisfaction and the firm's ability to manage its alliances. Regarding alliance satisfaction, research has mainly focused on partnering experience (as repeated partnering), providing evidence of its moderating role on the relationship between firms allying and their performance (Rothaermel and Deeds, 2006). We provide a more fine-grained view of alliance satisfaction by assessing firm's satisfaction with alliance performance. Alliance management capabilities

has become a central topic in alliance research, given its influence on the ability of firms to create and capture value through alliances (Cabello-Medina et al., 2019). When partners are also competitors, coordination capabilities may be the key resource for managing the interplay and coping with the tension between cooperation and competition (Hoffmann et al., 2018).

Based on the above discussion, we propose two research questions: (1) does coopetition influence human capital in biotech firms through the mediating role of alliance proactiveness? and (2) are these relationships moderated by alliance satisfaction and alliance coordination? Our study adds to the theory of alliance management by further explaining how competitor alliances drive firm behavior in terms of further collaboration and the development of internal human capital. We provide empirical evidence that coopetition improves the human capital of the firm through the mediating role of alliance proactiveness and demonstrate the context-dependent nature of coopetition.

2. Theory and hypotheses development

Literature on coopetition and innovation is mainly built on arguments from transaction cost, game theory, and resource-based view (Quintana-García and Benavides-Velasco, 2004; Le Roy et al., 2018). Our research is mainly built around the resource-based view (RBV) as it underscores the opportunities of coopetition to access complementary assets that are difficult to acquire, and to obtain new knowledge, skills, and capabilities from the competitive partner. We are particularly interested in knowing how collaboration with competitors can contribute to the development of those difficult to acquire resources, particularly the knowledge, skills, and capabilities of the firm's individuals (human capital), which are one of the primary resources for innovation and competitive advantage.

A number of successful experiences of alliances between competitors (IBM and Apple, KONE and Toshiba, Sony and Samsung; and in the biotech area, Paradigm Genetics and Lion Bioscience AG, Lion Bioscience AG and Tripos, and Human Genome Project, one of the most prominent biotechnology research projects that involved multiple partners) reveal how coopetition has contributed to improve innovation and competitive advantage through the combination of resources, competencies, and knowledge (Bouncken et al., 2018). The literature on coopetition underscores that, given that most of the competitors face similar challenges, their resources (among others human capital) and capabilities may be relevant or applicable to each other and, thus, firms can reap significant advantages from collaboration with competitors (Gnyawali and Park, 2009; Van Den Broek et al., 2018).

We are interested in analyzing the internal benefits that may arise from coopetition. If coopetition facilitates the acquisition of new knowledge, then the human capital of a firm can be significantly improved. Even in case, that a particular alliance with a competitor is not as successful as expected, the individuals involved in the collaboration would not only have acquired new knowledge and skills from the partner, but they would have also created and accessed other capabilities based on intensive exploitation of existing ones (Quintana-García and Benavides-Velasco, 2004; Gnyawali and Park, 2011). This will increase their chances of transforming coopetitive strategies into win–win externalities by developing certain routines, practices and norms that are especially embedded in the coopetitive arrangements (Raza-Ullah, 2018). Pekovic et al. (2020) suggests that in addition to other explanatory variables like economic performance, a possible way to test this insight would be to introduce the proxies for experience and specific capabilities devoted to coopetition. Hence, firms could gain specific experience in managing coopetitive alliances and enrich their human capital; that will further enable them to protect their resources and gain more benefits from their partners.

Through our theoretical discussion below, we propose that the impact of coopetition on human capital will be mediated by alliance proactiveness, and will be moderated by alliance satisfaction and alliance coordination. Figure 1 displays our conceptual framework.

2.1. Coopetition, alliance proactiveness, and human capital

Competitor alliances motivate firms to assess their own strengths and weaknesses relative to their competitors (Levinthal and Myatt, 1994; Luo et al., 2007) and, therefore, firms are more likely to initiate actions in forming additional alliances ahead of their competition in the R&D area, which is key to innovation and new product development. There are three reasons why coopetition may increase a firm's proactiveness to form R&D alliances. First, on the one hand, a firm engaged in coopetition is more likely to understand market conditions, more likely to identify potential product and research opportunities that provide them with possibilities of entering into additional alliances

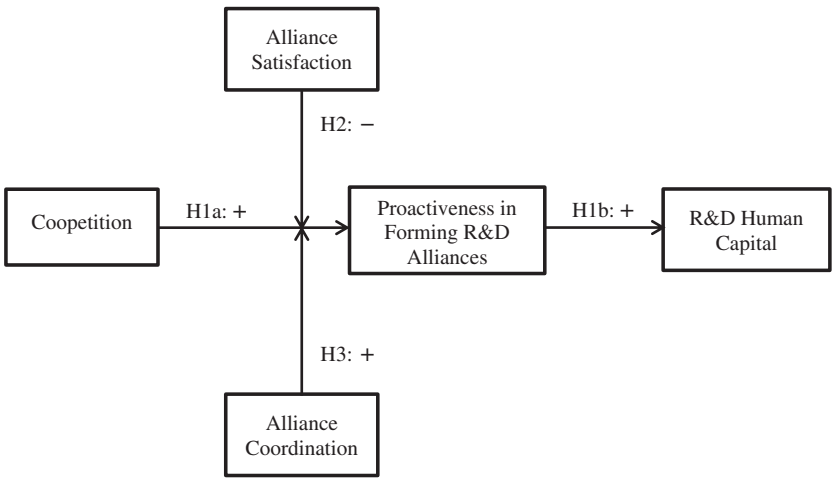

Figure 1. Conceptual model.

and enhancing their own R&D and innovation capabilities (Gnyawali and Park, 2009; Bouncken and Fredrich, 2016). On the other hand, a lack of proactiveness or spanning the organizational boundaries can hinder access to radically new ideas (Nagarajan and Mitchell, 1998; Rosenkopf and Nerkar, 2001). Second, prior alliances are often a proxy for alliance experience (Hoang and Rothaermel, 2005; Rothaermel and Deeds, 2006). Overall, alliance experience is also indicative of a strong position within the alliance network and it is a sign of credibility or positive reputation with other alliance partners (Gopalakrishnan et al., 2008). Even more, it is expected that coopetitive experience of firms improve their organizational routines (Gnyawali and Park, 2011), making them more amenable to readily identify alliance partners in the R&D arena and thus be more proactive in forming additional alliances. Finally, coopetition helps to build absorptive capacity within the firm because it enables them to better understand competitor action, recognize the value of new information, and assimilate it (Cohen and Levinthal, 1990; Ritala and Hurmelinna-Laukkanen, 2013). Firms with higher absorptive capacity, that stem from coopetition, are more aware of product and technology gaps and, therefore, are more proactive in forming R&D alliances (Bouncken and Fredrich, 2016).

We also propose that increased proactiveness in forming R&D alliances in turn enhances the internal human capital in the R&D area. This is supported by the knowledge-based view of the firm that focuses on the strategic significance of knowledge and emphasizes organizational learning as the basis for establishing human capital involvement in the structural and routine activities of the firm (Draulans et al., 2003; Bouncken and Kraus, 2013). There are again three reasons for this relationship. First, we assume that alliance-proactive firms in the end participate in more alliances, more projects, and engage in greater transfer of knowledge across projects, creating more new knowledge within the firm (Newell et al., 2006). Furthermore, individuals that tend to share knowledge (routines, assets, etc.) on a regular basis within alliances tend to expand their resource base (Bouncken and Kraus, 2013) and improve human capital within the firm. Second, forming new alliances enhances an organization's capital by facilitating and improving the effectiveness of knowledge used by its personnel (Bouncken and Fredrich, 2016). Organizational capital has also been found to enhance human capital development as firms learn to combine knowledge possessed by different members (Garud and Nayyar, 1994) and create a more integrated knowledge pool that is embedded in the organization's routines (Kogut and Zander, 1996). Finally, cumulative alliance learning indicates that proactive firms possess the alliance capability that leads to greater value creation from alliances and helps to develop the human capital in the R&D area (Kale et al., 2000; Rothaermel and Deeds, 2006; Schilke and Goerzen, 2010). For instance, proactiveness facilitates the development of knowledge associated with partner selection (Hitt et al., 2000).

To sum up, over time, the learning from competitive alliances cultivates the requisite knowledge base and the cognitive mechanisms, which help to identify relevant external knowledge, assimilate it, and store it within the firm. It has been argued that the lack of alliance proactiveness makes the firm more inward looking, and this can inhibit the exposure to new knowledge and in turn hinder

organizational change and the development of innovations (Nagarajan and Mitchell, 1998; Degener et al., 2018). External knowledge assimilation is therefore essential to the development of human capital, which improves the efficiency and facilitates innovation (Lerchenmueller and Nembhard, 2013). Based on these arguments we propose the following:

H1: The relationship between coopetition and internal R&D human capital is positively mediated by the proactiveness in forming R&D alliances.

H1a: *There is a positive relationship between the coopetition and the firm's proactiveness in forming R&D alliances.*

H1b: *There is a positive relationship between the proactiveness in forming R&D alliances and extent of internal R&D human capital.*

2.2. The role of alliance satisfaction and alliance coordination as moderators

As suggested in the previous literature (Ritala, 2012; Arslan, 2018; Asgari et al., 2018), we adopt a contingency perspective to examine how this mediated effect is moderated by two alliance factors, satisfaction and coordination. Alliance satisfaction is defined as partner firms being satisfied with the overall results of the alliances that they are engaged in (Krishnan et al., 2006). Das and Teng (2000) found that when alliance performance matches expectations, the partners become more satisfied and they are more likely to remain in the alliance. That is, positive experiences and satisfaction are predictors for alliance reformation (Draulans et al., 2003). For instance, Hakansson (1993) looked into the effect of prior contact between companies and found that satisfaction led companies to enter into alliances with partners that they had cooperated with previously. These results suggest that alliance satisfaction is positively related to repeated relationships because when the alliance is meeting the overall desired results firms are less likely to further engage in identifying and responding to new partnering opportunities. Moreover, when firms are satisfied with their current partners, they are lulled into a sense of competitive complacency and are less likely to want to form additional or new R&D alliances to hone their competitive skills (Zollo et al., 2002). Firms tend to maintain alliances with their prior partners as those alliances ease knowledge transfer (Zahra and George, 2002), facilitating smooth collaboration (Hoetker, 2005), and such alliances also allow for the development of trust (Li et al., 2008). Trustworthy partnerships reduce the transaction costs and uncertainties involved in information sharing and transfer (Dyer and Chu, 2003; McEvily et al., 2003; Beckman et al., 2004).

If the previous relationships were adequate, more relational capital is generated between partners and they will continue to collaborate for innovation (Li et al., 2008). Relational capital includes mutual trust, respect, and friendship (Kale et al., 2000), leading to satisfaction with the alliance. In sum, alliance satisfaction is indicative of higher relational capital where, the partners feel less threatened and consequently there is less interest in pursuing other new relationships (Kale et al., 2000). Therefore, it weakens the positive relationship between coopetition and the proactiveness to form new R&D alliances. This leads to the following hypothesis:

H2: *Alliance satisfaction negatively moderates the relationship between coopetition and proactiveness in forming R&D alliances.*

Alliance coordination is defined as the set of routines to coordinate activities and resources with the alliance partner (Schilke and Goerzen, 2010). Madhok and Tallman (1998) found that when firms effectively managed the alliance after formation, they coordinated tasks, shared relevant know-how and information, and resolved the conflicts that emerged. Coordination exists when partner activities and tasks in alliances are well understood, the job is synchronized between the partners, and there is great degree of interaction between the partners in most of the decisions (Gopalakrishnan et al., 2017).

We argue that alliance coordination works in the opposite direction to alliance satisfaction, and it is expected to strengthen the positive relationship between existing alliances with competitors and the pro-activeness to form other R&D alliances. Alliance coordination allows firms to assimilate acquired external knowledge and this in turn enhances the firm's alliance management capabilities and routines; and when coupled with the alliance experience, it makes a firm more amenable for identifying additional alliance opportunities (Draulans et al., 2003; Degener et al., 2018). Additionally, coopetition is regarded as the 'dancing with wolves' strategy and particular sets of routines and resources are needed to coordinate the dance. For instance, the case study on San Benedetto SpA (Bonel and Rocco, 2007) showed that coopetition can cause serious coordination and prioritizing problems, and that firms need to manage those coopetitive relationships carefully. When an alliance is managed, it is highly coordinated and that provides more time to identify other alliance

opportunities and new valuable partnerships. Hence, we suggest that in the presence of high alliance coordination firms will be more inclined to identify new opportunities and engage in new partnerships. As a result:

H3: *Alliance coordination positively moderates the relationship between coopetition and proactiveness in forming R&D alliances.*

3. Research method

3.1. Sampling procedures and sample characteristics

In this study we examined R&D alliances in biotechnology industries. Biotechnology is in its essence a result of cross-industrial and cross-disciplinary scientific synergies among a wide variety of actors. Principally relationships between these actors are based on the need to access unique resources, expert knowledge, and technology that is critical to the technological performance and industry's survival (Liebeskind et al., 1996). Zucker et al. (1998) showed that the growth and diffusion of human capital were the main determinants of the development of biotechnology industry and these were essential factors for the success of biotech firms. Biotechnology is a highly innovative sector. According to Nature Reviews Drug Discovery (2017), biotechnology R&D spending reached $ 45.7 billion in 2016 (Mullard, 2017). In the same year, R&D investment increased by 14% in the United States and 3% in Europe. The biotechnology sector also experienced some of the highest alliance frequencies (Rothaermel and Deeds, 2004). For example, RECAP, a consulting firm specialized in biotechnology, recorded over 24,000 alliances since 1973 (Schilling, 2009).

A survey technique was adopted in this study in two countries. In Spain, the questionnaire was completed during the interview with the CEO or person responsible for R&D, while in the United States (US) an online questionnaire was implemented. Spain has become a new hotspot for biotechnology in Europe – more than €400 M of venture capital was predicted to be available in 2017 to fund start-ups in the life sciences sector alone (Negroni, 2017). Genetic Engineering & Biotechnology News ranked Spain as one of the top five biopharmaceuticals country in Europe (Philippidis, 2017). The United States has long been the leader worldwide in biotechnology. For instance, its biopharmaceuticals market accounted for about one third of the global market (Select USA, 2017). We selected the New Jersey region for sampling. New Jersey is home to 13 of the world's 20 largest biopharma firms (BioNJ, 2018).

The survey was distributed to 285 Spanish firms located in five major biotechnology clusters: Andalusia, the Basque Country, Catalonia, Valencia, and Madrid. Ninety-three responses were returned, generating a response rate of 32.63%. In the United States, the survey was sent to member firms of BioNJ, an organization of networking biotechnology firms in the state of New Jersey. Among 115 firms that received this survey, 30 firms responded, resulting in a response rate of 26.09%. Among the 123 received responses, 12 cases were removed due to substantial missing data. The remaining 111 cases were used for data analysis, resulting in a usable rate of 90.24% based on returned responses and 27.75% based on the entire sampling frame. Figure 2 summarizes the phases of data collection and research design. No significant difference in focal variables in the conceptual model was found between the two countries, Spain and United States: *P*-value ranged between 0.36 and 0.65. Thus, we grouped them in our model testing. We also controlled for the country and did not find its significant effect on our results. Last, no difference was found in firm size ($P = 0.58$) and firm age ($P = 0.77$) between early and late respondents, suggesting that non-response bias was not a concern in this study. The distribution of firm characteristics is shown in Table 1. Participating firms' primary business fell into three categories: healthcare and pharmaceuticals (63.06%), industrial/environmental science (18.92%), and agriculture (18.02%).

3.2. Measures

Table 2 includes scale items, standardized factor loadings, Cronbach's Alpha (α), composite reliability (CR), and average variance extracted (AVE). Table 3 displays descriptive statistics, correlation matrix, and discriminant validity.

3.2.1. Focal variables

R&D human capital

Four scale items adapted from Subramaniam and Youndt's (2005) were used to measure R&D human capital. *Coopetition*. It was measured by the number of competitor alliances in which a given firm engaged in the previous 5 years at the time of data collection. *Proactiveness to form R&D alliances*. It was measured by a three-item measure adapted from Schilke and Goerzen (2010). *Alliance*

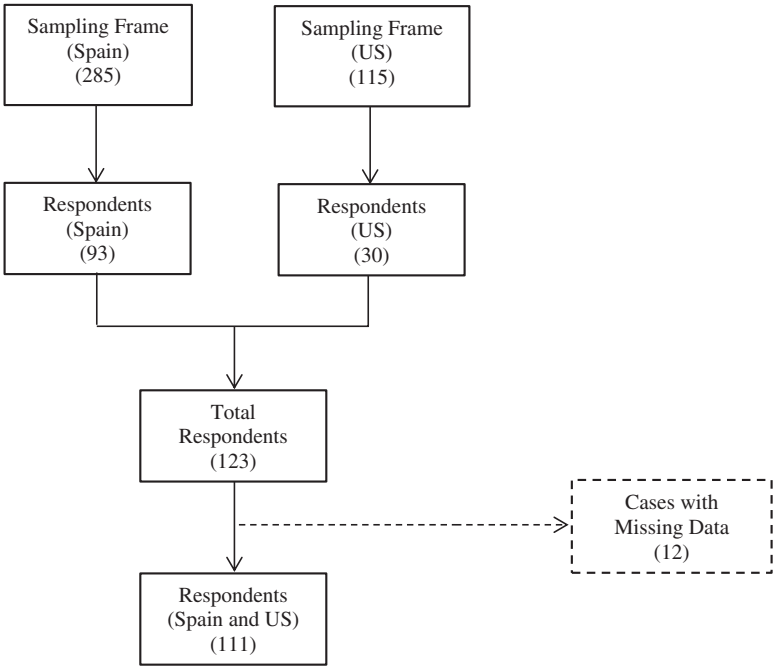

Figure 2. Research design. Solid line: used cases; dashed line: removed cases due to missing data.

Table 1. Firm characteristics

Firm size (number of employees)	
<5	33.33%
6–20	38.74%
21–50	10.81%
51–200	6.31%
Over 200	10.81%
Firm age (in years)	
<5	15.32%
5–10	43.24%
11–15	19.82%
16–20	8.11%
Over 20	13.51%

satisfaction. It was measured by four scale items adapted from Krishnan et al. (2006), examining how much alliance partners were satisfied with financial performance and overall alliance results. *Alliance coordination*. It was measured by a four-item measure adapted from Schilke and Goerzen (2010).

3.2.2. *Control variables*

Data in this survey were collected in two countries. Thus, we controlled for the country effect: 0 = Spain, 1 = United States. Second, we took into account each firm's innovation capabilities by controlling for *R&D intensity*, which was measured as the percentage of total revenues spent on internal R&D. At the firm level, we also controlled for firm size, which was measured as the number of employees. Both R&D Intensity and Firm size were log-transformed for normality. Also, it was possible that firms had other types of alliances. Thus, we controlled for the number of other types of alliances (customer, supplier, and university). In addition, when firms had multiple types of alliances, they may have paid (un) equal attention among them. As such, we controlled for alliance diversity and adopted Blau Index of Variability (Blau, 1977) to compute alliance diversity: $D = 1 - \sum p_i^2$, where D represents alliance diversity, p represents the proportion for each of the four alliance categories, and i represents the number of categories.

3.3. *Measurement model, convergent validity, and discriminant validity*

EQS was used for confirmatory factor analysis (CFA) of all multi-item constructs. The following fit indices show satisfactory model fit and unidimensionality: χ^2 = 188.02, d.f. = 84, $P < 0.01$; comparative fit index (CFI) = 0.91; incremental fit index (IFI) = 0.91; standardized root mean square residual (SRMR) = 0.07; and root mean square error of approximation (RMSEA) = 0.10. Additionally, Table 2 shows that all reliability indices (α and CR) exceeded 0.70, all standardized factor loadings exceeded 0.60, and all AVEs exceeded

Table 2. Measure, confirmatory factor analysis, and convergent validity

Construct	Scale item	SFL	α	CR	AVE
Coopetition	Number of competitor alliances				
Proactiveness (1 = Strongly disagree, 7 = Strongly agree)			0.820	0.823	0.608
	We strive to be ahead of our competitors by initiating R&D alliances.	0.719			
	Compared to our competitors we are more proactive and responsive in finding and pursuing partnerships for R&D and innovation.	0.830			
	We monitor our environment to identify opportunities for collaboration in R&D and innovation.	0.787			
R&D human capital (1 = Strongly disagree, 7 = Strongly agree)	People involved in R&D and innovation…		0.833	0.844	0.579
	Are considered the best in our sector.	0.642			
	Are creative and bright.	0.914			
	Are experts in their job functions.	0.687			
	Develop new ideas and knowledge.	0.772			
Alliance satisfaction (1 = Strongly disagree, 7 = Strongly agree)			0.914	0.922	0.750
	Our company is satisfied with the financial performance of alliances.	0.719			
	Our company is satisfied with the overall result of alliances.	0.837			
	Our partners seem satisfied with the financial performance of alliances.	0.957			
	Our partners seem satisfied with the overall result of alliances.	0.930			
Alliance coordination (1 = Strongly disagree, 7 = Strongly agree)					
	Our activities with partners in R&D alliances are well coordinated	0.852	0.892	0.898	0.688
	We ensure that our job is synchronized with that of our partners	0.907			
	There is great degree of interaction with our partners in most of the decisions.	0.757			
	We ensure that there is adequate coordination between the activities of different R&D alliances.	0.793			
Control variables					
Country	0 = Spain; 1 = United States				
R&D intensity	Average annual expenditure on internal R&D as a percentage of total income				
Firm size	Number of employees				
Other alliance types	University alliance; customer alliance; supplier alliance				
Alliance diversity	Computed based on variance of competitor alliance, university alliance, customer alliance, and supplier alliance				

SFL = Standardized Factor Loading, α = Cronbach's Alpha, CR = Composite Reliability, and AVE = Average Variance Extracted. All factor loadings are significant at the 0.05 level.

0.50. Moreover, as Table 3 shows, the square root of a given AVE exceeds correlation coefficients between the pair of corresponding constructs, indicating satisfactory discriminant validity.

3.4. Common method bias

First, Harman's single-factor method was used to examine all four multi-item constructs. The

Table 3. Descriptive statistics, correlations, and discriminant validity

	Mean	SD	1	2	3	4	5	6	7	8	9	10
1. Coopetition	0.405	0.957	n/a									
2. Proactiveness	5.149	1.205	0.181	(0.780)								
3. R&D human capital	5.929	0.756	0.024	0.278	(0.761)							
4. Alliance satisfaction	5.391	1.111	0.012	0.359	.252	(0.866)						
5. Alliance coordination	5.560	0.857	−0.022	0.450	0.353	0.479	(0.829)					
6. Country	0.162	0.370	0.044	0.030	−0.109	0.050	−0.065	n/a				
7. R&D intensity (log)	−0.924	0.992	0.009	−0.148	−0.112	0.014	0.004	0.080	n/a			
8. Firm size (log)	2.709	1.876	0.120	−0.020	−0.041	0.062	−0.197	0.318	−0.508	n/a		
9. Other alliances	1.865	0.814	0.293	0.114	−0.086	0.002	−0.014	−0.047	0.080	−0.107	n/a	
10. Alliance diversity	0.339	0.251	0.442	0.095	−0.106	0.000	−0.116	0.017	0.043	−0.036	0.848	n/a

Diagonal values in parentheses are values of square root of AVEs. Correlations whose absolute values greater than 0.19 were significant at 0.05. n/a = not applicable; SD = standard deviation.

single-factor model showed the following model fit: χ^2 = 654.98, d.f. = 89, P < 0.01; CFI = 0.48; IFI = 0.49; SRMR = 0.18; RMSEA = 0.24. Compared with the measurement model, the single-factor model had a significantly poorer fit ($\Delta\chi^2$ = 466.96, Δd.f. = 5, P < 0.01). Second, we employed exploratory factor analysis (EFA) including the four multi-item constructs. Four factors emerged with eigenvalue greater than 1: 6.08, 2.20, 1.73, and 1.45. They explained 76.34% of variance. The first factor accounted for 21.93% of variance, suggesting that there was not a dominant factor in the survey. In conclusion, common method bias was not a concern in this study.

4. Results

PROCESS analysis was adopted for hypotheses testing. Tables 4 and 5 display the results. The mediation effect in H1 was first tested. H1 proposed that proactiveness positively mediates the relationship between competitor alliance and R&D human capital. Table 4 shows that competitor alliance positively related to pro-activeness (b = 0.276, P < 0.05), and pro-activeness was positively related to R&D Human Capital (b = 0.170, P < 0.01). Thus, H1a and H1b are supported. Furthermore, the bootstrapping analysis shows that the indirect effect of competitor alliance on R&D human capital through pro-activeness was 0.047 and significant (95% confidence interval [CI] = 0.007, 0.129), confirming existence of the mediation effect in H1.

PROCESS analysis was also used to test the moderated mediation. Variables involved in interaction terms were mean-centered. H2 and H3 state that alliance satisfaction (negatively) and alliance coordination (positively) moderate the relationship between competitor alliance and pro-activeness. Table 5 shows that the interaction term of competitor alliance and alliance satisfaction was significant (b = −0.269, P < 0.05). Thus, H2 is supported. In addition, the interaction term of competitor alliance and alliance coordination was not significant (b = 0.045, P = 0.683). Therefore, H3 is not supported. Table 5 also presents that conditional indirect effect based on PROCESS analysis, where the two moderators were set one standard deviation above and below the mean. Last, we conducted simple slope analysis for H2, where alliance satisfaction was set at high and low levels with one standard deviation above and below the mean. Figure 3 shows the results. When alliance satisfaction was low, competitor alliance had a positive effect on proactiveness (b = 0.522, t = 2.951, P < 0.01), but this effect was not significant when alliance satisfaction was high (t = −0.076, P = 0.669).

Table 4. Results of mediation

	Model 1		Model 2	
	Proactiveness		R&D human capital	
Regression results				
Proactiveness			**H1b**	0.170**
Coopetition	**H1a**	0.276*		0.042
Country		0.395		–0.182
R&D intensity (log)		–0.334*		–0.071
Firm size (log)		–0.135†		–0.028
Other alliances		0.287		–0.024
Alliance diversity		–0.789		–0.395
R^2		0.095		0.116
Bootstrapping results				
Indirect effect (H1)				
		Indirect effect	**Boot SE**	**95% CI**
Coopetition → proactiveness → R&D human capital		0.047	0.029	[0.007, 0.129]
Mean difference in proactiveness (ANOVA and ANCOVA) (coopetition was recoded at two levels: 0 = no; 1 = yes)				
$M_{no\ coopetition} = 5.031$ $M_{coopetition} = 5.576$		$M_{difference} = 0.545$ ($P < 0.01$)		

All coefficients are unstandardized. SE = standard error; CI = confidence interval.
†$P < 0.10$, *$P < 0.05$, **$P < 0.01$ (two-tailed).

In addition, and as a robustness check, we have conducted additional tests to compare the difference between those firms who had allied with competitors and those who had not, on alliance proactiveness. Originally, coopetition was measured as a continuous variable, but for this purpose we recoded it to a dummy variable: 0 = without competitor alliance, 1 = with competitor alliance. Two tests were run, ANOVA and ANCOVA (with control variables). Table 4 shows that both resulted in significant effects ($P < 0.05$) of coopetition on alliance proactiveness. The mean difference between the two was 0.545, indicating that proactiveness for those who were engaged in coopetition was 0.545 greater, as compared with those who did not ally with competitors.

5. Discussion

This study examines the impact of coopetition on the development of internal R&D human capital through alliance proactiveness. Our results demonstrate the benefits of coopetition for improving the capabilities of individuals involved in innovation activities (R&D human capital), as coopetition provides them with valuable knowledge about how to generate value from cooperation. The results also show that this relationship is context-dependent: When the focal firm is highly satisfied with its partners, the chance of further pursuing additional R&D alliances diminishes.

Coopetition involves both opportunities and drawbacks for the concerned parties. While it is a relevant mechanism that firms can use to survive and become competitive, it also has inherent risks as indicated by Transaction Cost Theory. Thus, the benefits of coopetition for the concerned partner firms remain poorly understood. Little research has been done on how coopetition may help to foster human capital (Van Den Broek et al., 2018) and our findings mainly fill this gap. This study contributes to the literature on coopetition in three areas. First, the study provides insights about the effects of coopetition in the biotech industry, where rival firms tend to cooperate to conduct R&D. Second, it focuses on the less researched, intermediate benefits such as the forming of R&D alliances in the development of human capital, as compared to more common dependent variables such as innovative performance. Finally, we apply a contingency perspective, that researchers claim is key to the literature on coopetition (Ritala, 2012; Arslan, 2018; Asgari et al, 2018).

Based on the pillars mentioned, we demonstrated that competitor alliances play an important role in allowing a firm to form additional R&D alliances (H1a), which in turn plays a significant role

Table 5. Results of moderated mediation

		Model 3
		Proactiveness
Regression results		
Coopetition		0.223†
Alliance satisfaction		0.168
Alliance coordination		0.498**
Competitor alliance × alliance satisfaction	**H2**	−0.269*
Competitor alliance × alliance coordination	**H3**	0.045
Country		0.312
R&D intensity (log)		−0.266*
Firm size (log)		−0.060
Other alliances		0.199
Alliance diversity		−0.241
R^2		0.341
Bootstrapping results		
Conditional indirect effect		

Alliance satisfaction	**Alliance coordination**	**Effect**	**Boot SE**	**95% CI**
−1.111	−0.857	0.082	0.061	[−0.025, 0.218]
−1.111	0.000	0.089	0.064	[−0.003, 0.228]
−1.111	0.857	0.095	0.080	[0.014, 0.288]
0.000	−0.857	0.031	0.042	[−0.032, 0.144]
0.000	0.000	0.038	0.033	[−0.010, 0.109]
0.000	0.857	0.045	0.046	[0.004, 0.158]
1.111	−0.857	−0.020	0.058	[−0.154, 0.083]
1.111	0.000	−0.013	0.039	[−0.106, 0.048]
1.111	0.857	−0.006	0.037	[−0.104, 0.045]

All coefficients are unstandardized. SE = standard error; CI = confidence interval.
†$P < 0.10$,
*$P < 0.05$,
**$P < 0.01$ (two-tailed).

in developing the R&D human capital in the firm (H1b), a vital organizational resource in the dynamic biotechnology industry. Firms involved in alliances with competitors are likely keenly aware of what is occurring in the competitive marketplace and develop a strategy that focuses on investments in these areas (Bouncken and Kraus, 2013; Park et al., 2014). Through coopetition, these firms are able to evaluate their own strengths and weaknesses relative to their competitors (Levinthal and Myatt, 1994; Luo et al., 2007) and are more likely to be proactive in forming additional alliances. Our findings are in line with previous research (Gnyawali and Park, 2009; Van Den Broek et al., 2018) in that firms cooperate with competitors to fill resource gaps in the area of human resources. Even when alliances are not successful, firms are able to create additional capabilities based on the interaction with the competitors (Gnyawali and Park, 2011). R&D employees involved in those interactions will have opportunities to identify valuable knowledge, acquire it, and apply it to the innovation activities. This is an important finding because increased R&D human capital leads to increased innovation potential, which is a key requirement in highly competitive industries. Findings of this study clearly support the view that competitive alliances through R&D alliances serve to enhance the human resource potential allowing us to better understand how RBV works in the alliance context (Barney, 1991).

With respect to the contingency factors, we theorized that satisfaction with current alliances could negatively moderate the effect of coopetition on pursuing new R&D relationships (proactiveness) (H2), while alliance coordination capabilities would act in the opposite way (H3). Our results show that, indeed, the degree of satisfaction was, as expected, an important moderator. Specifically, low satisfaction seemed to exercise a stronger influence on the coopetition-proactiveness relationship when compared with high

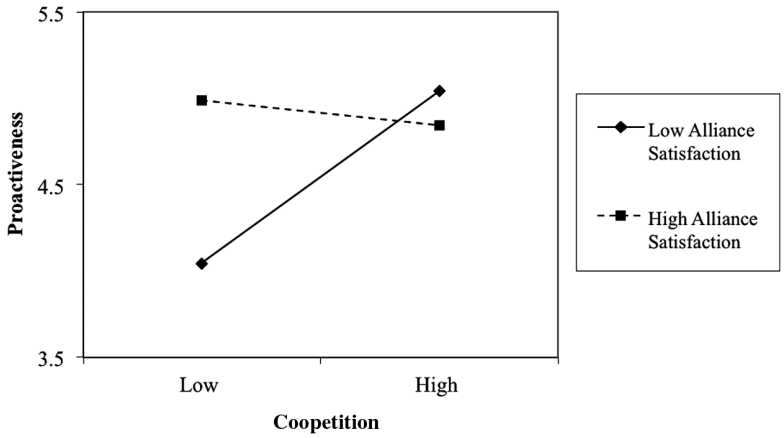

Figure 3. Moderation effect.

satisfaction. On the one hand, dissatisfaction with current alliances may force firms to more actively scan the environment to identify new opportunities to establish promising new alliances with more suitable partners. On the other hand, when current partnerships are evaluated positively, the firm is less likely to seek out additional partnerships. Nevertheless, this lack of motivation may not completely nullify the alliance proactiveness of the firm.

The moderating role of alliance coordination proved to be irrelevant (H3 was not supported). Theory provides arguments predicting that alliance coordination capabilities should increase the willingness to explore opportunities for engaging in new R&D alliances. It must be especially true for alliances with competitors, where serious coordination problems may arise, and where relationships need to be carefully managed. Nevertheless, we did not find a significant moderation effect of alliance coordination. We surmise that there may be two reasons for this finding. First, it may be that alliance coordination impacts the management of alliances rather than the initiation of R&D alliances as speculated in H3. In line with this, Degener et al. (2018) found that alliance portfolio coordination and proactive partner selection are substitute routines, that is alliance management capabilities influences biotech firms' R&D and innovation benefits. Second, it could be that the effect of alliance coordination may take longer to manifest itself in the context of firms as compared to alliance satisfaction.

6. Conclusion

Our study demonstrates the benefits of coopetition for enhancing R&D human capital, which is a strategic resource for companies in knowledge-intensive industries, as well as the relevance of other variables (proactiveness, as mediator, and satisfaction, as moderator) for making such benefits possible. Since an important outcome of alliances is knowledge acquisition and assimilation, it would seem reasonable that coopetition holds promise since it leads to higher levels of knowledge acquisition, increased levels of innovation, and enhanced financial returns (Hamel et al., 1989; Calabrese and Baum, 2000; Chen and Miller, 2015). Both competitor orientation and coopetition are key skills to learning the art of 'dancing with wolves' which in turn allows firms to develop their internal human capital. In designing public policy, governments should pay more attention and provide incentives to foster and develop networks involving competing companies because the success of coopetition may go beyond achievements related to economic and innovative performance. Our study suggests that companies that participate in these types of alliances enjoy other internal benefits.

Several managerial implications arise from our study that could also be relevant in the context of other technologies that share similarities with the biotechnology industry. First, our research suggests that firms can obtain benefits from cooperating with competitors in R&D activities. When evaluating the effectiveness of this type of cooperation, managers should pay attention not only to the innovation, financial, and market goals achieved through the alliance, but also to the improvement of internal capabilities of the firm. By interacting with competitors, employees will have the opportunity to share and acquire new knowledge to be applied to their innovation activities. Meanwhile, the firm will learn more about its weaknesses and strengths and be able to identify the right partners and establish alliances that are more likely to succeed.

Second, firms should be especially cautious about alliance satisfaction. While partners tend to seek satisfaction in an inter-organizational relationship, the

sense of satisfaction is likely to give firms a feeling of optimism about the current partnership thus, making them complacent about pursuing additional R&D alliances. Although satisfaction is a positive indicator of an existing partnership, we recommend that managers consider getting out of their comfort zone so as to continuously seek opportunities to strengthen their firms' R&D and innovation capabilities.

We recognize some limitations in this study, which may be explored in future research. This study examined several factors associated with engaging in competitor alliances and improving internal R&D human capital, in the biotech industry. Although we suspect that the results of this study are generalizable beyond this industry, further research is needed to further investigate this topic. First, it should be noted that this study only examined an internal outcome variable, R&D human capital. Looking at other internal outcome variables, such as R&D efficiency and effectiveness, would provide additional insights into the impact of coopetition. In addition, the data were only collected from two countries. While we did not find a significant difference between the two countries, future research could adopt data from other countries especially those with different types of national cultures. For instance, the difference between eastern and western cultures may demonstrate distinct outcomes. Finally, the data were collected cross-sectionally, therefore, we need to exhibit caution in attributing causality. A longitudinal study should be considered for future studies to provide an opportunity for each participant to be observed at multiple time points, thereby allowing trends in an outcome to be monitored over time.

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