LOOKING FOR SOURCES OF DISSIMILARITY: WHEN DOES COOPETITION LEAD TO INNOVATION RESULTS?

María Jesús Nieto
Luis Santamaría
Alicia Rodríguez

University Carlos III of Madrid (Spain)

Abstract

The paper examines collaboration with competitors –coopetition– to understand under what conditions this complex relationship contributes to innovation performance. We propose a joint analysis of two dimensions: (i) information similarity in the innovation process; and (ii) geographical location of the competitor –in the home-country or abroad. The study identifies four coopetition settings and analyzes the conditions that lead to innovation with different levels of novelty –new-to-the-market and new-to-the-firm. Using a broad sample covering 2004 to 2013, the findings indicate that coopetition with competitors located in the home-country only boosts innovation performance (both new-to-the-market and new-to-the-firm) in settings of low information similarity. In contrast, coopetition with competitors located abroad contributes positively to sales of new-to-the-market products (regardless of information setting), but only contributes to sales of new-to-the-firm products when high information similarity exists in the innovation process. These findings lead us to conclude that dissimilarity must be present in at least one of the dimensions –information similarity or geographical location– to achieve innovation results.

Keywords: Coopetition, competitor information sources, geographical location, competitive similarity, panel data, sales of innovative products.

INTRODUCTION

The phenomenon of coopetition, a strategy in which firms simultaneously cooperate and compete with each other, has grown in importance over recent years in both management research and business practice (Bengtsson and Kock, 2000, 2014; Gnyawali and Park, 2009, 2011, Gast et al., 2015; Hong and Snell, 2015). This increasingly common strategy can appear paradoxical as it brings partners some pain in the shape of competitive tensions to go along with the gains it provides (Gnyawali et al., 2016; Stadtler and Wassenhove, 2016). In some ways, then, coopetition locks firms together in a love-hate relationship: the love delivered by their shared objectives (Bengstsson and Kock, 2000) and the hate by their potential conflicts of interests (Gnyawali et al., 2016). Despite the difficulties, however, firms continue to engage in R&D partnerships with competitors. And numerous success stories (e.g., Apple and Canon with the 'LaserWriter'; IBM, Sony and Toshiba with a high-performance microprocessor; among several others) prove that this organizational strategy can be an effective way of creating value. It is, therefore, important to examine the conditions under which firms engaged in coopetition are able to achieve positive outcomes (Gnyawali and Park, 2011).

We focus our attention on some conditions that surround coopetition to better understand the outcomes of cooperating with competitors. One outcome that remains under-researched in the coopetition studies is innovation performance. Indeed, research into the complex relationship between coopetition and innovation is still in its infancy (Ritala, Kraus and Boucken, 2016). We address this relationship by analyzing under what conditions coopetition may help firms to innovate.

To unravel the complex nature of collaboration with competitors and its effect on innovation performance requires an approach that goes beyond the analysis of

coopetition as something homogeneous. It is important to remember that competition and cooperation face critical paradoxical organizational conditions (Gnyawali and Park, 2011; Bengtsson and Kock, 2014). Accordingly, we base our analysis of the impact of coopetition on innovation results on the idea that firms should avoid competitively similar partners, in terms of geographical coverage, technological expertise and strategic strength (Stadtler and Wassenhove, 2016). Thus, we see different degrees of competitive similarity between competitors as an explanatory factor in the coopetition-innovation relationship.

Specifically, we analyze two dimensions that have traditionally been included in innovation management research. First: information sources to innovate. This dimension has been used by scholars to analyze the influence of external knowledge sources on innovation performance (e.g., Monteiro et al., 2016; Mention, 2011). And second: the geographical location of the partner (in the home country or abroad). The geographical origin of the partner, and by extension the knowledge being tapped into, has been identified as a relevant factor for innovation outcomes (Phene et al., 2006). We jointly analyze these dimensions in this paper. In our examination of information sources, we introduce the concept of 'information similarity' to define the extent to which competitors' knowledge has been used in the innovation process by the focal firm. And in our examination of geographical location, we identify if the partner-competitor is located in the same country as the focal firm or abroad. These dimensions are combined via four coopetition settings with distinct levels of competitive similarity. This combination allows us to examine how these differences –in terms of information similarity and geographical location– affect the achievement of innovations with different levels of novelty: new-to-the-market or new-to- the-firm products. We identify different levels of novelty in innovation performance because each outcome is

characterized by its own R&D strategies (Leiponen and Helfat, 2011) and technological collaboration features (Tether, 2002). Different coopetition settings, then, are likely to have varying implications for these innovation outcomes.

The contribution of this study is threefold. First, the work contributes to technological collaboration literature; specifically, we add to the discussion of the potential effects of coopetition on innovation performance. Most previous research on technological collaboration with competitors finds that it has a negative effect on a variety of measures of innovation performance (Nieto and Santamaría, 2007; Un and Asakawa, 2015; Un and Rodríguez, 2017); some studies, however, do find a positive effect (Quintana-García and Benavides-Velasco, 2004) or no effect (Mention, 2011). These inconclusive results could be because the complexity of coopetition demands an analysis that is not limited to a single dimension (i.e., whether firms are coopeting or not), but requires an examination of the diverse contexts in which it takes place. In this paper we delve into the phenomenon by analyzing the abovementioned dimensions: (i) information similarity in the innovation process; and (ii) the geographical location of competitor.

Second, we contribute to the literature on international business and innovation management by analyzing the effect of external knowledge on innovation performance (Leiponen and Helfat, 2010, 2011), with particular attention paid to the geographical location of the knowledge source. Papers on geographical distance (Reuer and Lahiri, 2014) and the origin of partners (Phene, Fladmoe-Lindquist and Marsh, 2006) reveal the importance of an international knowledge source. We join this research stream by examining the geographical location of a highly specific type of external knowledge source: information from competitors.

Third, we contribute empirically by using a broad sample of firms from diverse sectors with a long time range (from 2004 to 2013). We feel that the inconclusive nature of previous work on coopetition and innovation performance may be due in part to the different contexts analyzed. Some of these studies examine coopetition in high-tech sectors (Quintana-García and Benavides-Velasco, 2004), while others look at service sectors (Mention, 2011). In this paper, we analyze coopetition in manufacturing and service sectors with varying degrees of technological intensity (high-tech; medium-tech; low-tech; KIBS; conventional services; and other activity sectors). The diverse and enriched nature of these contexts makes it possible for us to offer more comprehensive results.

THEORETICAL BACKGROUND AND HYPOTHESES

Disentangling coopetition: information similarity and geographical location

Building on the ideas of market commonality and resource similarity (Chen, 1996), we develop a theoretical framework by analyzing two dimensions: (i) information similarity in the innovation process; and (ii) geographical location of partners (in the home-country or abroad).

Various studies examine the influence of partner similarity on the fruitfulness of alliances (Darr and Kurtsberg, 2000; Luo and Deng, 2009). Although the results are not entirely clear, partner similarity is unquestionably identified as a key dimension for the analysis of the success of alliances. As Ritala and Hurmelinna (2013) show, partners must share a knowledge base to generate innovations. Indeed, collaboration without knowledge sharing is useless. And particularly in coopetition, a thorough understanding of each other's technologies and businesses (Dussauge et al., 2000; Lane and Lubatkin, 1998) may enable firms to find new ways of differentiating themselves from others. Partner similarity aids knowledge transfer as cooperation and coordination are easier

(Zander and Kogut, 1995; Darr and Kurtzberg, 2000). On the other hand, sharing analogous resources can make partners competitive against each other and reduce the likelihood of complementing each other's needs and the chance to acquire new skills and knowledge (Khanna et al., 1998; Das and Teng, 2000; Silverman and Baum, 2002; Bell et al., 2006). Additionally, an absence of heterogeneity may limit the development of more novel innovations (Crossan and Inkpen, 1995; McGrath, 2001).

In this paper, information similarity is defined as the extent to which competitors' information and knowledge are used in the innovation process by the focal firm. Briefly put, high information similarity is present in coopetition when firms use competitors as important information sources and manage knowledge and technological resources similar to their own. Conversely, low information similarity is present in coopetition when competitors play a more peripheral role as sources of information in the innovation process of the focal firm. In this setting, then, a lower degree of shared information and knowledge exists.

Nevertheless, the role of competitors' information and its interpretation in terms of resource similarity may be qualified by a second dimension. We expect the added dimension of geographical location of the competitor to contribute to our understanding of the conditions under which technological coopetition is valuable to innovate. Specifically, the inclusion of location enables us to identify if the competitor is based in the home country or abroad, thereby in some sense supplying a measure of the geographical similarity of coopetition. This is critical information when considering innovation because the capacity of the firm to learn and create knowledge is affected by country-level factors such as public policies on R&D investment and education, resource endowments, supply and demand conditions of the firm's products, and culture (Porter and Rivkin, 2012). Together with the idiosyncrasies of each national innovation

system, firms in individual countries also vary in their creative ability to search for novel ideas and combine them with new scientific knowledge to generate innovations (Shane, 1993; Amabile et al., 2005).

Apart from enriching firms with diverse knowledge, collaboration with a competitor located abroad can be useful to ease some of the problems that may result from coopetition; it will also, though, introduce difficulties that are inherent to international knowledge sharing. Coopetition with an international partner diminishes the problems of market commonality (Chen, 1996). In other words, alliances with international competitors lessen the risk of pursuing similar goals in the market and the consequent increase in the likelihood of value appropriation (Lavie, 2007). But partners in international coopetition relationships face the difficulties of sharing knowledge across borders, an important consideration when it comes to achieving innovation results.

This combination of information similarity with the competitor's geographical location enables us to identify four settings for coopetition (see figure 1): i) Domestic-Low Coopetition: when the firm collaborates with a competitor in the home-country with a low degree of information similarity; ii) International-Low Coopetition: when the firm collaborates with a competitor located abroad with a low degree of information similarity; iii) Domestic-High Coopetition: when the firm collaborates with a competitor located in the home country with a high degree of information similarity; iv) International-High Coopetition: when the firm collaborates with a competitor located abroad with a high degree of information similarity.

[Insert Figure 1 about here]

In this study, we analyze the effects of coopetition on innovation in three of the abovementioned settings. Specifically, we examine the contexts in which at least one type of dissimilarity exists, either in terms of information shared or the geographic

location of partners. Partners with high information similarity that are based in the home-country (i.e., domestic high coopetition) will have high competitive similarity. In this context, then, competitors are likely to find it extremely difficult to exchange valuable information to achieve new product innovations. Consequently, we do not present a hypothesis about the effects of domestic high coopetition, we include it instead as a control variable.

Domestic coopetition with low information similarity

Partners in collaborations with home-country competitors face a market commonality (Chen, 1996) that may lower the chances of success. In this setting contradictions such as the divergence of economic goals (Gnyawali et al., 2016) are more likely to occur. In a context of low information similarity, however, home-country partners can be useful for innovation in at least two ways.

First, dissimilarity can support the search for different solutions and help avoid the risk of falling into the trap of familiarity, thereby providing a basis for breakthrough innovations (Ahuja and Lambert, 2001). The simple fact that the information shared between partners is not redundant can boost the acquisition of competitive capacities; the diversity and novelty of information obtained from a non-redundant tie are predicted to be much greater than from a redundant tie (McEvily and Zaheer, 1999). This dissimilarity can contribute to the generation of more novel innovations. In addition, location in the home-country can also help assimilate and exploit new information. The assimilation of different knowledge poses difficulties that can be mitigated by the presence of a common national context (Phene et al., 2006). The underlying economic and institutional structure, as well as microeconomic linkages between firms in the same country, is important to generate innovative activity and knowledge spillovers (Glaeser et al., 1992; Feldman and Audretsch, 1999). These links promote the creation of

common institutional practices and reduce the impact of problems that arise from the use of dissimilar information sources and knowledge bases (Phene et al., 2006). Therefore, the underlying presence of shared national values can allow firms to utilize dissimilar knowledge from its own national context to disrupt the market via new products (i.e., not previously introduced by a competitor).

Second, partner-competitors located in the home-country may improve the capacity to generate incremental innovations, particularly new-to-the-firm innovations. Incremental innovations result largely from a firm's improved understanding of its existing product offerings and minor refinements and extensions to them (Henderson and Clark, 1990). These innovations require minimal changes in technology and present little deviation from the current product-market experience of the firm (Atuahene-Gima, 2005). This context requires some 'common knowledge' to facilitate communication and to allow mutual recognition of individual knowledge domains; a 'common knowledge' is fundamental for incremental innovation (Xu, 2015). Collaboration with a home-country competitor makes it possible to quickly acquire knowledge and apply it to the markets (Ritala and Hurmelinna-Laukkanen, 2013). Despite the dissimilarity of information between competitors, then, shared cultural and social values along with market knowledge of clients are decisive factors for the development of incremental improvements to existing products.

Therefore, collaboration with home-country competitors in contexts of low information similarity may affect the achievement of innovative products with different levels of novelty (new-to-the-market and new-to-the-firm). The following hypothesis captures this idea:

> *Hypothesis 1: In a setting of low information similarity, domestic coopetition is expected to have a positive effect on the likelihood of both new-to-the-market and new-to-the-firm innovations.*

International coopetition and information similarity

Countries possess distinct resource endowments because of the heterogeneous distribution of technological advantages and the localization of knowledge and its spatial concentration (Jaffe, Trajtenberg and Henderson, 1993). The result is a configuration of distinct national innovation systems, which leads firms to create knowledge with varied characteristics (Cantwell, 1989; Nelson, 1992; Patel and Pavitt, 1994). In addition, firms from different countries differ in their capacities to search for new ideas and incorporate them to generate innovations (Shane, 1993; Amabile et al., 2005).

Access to available knowledge and heterogeneous technologies in different national contexts increases the opportunities to discover novel combinations, perspectives and approaches (Phene et al., 2006). The location of partner-competitors in foreign countries enriches firms with diverse knowledge, which permits them to achieve more novel innovations. Apart from the value of heterogeneous knowledge in itself, collaboration with foreign partners may also benefit firms by limiting problems of market commonality (Chen, 1996). Specifically, coopetition of this kind may reduce the stresses that flow from the divergence of economic interests (Gnayawali et al., 2016). Moreover, collaboration with an international competitor opens the doors to numerous value-creating opportunities (Lavie, 2007).

The potential to create value by collaborating with a foreign competitor, however, is tempered by the degree of similarity (or dissimilarity) of the information shared between the partners to their innovation activities.

International coopetition with high information similarity

When firms collaborate with competitors located abroad, but the degree of information similarity is high, the source of heterogeneity for innovations is affected by country-

specific characteristics (i.e., national innovation systems). In this context, the geographical origin of the partner is the dimension that provides possibilities to obtain dissimilar knowledge.

As previously mentioned, country-level factors (Porter and Rivkin, 2012) affect the learning capacity of firms because the distribution of technological advantages and localization of knowledge is not uniform –each country possesses its own individual 'technological baggage' (Jaffe et al., 1993). These differences will result in distinct national innovation systems, which will in turn have an impact on each country's chances of generating innovations and influencing the capacity of firms to search for ideas and combine them with new knowledge to achieve innovations.

Thus, international link-ups provide access to heterogeneous knowledge and information inputs that are often valuable for innovation –in particular for breakthrough innovations. Phene et al. (2006) conclude that external and technologically proximate information delivers the greatest positive impact on the likelihood of achieving more novel innovations. Logically, the most proximate knowledge to the firm is that which resides in the industry and is in the hands of competitors. Coopetition with partners with high information similarity that are located abroad, then, is a good context for developing new-to-the-market innovations. This is the case because the partner's foreign location makes its knowledge heterogeneous and because its high level of similarity eases its transfer and the likelihood of innovation.

Firms involved in this type of coopetition strategy also increase their chances of generating new-to-the-firm innovations (i.e., more incremental). In a similar manner to what occurs with collaboration with home-country competitors, the existence of 'common knowledge' makes it easier to communicate and find improvements to existing products. Given that incremental innovations (i.e., new-to-the-firm) require

new solutions based on existing technologies (Xu et al., 2013), sharing information about the innovation process with partners may boost their generation.

These arguments lead us to expect that in contexts of high information similarity the international location of the partner will be sufficiently enriching to achieve new-to-the-market and new-to-the-firm innovations. Accordingly, we postulate the following hypothesis:

> *Hypothesis 2: In a setting of high information similarity, international coopetition is expected to have a positive effect on the likelihood of new-to-the-market and new-to-the-firm innovations.*

International coopetition with low information similarity

When firms collaborate with competitors located abroad and the degree of information similarity is low, greater distance exists between the partners in terms of both geographical coverage and information-based resources or technological expertise. This coopetition strategy offers more potential to avoid competitive similarity (Stadtler and Wassenhove, 2016) and redundancies (McEvily and Zaheer, 1999). In other words, coopetition of this kind presents greater dissimilarity, with the potential advantages of more novel and disruptive knowledge along with the disadvantages of managing greater heterogeneity (which usually complicates innovation processes). Such relationships can facilitate access to radically new information that is beyond a firm's own scope and that when combined with existing know-how can lead to more novel innovations (Sivadas and Dwyer, 2000). In principle, then, the wide differences in knowledge bases that exist in contexts of low information similarity with foreign-based competitors seem likely to stimulate innovations with a high degree of novelty (Phene et al., 2006).

In contrast, more incremental innovations (i.e., new-to-the-firm) need some level of 'common knowledge' to facilitate communication and allow mutual recognition of individual knowledge domains (Xu, 2015). As this situation is unlikely to occur in

contexts with low knowledge similarity and foreign-based competitors, this is not an optimal setting to achieve incremental innovations.

Collaboration with international competitors when the degree of information similarity is low, then, is only likely to be valuable for new-to-the-market innovations. We capture this idea in our third hypothesis:

> *Hypothesis 3: In a setting of low information similarity, international coopetition is expected to have a positive effect on the likelihood of new-to-the-market innovations.*

EMPIRICAL ANALYSIS

Sample

The data for analysis are drawn from the annual Spanish response to the Community Innovation Survey. Spain's National Statistics Institute, Science and Technology Foundation, and Foundation for Technical Innovation compile the data on a yearly basis to produce the Technological Innovation Panel (TIP). This panel has been used in previous academic articles (for recent prominent contributions using TIP data, see Cuervo-Cazurra, et al., 2017; Rodríguez and Nieto, 2016; Santamaría, Nieto and Miles; 2012). The TIP gives detailed information on a wide range of innovation activities and results. Specifically concerning our research question, the database provides details on the collaborating partner (including location: home-country or international), knowledge sources, and different innovation results.

In this research, we use an unbalanced panel with more than 10,000 firms from various manufacturing and service sectors for the period from 2004 to 2013. The unbalanced panel includes firms that may not be present in every year in the period or that may not have responded to some of the survey questions in one or more of the years. This causes the number of observations per time period to vary (i.e., the number of firms is not always the same).

Spain is an appropriate context for our analysis of innovation results because of its position –in terms of technological competences– in the middle of the UNCTAD Innovation Capability Index (UNCTAD, 2005). This in-between position can help generalize our results to a wide range of locations that are similar to Spain, to countries that are neither in the vanguard of technological development nor at the back of the pack (OECD, 2014). Therefore, given our empirical setting and sample, this paper should contribute to building a body of evidence on coopetition and innovation results that will be generalizable to different industries and national contexts. Additionally, the TIP database is based on the CIS questionnaire, with similar questions to the OECD's Oslo Manual that make it possible to compare findings across industries and countries (Monteiro, Mol and Birkinshaw, 2017). The make-up of our database, then, should allow future researchers to replicate our findings and further refine the study of coopetition and innovation (Gnyawali and Song, 2016).

Variables

Dependent Variable

We analyze innovation as an outcome, which is usually the key dependent variable in empirical studies of innovation (Crossan and Apaydin, 2010). To be exact, we examine the share of sales from new products (Grimpe and Kaiser, 2010; Laursen and Salter, 2006; Leiponen and Helfat, 2011), distinguishing whether these sales come from new-to-the-firm or new-to-the-market products (García and Calantone, 2002; de Jong and Vermeulen, 2006). These measures of innovation performance provide direct information on the success of commercializing product innovations. Sales are commonly assumed to be a good indicator of market acceptance of a new product (Atuahene-Gima and Li, 2004), an indicator seen as superior to other measures because it offers greater cross-industry validity (Wu, 2012) by including innovations that are not patented but are employed in

the production process (Liu and Buck, 2007). Specifically, we use two dependent variables: (i) *New-to-the-firm product innovation* –the share of sales from products substantially improved or entirely new to the firm but that may already exist in the market; and (ii) *New-to-the-market product innovation* –the share of sales from products that debut in the market and are therefore new not only to the firm but also to the market.

Independent Variables

We use three independent variables that are derived from the firms' responses on collaboration with competitors and the importance of these competitors as information sources for their innovation activities

Following previous studies (e.g., Nieto and Santamaría, 2007; Un and Rodríguez, 2017), we determine if the firm collaborates with competitors by seeing if it responds affirmatively to the question on collaborating on innovation activities and identifies competitors as partners. In line with other studies of collaboration with foreign partners (e.g., Rodríguez and Nieto, 2012), international collaborations are identified when the respondent indicates that its partner is located abroad.

To capture the level of information similarity in the competitor's innovation activities, we used the following question: 'How important to your enterprise's innovation activities were each of the following information sources?' Responses to this question have been used in notable papers by Cassiman and Veugelers (2002), Belderbos et al. (2004), Leiponen and Helfat (2010), Mention (2011) and Reichstein and Salter (2006), among many others, as well as in more recent work such as Monteiro et al. (2017). Our study specifically uses the responses linked to the importance of information for innovation from competitors/other enterprises in the sector. Respondents chose among four options: (i) Not used (coded 0); (ii) Low importance (coded 1); (iii) Medium importance (coded 2); and (iv) High importance (coded 3). The level of importance of

the competitor's information as a source for firm's innovation activities allows us to capture if we are in a setting of low information similarity (when the firm responds 'low' or 'medium importance') or in a setting of high information similarity (when the firm responds 'high importance').

With the responses to the questions described above, our three independent variables were operationalized in the following manner:

Domestic low coopetition is a dichotomous variable that takes value 1 when the firm collaborates with a competitor located in the home-country and reports that the competitor's information source has a low-medium degree of importance for its innovation activities; otherwise it takes value 0.

International high coopetition is a dichotomous variable that takes value 1 when the firm collaborates with a competitor located abroad and reports that the competitor's information source has a high degree of importance for its innovation activities; otherwise it takes value 0.

International low coopetition is a dichotomous variable that takes value 1when the firm collaborates with a competitor located abroad and reports that the competitor's information source has a low-medium degree of importance for its innovation activities; otherwise it takes value 0.

All the independent variables are included with a two-period lag, because R&D investments require some time to translate into innovative outputs (Belderbos et al., 2004; Calantone and Stanko, 2007; Santamaría, Nieto, and Barge, 2009), results which in turn need additional time before they bear fruit in the shape of marketable new products (Rodríguez and Nieto, 2016).

Control Variables

In this study we control for different innovation activities, specific characteristics of firms and factors that may be relevant to innovation performance (Belderbos et al., 2004; Grimpe and Kaiser, 2010; Laursen and Salter, 2006; Veugelers and Cassiman, 1999).

First, we control for collaboration with competitors in the home country in a setting of high information similarity by including *Domestic high coopetition.* This is a dichotomous variable that takes value 1 when the firm collaborates with a competitor located in the home country and reports that the competitor's information source has a high degree of importance for its innovation activities; otherwise it takes value 0. Second, we control for other innovation activities via the following variables: i) *Other collaborations* is a dichotomous variable that takes value 1 when the firm collaborates on innovation activities with other firms or organizations (e.g., suppliers, clients, institutions, or other non-competitors). It is important to know whether the firm collaborates technologically with other partners because these collaborations can play a significant role in innovation results (Nieto and Santamaría, 2007; Un, Cuervo-Cazurra and Asakawa, 2010; Un and Rodríguez, 2017); ii) *Offshoring R&D* is a dichotomous variable that indicates whether the firm acquires R&D services abroad; it takes value 1 when the firm obtains R&D services from an internationally located affiliate or captive center, or from foreign-based firms, public administrations, universities, or organizations (Nieto and Rodríguez, 2011). Previous studies show the importance of offshore R&D activities for sales from new products (Cuervo-Cazurra et al., 2017; Mihalache et al., 2012); iii) *Innovation effort* controls for the firm's innovation effort and is calculated by dividing the firm's total innovation expenses by its total sales (Nieto and Rodríguez, 2011; Santamaría et al., 2012). These variables are included in

the analyses with the same two-period lags as the independent variables; as stated above, this is due to the time required for innovative outputs (Belderbos et al., 2004) and subsequent sales (Rodríguez and Nieto, 2016) to be generated.

Third, we control for the firms' characteristics. Specifically, we control for *Size*, because it is important in determining the firm's innovative behavior (Becheikh, Landry, and Amara 2006; Link and Bozeman, 1991; Shefer and Frenkel, 2005); this variable is measured by the logarithm of the number of employees (Monteiro et al., 2017). And since younger firms may display different innovation behavior (García-Quevedo, Pellegrino, and Vivarelli, 2014), we include *Start-up*; this is a dichotomous variable that controls for age and takes value 1 when the firm has been set up in the previous two years (Laursen and Salter, 2006). In addition, as membership of a business group may affect innovation behavior by providing better access to resources (Galunic and Eisenhardt, 2001; Khanna and Yafeh, 2007), we include a dichotomous variable *Group* that takes value 1 when the firm belongs to such a business group (Nieto and Rodríguez, 2011).

Fourth, we control for other factors that may be relevant to innovation performance. *Geographic Market Scope* (Laursen and Salter, 2006) is included because greater market scope increases the possibility of commercializing the new product and augmenting sales (Patel, Fernhaber, McDougall-Covin, and van der Have, 2014). Moreover, participation in foreign markets allows firms to acquire knowledge (Zahra, Ireland, and Hitt, 2000) that helps them innovate (Frenz, Girardone, and Ietto-Gillies, 2005). This variable takes values from 1 to 4, with 1 corresponding to 'local' and 4 corresponding to 'international'. We also control for sectors in all the models to capture the different behavior and propensity to innovate across industries (Malerba, 2005). Since previous studies of coopetition reveal the importance of industrial context –

specifically high-tech industries– our study includes dummy variables that identify the firm's sector in terms of technological intensity. In accordance with the OECD classification, we group the different activities into six categories: high-tech; medium-tech; low-tech; KIBS; No-KIBS; and other activities. Traditional services (not knowledge intensive) are not included in the models as this is used as a baseline category; excluding one of the sectors in this way is necessary to avoid problems of perfect multicollinearity.

Lastly, since we use panel data with information for ten years, *Year* dummies are included to account for possible temporal effects.

Methodology

We use a Tobit analysis since the dependent variable is the percentage of innovative sales (with values from 0 to 100); this is heavily left-censored as many firms do not introduce new-to-the-market products and consequently have no innovative sales. Tobit models are appropriate to account for this specific feature of our data (Gujarati, 1995; Berchicci, 2013; Grimpe and Kaiser, 2010; Monteiro et al., 2017; Wu and Wu, 2014) because they treat firms without new products differently from those with such products (Grimpe and Kaiser, 2010; Laursen and Salter, 2006). Specifically, we use a random-effects panel Tobit model, which addresses concerns of unobserved heterogeneity.

Additionally (and in line with previous research), the dependent variable is used in its logarithmic[1] form as this reduces the problem of non-normality of the residuals (Berchicci, 2013; Greene, 2003; Laursen and Salter, 2006; Monteiro et al., 2017). The model specification adopted to analyze innovation performance is:

[1] The paper follows Laursen and Salter (2006) by applying the logarithmic transformation Innovation performance = ln (1 + percentage of innovative sales).

Sales from new products (New-to-the-market/ new-to-the-firm)$_{it}$ = α + β_1 (International high coopetition)$_{it-2}$ + β_2 (International low coopetition)$_{it-2}$ + β_3 (Domestic low coopetition)$_{it-2}$ + β_4 (Domestic high coopetition)$_{it-2}$ + β_5 (Other collaborations)$_{it-2}$ + β_6 (Offshoring R&D) $_{it-2}$ + β_7 (Innovation effort) $_{it-2}$ + β_8(Size)$_{it}$ + β_9 (Startup) $_{it}$ + β_{10} (Geographic Market Scope) $_{it}$ + β_{11} (High-tech) $_{it}$ + β_{12} (Medium-tech) $_{it}$ + β_{13} (Low-tech)$_{it}$ + β_{14}(Kibs) + β_{15}(Other activities) + β_{16}(Year$_t$)$_{it}$ + ε_i

where α is the constant intercept, β is the coefficient vector, and ε is the error term.

Descriptive statistics

Table 1 displays the descriptive statistics, correlations and collinearity diagnostics of the independent and control variables used in this study (with the exception of yearly dummies). Problems of multicollinearity do not exist among the variables included in the models as the variance inflation factor (VIF) values of the independent and control variables do not exceed 10.00 individually or 6.00 in the mean VIF (Neter, Wasserman and Kutner, 1989). The highest value is 2.44 in both models; with mean values of 1.47 and 1.40, which are below the threshold points.

[Insert table 1 about here]

Table 2 shows the distribution of the different types of coopetition analyzed in this study (*Domestic high coopetition; Domestic low coopetition; International high coopetition; International low coopetition*) by sectoral groups (high-tech; medium-tech; low-tech; KIBS; No-KIBS; and other activities).

[Insert table 2 about here]

This distribution shows that international coopetition represents 32 percent of the observations, compared to 68 percent for domestic coopetition. Similar percentages can be observed for the degree of relevance of the competitor's knowledge as a source for

innovation, with the lowest percentage corresponding to strong coopetition (31.8 percent) and the highest percentage corresponding to weak coopetition (68.2 percent). Analyzing the percentages of coopetition based on location –home country versus foreign country– and the relevance of competitor's knowledge source –high versus low-medium– reveals that *Domestic low coopetition* (47 percent) is the most frequent and *International high coopetition* (11 percent) is the least common. *International low coopetition* and *Domestic high coopetition* fall between these two (both with 21 percent).

EMPIRICAL RESULTS

Table 3 shows the Tobit regression analyses of sales of new-to-the-market and new-to-the-firm products. Columns 2 and 4 in the table contain the results of the analyses performed to test our hypotheses. First, we find support for hypothesis 1, as the coefficient for *Domestic low coopetition* is significant and positive for both innovation results –new-to-the-market and new-to-the-firm. This result indicates that in a setting of low information similarity, collaboration with home-country competitors has a significant and positive effect on the sales of new-to-the-market and new-to-the-firm products. Second, we find support for hypothesis 2, as the coefficient for *International high coopetition* is significant and positive for both innovation results. This finding shows that in a setting of high information similarity, collaboration with internationally-based competitors has a positive effect on the sales of new-to-the-market and new-to-the-firm products (with greater significance for new-to-the-market). Third, in the case of *International low coopetition*, the estimated coefficients vary depending on the innovation result, significant and positive for new-to-the-market, but not significant for new-to-the-firm. This finding supports hypothesis 3, as it indicates that international

coopetition has a positive effect on achieving sales from new-to-the-market innovations in a setting of low information similarity.

Concerning the control variables, the coefficients for *Domestic high coopetition* are not significant, while the coefficients for *Other collaborations, Offshoring R&D, Innovation effort, Size, Group, Geographic market scope* and the different sectoral categories are all significant and positive in explaining the percentage of sales of new-to-the-market and new-to-the-firm products. In contrast, the coefficient for *Startup* depends on the innovation result, not significant for new-to-the-market, but significant and positive for new-to-the-firm innovations. Therefore, collaboration with other types of partners, access to international R&D and the performance of other innovation efforts improve innovation performance. Moreover, these results are in accordance with previous research (e.g., Nieto and Santamaría, 2007; Un, Cuervo-Cazurra and Asakawa, 2010, in relation to other collaborations; Mihalache et al., 2012 and Nieto and Rodríguez , 2011, in relation to offshoring R&D and innovation effort).

As far as firm characteristics are concerned, larger size is positively related to obtaining a greater percentage of sales from innovative products. This finding squares with the idea that larger firms possess more resources to innovate and therefore will be in a better position to launch and market new products successfully (Leiponen and Helfat, 2010). Being a start-up, however, has a distinct impact on different innovation results. On the one hand, we find that it supplies no positive impact on new-to-the-market innovations (in line with Laursen and Salter (2006) and Monteiro et al. (2017)). And on the other, we find that it positively affects the likelihood of obtaining product innovations (in line with studies such as Cuervo-Cazurra et al. (2017)), as reflected in our study in relation to new-to-the-firm innovations. Conversely, membership of a group does contribute to innovation performance, which supports the idea that such

groups provide better access to resources (Galunic and Eisenhardt, 2001; Khanna and Yafeh, 2007) and in turn more innovation activity. Market scope also has an impact on the sales of innovative products (in accordance with previous work such as Laursen and Salter, 2006), with greater geographical scope corresponding to higher sales.

DISCUSSION

Growth in inter-firm coopetition over recent decades has turned it into a hot topic for management literature, one with important lessons to be learnt by practitioners. This relationship of simultaneous cooperation and competition is surrounded by paradoxical conditions and tensions that affect the performance of the alliance (Gnyawali et al., 2016). Despite the difficulties, however, firms continue to engage in technological partnerships with competitors and numerous success stories show that this can be a valuable innovation strategy. Improving our understanding of technological coopetition and extending previous research, though, requires us to disentangle aspects that until now have not been explored. This paper delves into the black box of coopetition to advance our knowledge about the conditions under which this strategy contributes to innovation performance.

We start from the premise that competitive similarity between partners is a key factor behind the success or failure of a coopetition relationship (Stadtler and Wassenhove, 2016). For this reason, in our work we identify four contexts of competitive similarity and analyze each of them for the different impacts they exert on innovation performance. The degree of competitive similarity is defined by two contextual dimensions: (i) information similarity (with partner-competitors) in the innovation process; and (ii) the geographical location of partner-competitors (i.e., home country versus abroad). Based on this, we postulate three hypotheses on settings in which

dissimilarity between partners exists (related to shared information or geographical location). The underlying idea is that some degree of dissimilarity between partners is required, as heterogeneous knowledge will increase the chances of discovering novel combinations, perspectives and approaches (Crossan and Inkpen, 1995; McGrath, 2001; Phene et al., 2006).

We then proceed to identify a couple of scenarios in which competitive similarity –in addition to dissimilarity– exists in one of the two dimensions: (i) geographical location (hypothesis 1); (ii) information similarity in the innovation process (hypothesis 2). In these two settings we postulate that coopetition will have a positive impact on innovation outputs with different levels of novelty (i.e., new-to-the-firm and new-to-the-market). In addition, in settings in which competitive dissimilarity is high (i.e., low information similarity between partners from different countries), we posit a positive relation between coopetition and more novel innovations (hypothesis 3). Lastly, we expect to find no relation between coopetition and innovation in contexts of high competitive similarity (i.e., high information similarity between partners from the same country). In summary, we postulate that the most productive contexts for coopetition will be those in which a certain balance exists between similarity and dissimilarity. More precisely, contexts with high dissimilarity are generally positive for innovation, but they are not appropriate for achieving incremental innovations. And in contexts with high competitive similarity between partners, coopetition is likely to find difficulties to exchange valuable information to achieve new product innovations.

Our results provide empirical support for our hypotheses and allow us to offer a finer-grained picture of this complex collaboration strategy between rivals. These findings can be interpreted in terms of value creation flowing from the information partners share in the coopetition relationship. Thus, the diverse and novel information supplied

by competitors contributes to innovation performance. Specifically, these innovations will be more novel when dissimilarity exists between partners. In the three settings with competitive dissimilarity, coopetition boosts new-to-the-market innovations. In contrast, incremental innovations (i.e., less novel) require a base of 'common knowledge' (Xu, 2015). This is why in contexts of high dissimilarity –in terms of information and geographical location– no relation exists between coopetition and new-to-the-firm products (i.e., incremental innovations).

Our study reveals that the geographical dimension plays a fundamental role in the coopetition relationship. The learning opportunities offered by an international partner – even in high information similarity settings– are greater due to the differences among national innovation systems and the heterogeneous knowledge that results from (among other factors) cultural differences. And when information similarity with the partner-competitor is low, coopetition provides valuable knowledge independently of geographical location. By adding this new information to the knowledge pool of the focal firm, it becomes possible to boost value creation and generate innovative products that differ markedly from those of the partner.

The study contributes to several streams in the research literature. With regard to the technological collaboration literature, our findings shed new light on the conditions under which coopetition leads to innovation results. Previous theoretical research had highlighted the key role of coopetition, but the empirical evidence analyzing the effects of collaboration with competitors on innovation results had been inconclusive. Some studies provide evidence of its positive effects (Quintana-García and Benavides-Velasco, 2004), while others find negative effects (Nieto and Santamaría, 2007; Un and Rodríguez, 2017). These inconclusive results may be partly due to the complex nature of coopetition strategies. Analyses that are limited to solely whether collaboration does

or does not take place with a competitor are insufficient to understand the benefits of coopetition for innovation. In this study, we advance our knowledge of the effects of technological coopetition on innovation via a joint analysis of two dimensions (i.e., information similarity and geographical location). This approach enables us to identify four coopetition settings with different degrees of competitive similarity and to reach conclusions on their contributions to innovations with different levels of novelty.

Our work also makes specific contributions to the intersection between international business and innovation management literatures (Phene et al., 2006; Reuer and Lahiri, 2014) by using the international location of the competitor in the collaboration to explain innovation performance. Our findings stress the importance of the international location to reduce some of the tensions present in coopetition and increase the chances of launching innovative products. The paper shows the importance of including multiple dimensions in research on international coopetition and innovation performance. The results reveal that international coopetition leads to innovative new-to-the-market products in both settings –low and high information similarity. But the results also indicate that settings of high information similarity are required to achieve less novel innovations. This study, then, enriches previous analyses of international collaboration and knowledge sources (particularly with competitors) and offers new insights for further research. Empirically our results go beyond the evidence provided by previous work on coopetition. The use of a wide and diverse database with firms from different sectors over a ten-year period enables us to reach robust conclusions that are highly generalizable to different contexts.

Managerial implications

From the point of view of practitioners, our paper contributes by helping managers understand the likely results of different technological coopetition settings. This

knowledge will allow them to match their innovation strategies with the most appropriate coopetition setting. Although rivalry between the parties is often seen as an obstacle to the performance of technological coopetition, our findings reveal that coopetition with both home-country and international competitors is an effective means of boosting sales of innovative products. Managers, though, should be aware of the relevance of coopetition context (i.e., home-country or international coopetition in settings of low or high information similarity) for the novelty of the product to be developed. In settings in which the importance of the competitor's information is low (i.e., low information similarity), coopetition with home-country and international partners delivers equal benefits in terms of new-to-the-market product innovations. But in contexts in which competitors are important knowledge sources for innovation (i.e., high information similarity), firms looking to augment sales of innovative products should opt for international coopetition. In these alliances the focal firm will learn more from the competitor and be less fearful of the danger of involuntary spillover or opportunistic behavior in its market. Conversely, collaborating with competitors in the home country in settings of high information similarity will provide little help in achieving innovative sales. This finding is logical as both the focal firm and the competitor possess similar knowledge, thus making it more difficult for the former to generate distinct innovations in that market.

Limitations and future research

This study has limitations that future research should address. Despite the progress made in advancing our knowledge of the relation between coopetition and innovation results, further work is required to deepen our understanding of this phenomenon. Future researchers should pay special attention to the risks inherent in coopetition, as this will make it possible to provide academics and –more importantly– managers with

a clearer picture. Indeed, including an analysis of risks (e.g., opportunism, self-interest, value appropriation, failure of innovation projects) will be critical to measure the capacity of coopetition for value creation and value appropriation. Likewise, the availability of more complete information on alliance partners would enrich the research. For example, information about the network dynamics (e.g., interactions, roles and positions), the importance of the focal firm for the competitor, or the characteristics of the process itself could be included to advance on the 'how' question in coopetition. Additionally, the existence of multi-market contacts should be looked for, as they can occur in these collaborations and may exert an effect –potentially a moderating one– on the relation between coopetition and the sales of new-to-the-market products.

CONCLUSION

In conclusion, the joint analysis of two dimensions –information similarity and geographical location of the competitor in the home-country or abroad– makes it possible to clarify the conditions under which technological coopetition boosts the innovation performance of firms in terms of sales of new-to-the-market and new-to-the-firm products. In this paper we analyze coopetition settings with different degrees of competitive similarity and find strong evidence that: (i) coopetition with international partners –in both low and high information similarity settings– benefits highly novel innovations; less novel innovations, however, require a setting with high information similarity; (ii) coopetition with home-country partners only benefits innovation performance when the importance of the competitor's knowledge source is low (i.e., low information similarity setting); in contrast, when home-country coopetition takes place in settings of high information similarity, the focal firm is unlikely to generate product innovations successfully. These findings lead us to conclude that dissimilarity is

needed in one of the dimensions –information or geographical location– to achieve innovation results. In brief, competitive similarity should be avoided in at least one of the dimensions.

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Figure 1. Coopetition settings depending of information similarity and geographical location

		Information similarity	
		Low	*High*
Geographical location	*Same country (home)*	Domestic low coopetition	Domestic high coopetition
	Other country (abroad)	International low coopetition	International high coopetition

Table 1. Descriptive statistics, correlations and collinearity diagnostics of the independent and control variables

	N	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	VIF[a]	VIF[b]
1.International high coopetition	104340	1.000																	-	1.16
2.International low coopetition	104340	0.123***	1.000																-	1.12
3.Domestic high coopetition	104340	0.360***	0.023***	1.000															-	1.16
4.Domestic low coopetition	104340	0.018***	0.282***	0.119***	1.000														-	1.13
5. Other collaborations	104340	0.114***	0.159***	0.143***	0.203***	1.000													1.11	1.17
6. Offshoring R&D	104340	0.061***	0.077***	0.038***	0.039***	0.163***	1.000												1.07	1.08
7. Innovation effort	104340	0.055***	0.069***	0.069***	0.093***	0.201***	0.081***	1.000											1.21	1.22
8. Size	104335	0.025***	0.049***	0.027***	0.032***	0.070***	0.105***	-0.232***	1.000										1.36	1.37
9. Startup	104337	-0.002	0.002	0.002	-0.001	0.007**	-0.004	0.044***	-0.062***	1.000									1.00	1.00
10. Group	104340	0.035***	0.039***	0.022***	0.020***	0.120***	0.128***	-0.099***	0.446***	-0.016***	1.000								1.30	1.30
11. Geographic market scope	104340	0.034***	0.056***	0.018***	0.028***	0.153***	0.138***	0.003	0.096***	-0.038***	0.138***	1.000							1.34	1.34
12.High tech	104340	0.044***	0.026***	0.032***	0.016***	0.060***	0.099***	0.083***	-0.019***	0.005*	0.029***	0.114***	1.000						1.32	1.32
13. Medium tech	104340	-0.004	-0.005	-0.016***	-0.026***	0.034***	0.071***	-0.081***	-0.055***	-0.021***	0.001	0.308***	-0.143***	1.000					2.44	2.44
14. Low tech	104340	-0.020***	-0.012***	-0.017***	-0.020***	-0.012***	-0.012***	-0.078***	-0.035***	-0.009***	-0.064***	0.153***	-0.093***	-0.294***	1.000				1.91	1.91
15. KIBS	104340	0.023***	0.022***	0.041***	0.058***	0.017***	-0.061***	0.224***	-0.005	0.043***	-0.012***	-0.286***	-0.128***	-0.406***	-0.264***	1.000			2.19	2.19
16. Services (No-kibs)	104340	-0.021***	-0.021***	-0.027***	-0.037***	-0.096***	-0.054***	-0.104***	0.101***	-0.015***	0.051***	-0.137***	-0.086***	-0.273***	-0.177***	-0.245***	1.000		-	-
17. Other activities	104340	-0.007**	-0.001	-0.005	0.012***	0.009***	-0.011***	-0.048***	0.035***	-0.006**	0.017***	-0180***	-0.061***	-0.192***	-0.125***	-0.172***	-0.116***	1.000	1.43	1.43
Mean		0.005	0.010	0.010	0.022	0.251	0.038	0.489	4.139	0.006	0.398	2.904	0.043	0.311	0.160	0.267	0.141	0.075		
S.D.		0.072	0.099	0.098	0.148	0.433	0.190	0.127	1.711	0.078	0.489	1.089	0.203	0.463	0.367	0.442	0.348	0.264		
Minimum		0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0		
Maximum		1	1	1	1	1	1	1	10.633	1	1	4	1	1	1	1	1	1		
																	Mean VIF		1.47	1.40

***p<0.01, **p<0.05,*p<0.10. [a]Models 1; [b]Model 2

Table 2. Distribution of coopetition types classified by sectors

	International high coopetition	International low coopetition	Domestic high coopetition	Domestic low coopetition
High tech	1.8	1.9	2.2	2.9
Medium tech	3.3	5.8	4.9	10.9
Low tech	0.7	2.4	2.0	5.2
KIBS	4.3	7.5	9.3	20.6
No-KIBS	0.5	1.4	0.9	2.7
Other activities	0.5	1.8	1.4	5.1
Distribution of coopetition types	11.1	20.8	20.7	47.4

Percentage of observations.

Table 3.- Different coopetition settings and sales from new products (new to the market and new to the firm)

	Sales of innovative product			
	New to the market		*New to the firm*	
	(1)	(2)	(3)	(4)
International high coopetition $_{t-2}$		0.602***		0.307*
		(3.42)		(1.84)
International low coopetition $_{t-2}$		0.264**		-0.0531
		(2.13)		(-0.45)
Domestic low coopetition$_{t-2}$		0.326***		0.248***
		(3.71)		(3.05)
Domestic high coopetition $_{t-2}$		-0.00187		0.187
		(-0.01)		(1.52)
Other collaboration $_{t-2}$	0.672***	0.644***	0.511***	0.493***
	(18.33)	(17.37)	(15.65)	(14.94)
Offshoring R&D $_{t-2}$	0.287***	0.276***	0.289***	0.285***
	(4.07)	(3.92)	(4.42)	(4.36)
Innovation effort $_{t-2}$	3.503***	3.484***	2.576***	2.560***
	(24.68)	(24.54)	(19.59)	(19.46)
Size	0.109***	0.107***	0.168***	0.167***
	(5.31)	(5.22)	(9.73)	(9.65)
Startup	0.310	0.332	1.937***	1.954***
	(0.61)	(0.65)	(4.48)	(4.52)
Group	0.162***	0.161***	0.134***	0.134***
	(2.92)	(2.91)	(2.80)	(2.81)
Geographic market scope	0.523***	0.522***	0.452***	0.452***
	(20.72)	(20.69)	(20.93)	(20.92)
High-tech	2.164***	2.159***	2.090***	2.086***
	(13.81)	(13.79)	(14.97)	(14.95)
Medium-tech	1.680***	1.678***	2.001***	2.000***
	(15.49)	(15.48)	(21.50)	(21.50)
Low-tech	1.104***	1.105***	1.596***	1.596***
	(9.00)	(9.02)	(15.30)	(15.31)
KIBS	1.225***	1.209***	1.151***	1.142***
	(10.97)	(10.84)	(12.11)	(12.01)
Other sectors	0.331**	0.328**	0.0180	0.0147
	(2.15)	(2.13)	(0.14)	(0.11)
Years	Included	Included	Included	Included
Intercept	-7.157***	-7.149***	-5.864***	-5.860***
	(-47.74)	(-47.72)	(-46.67)	(-46.65)
N	78662	78662	78662	78662
chi2	3306.2***	3341.2***	3702.4***	3720.2***
df_m	19	23	19	23
Ll	-68371.0	-68353.0	-86425.4	-86416.5

t statistics in parentheses. * $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$