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Cooperation with competitors and product innovation: Moderating effects of technological capability and alliances with universities

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ABSTRACT

The relationship between cooperation with competitors and product innovation performance was investigated along with the moderating effect of the innovating firm's technological capability and its alliances with universities. The hypothesis that cooperation with competitors has an inverted U-shaped relationship with product innovation performance was tested using data on new product introductions from 1499 Chinese firms. The results support the existence of a bell-shaped relationship between co-opetition and product innovation performance. Technological capability and alliances with universities were shown to weaken the relationship. The findings add significantly to the emerging literature on dynamic co-opetition.

1. Introduction

To survive and prosper in today's highly competitive environment, firms are increasingly engaged in cooperative alliances with various partners ranging from universities (e.g., George, Zahra, & Wood, 2002; Wu, 2011), suppliers (e.g., Nieto & Santamaría, 2007; Tether, 2002), customers (e.g., Belderbos, Carree, & Lokshin, 2004; Wind & Mahajan, 1997), service intermediaries (e.g., Pangarkar & Wu, 2012; Zhang & Li, 2010) and government officials (e.g., Chen & Wu, 2011; Wu & Chen, 2012) to competitors (e.g., Ingram & Roberts, 2000; Luo, Rindfleisch, & Tse, 2007). Among these various cooperative alliances, cooperation with rivals (so called "co-opetition") has attracted increasing research interest over the past decade (Bengtsson, Eriksson, & Wincent, 2010; Bengtsson & Kock, 2000; Gnyawali & Park, 2009, 2011; Ritala, 2012; Ritala & Hurmelinna-Laukkanen, 2009).

While the impacts of co-opetition on innovation and firm performance seem quite evident, two important deficiencies in previous research limit our understanding of the effects involved. First, research into cooperation with competitors has revived debates about its positive and negative effects on strategic behavior and firm performance. While many scholars hold that cooperation with competitors mitigates the inefficiencies of competition, improves information exchange, helps gain economies of scale, reduces uncertainty and risks and speeds up new product development (Das & Teng, 2000; Ingram & Roberts, 2000; Gnyawali & Park, 2011; Ritala & Hurmelinna-Laukkanen, 2012), other scholars point to the downside of co-opetition such as unintended knowledge leakage, management difficulties, loss of control, facilitating collusion, and suppressing healthy competition (Kang & Kang, 2010; Luo et al., 2007; Nieto & Santamaría, 2007; Wu, 2012). Unfortunately, except for very few efforts (e.g., Luo et al., 2007), academic studies have previously tended to treat these two influences separately, rather than demonstrating both the positive and negative sides of co-opetition. Even worse, the boundary conditions of the *innovation* implications of the twin character of such relationships have largely been neglected in scholarly work.

Recent research on co-opetitition has recognized the value of the tensions arising due to the simultaneous cooperative and competitive interactions involved, and emphasized that firms in such relationships have an incentive to cooperate in the pursuit of mutual interests and common benefits while competing in the pursuit of their own interests at the expense of competitors (Bengtsson & Kock, 2000; Bengtsson et al., 2010; Gnyawali & Park, 2009). However, empirical studies which reflect the dynamics of the co-opetitive process accurately have been rare. As Luo, Rindfleisch and Tse have noted, "It appears that the traditional rivalry view is incomplete and not well suited toward understanding the complexity of engaging in alliance activities with competitors. As a result, managers are left with little guidance on whether firms can improve performance by forming such alliances" (2007: 73). A similar plea for more dynamic and nuanced models of co-opetition was made by Bengtsson, Eriksson and Wincent, who suggested (2010) that, "Because of the differences in focus between paradigms focusing on cooperative and competitive, respectively, it is, however, difficult to achieve such an integration within one of these fields" (p. 197). They therefore urged that, "As there is a lack of knowledge about the effects of co-opetition and different types of co-opetitive interactions, systematic empirical research that goes beyond our conceptual advancements [sic] is necessary" (p. 210).

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The present analysis addressed these weaknesses by examining the dynamics of cooperation between competing firms in their R&D activities (R&D co-opetition). Cooperation with competitors ranges from joint research and development (R&D) arrangements (Ahuja, 2000), to sharing marketing assets or brand names (Hagedoorn & Schakenraad, 1994), to sharing manufacturing process (Uzzi, 1997). Relative to other types of co-opetition, competitors engaging in R&D cooperation tend to have common goals and pursue common innovation projects. This makes the knowledge base of the rival firm more relevant, and competing partners can enhance their knowledge and skills and improve their absorptive capacity through the co-opetition. Meanwhile, the strong motive for opportunistic behavior can lead to information leakage, changes in the objectives and/or illegal transfer of core technology for individual gain (Gnyawali & Park, 2009; Kang & Kang, 2010). The relative difficulty of achieving a balance in the interactions makes R&D co-opetition a particularly useful setting for studying the dynamics that underlie all complex co-opetitive relationships.

This study addressed the twin effects of R&D co-opetition on firm product innovation. Product innovation refers to a firm's successful introduction of new products, which is a primary way firms achieve a position of competitive advantage (Eisenhardt & Tabrizi, 1995; Wu, 2012). It was hypothesized that the degree to which a firm engages in R&D co-opetition should be positively associated with its product innovation performance, but that any positive effect would decline as the extent of cooperation with competitors goes beyond some threshold. The study also explored the limits to effective R&D co-opetition arising from firm-specific capabilities and external linkages. Adopting an agnostic view, the study tested contradictory hypotheses about the moderating effects of firm-specific technological capability and ties with universities or research institutes. The results yield a contingent view of co-opetition and shed light on the competing claims published on the topic. The hypotheses were tested using data about co-opetition and product innovation in a sample of 1499 Chinese firms covering the period 1998–2000. The relatively aggressive innovation stance of Chinese firms, the variety in the firms' levels of technological development and increasing inter-firm cooperation since the late 1990s all made this an appropriate empirical context in which to test the proposed theoretical framework.

2. Theory

2.1. The concept of co-opetition

Examples of co-opetition abound in manufacturing and service industries where competing firms (e.g., Renault and Volvo) cooperate in different stages of the value chain. R&D co-opetition is exemplified by Nokia, Sony Ericsson, Samsung and other mobile phone firms joining together to create an operating system to compete with traditional computer companies in the battle over whether mobile phone operators or the computer companies will take the lead in integrating the internet with mobile telephony (Bengtsson et al., 2010). Neither the competition nor the cooperation paradigm takes account of such complicated co-opetitive relationships. The competition literature, drawing on neoclassical and industrial organization theories, emphasizes the desirable effects of competition for society in general and for firms in particular, and suggests that cooperation between competitors may breed implicit or explicit collusion and thus harm customers (Dobbin & Dowd, 1997; Podolny & Scott Morton, 1999). Dobbin and Dowd, for example, showed that cooperation between competitors helped firms conclude price-fixing agreements in the railroad industry in 19th century. Cooperation with competitors is thus viewed as a market imperfection hampering competitive dynamics and its resulting benefits. Scholars rooted in the cooperative literature, based on the network and game theories, have argued that cooperation with competitors improves firm performance by mitigating some negative effects of competition and enhancing information exchange, thus adding value for customers (Ingram & Roberts, 2000; Uzzi, 1996). But competitive influences on a relationship are usually ignored and the negative influences of competition are merely mentioned. In fact, the two diametrically different interactions must co-exist when competitors cooperate—they must compete due to their conflicting interests, and at the same time they must cooperate due to the interests they have in common (Das & Teng, 2000). To remedy the weaknesses of the conventional paradigms, the concept of co-opetition has been introduced to describe and analyze such phenomena. Academics have conceptualized co-opetition as simultaneous cooperation and competition which transcends the usual either/or choices and highlights the interaction between competition and cooperation (Bengtsson & Kock, 2000; Bengtsson et al., 2010).

2.2. Different views of co-opetition

The published work on cooperation with competitors displays two rather different lines of thinking on dynamic co-opetition. The first, the contextual argument, focuses on the environmental interaction in co-opetition and argues that sets of competitive and cooperative relationships and interdependences in the environment influence the behavior of individuals, groups or organizations, determining whether or not they engage in co-opetition (Lado, Boyd, & Hanlon, 1997; Nalebuff & Brandenburger, 1996). Co-opetition emerges as a contextual characteristic influencing firms' competitive behavior. In this view, as in military strategy, two competitors can cooperate with each other to better compete with a third firm. Research adopting this perspective has focused primarily on how individual units and organizations act, or should act, towards their environment in a co-opetitive setting. They tend to describe the competitive and cooperative parts of the relationship as divided between the actors; that is, a firm in a network can have a cooperative relationship with some firms in the network and a competitive relationship with others. However, as Bengtsson and Kock have noted, "This gives rise to a co-opetitive situation, but not a co-opetitive interaction. It follows that the identification of the boundaries of co-opetition in each specific situation becomes difficult." (2001: 199)

An alternative argument, the process view, describes co-opetition as a mutual interaction involving two or more entities (Bengtsson & Kock, 2000; Bengtsson et al., 2010). In a co-opetitive relationship, the expected benefits of cooperation are predicated on trust, forbearance and reciprocity; the simultaneous presence of competition suggests that the benefits from the cooperation may be constrained by the conflicting interests of the two parties. Such interactions are usually on the intra-organizational and inter-organizational levels (Tsai, 2002; Bengtsson & Kock, 2000), but co-opetition between colleagues competing for promotion is probably the most common form of all (Hatcher & Ross, 1991; Smith & Bell, 1992). The process view of co-opetition suggests that the competitive and cooperative parts of a co-opetitive relationship are segregated among activities rather than among actors (Bengtsson & Kock, 1999). The process view can be further classified into two different approaches based on whether co-opetition should be looked upon as occurring along one or two separate continua (Padula & Dagnino, 2007). One continuum ranges from complete competition to complete cooperation. In between is the possibility of different degrees of co-opetitive relationship. Relationships displaying stronger cooperation will have more restricted competitive behavior, and vice versa (Bengtsson & Kock, 2000). But this single-continuum approach does not take account of the interactions involved in any co-opetitive relationship.

The two-continuum approach suggests that cooperation and competition are two different interactions proceeding in parallel within a co-opetitive relationship, and the relationship should be treated as having two continuums rather than just one (Bengtsson et al., 2010). The two-continuum approach takes account of the fact that different levels of cooperation and competition can co-exist. Regarding a relationship that way opens up a vast number of possible combinations of cooperation and competition and allows for an understanding of both competition and cooperation as more multifaceted concepts. This two-continuum approach was the point of departure for this study. The interactions of competitive and cooperative aspects in co-opetition should have important implications for partnering firms' innovation performance.

3. Hypotheses

3.1. Co-opetition and product innovation

Product innovation is a primary way in which firms adapt to turbulent environments and achieve sustainable competitive advantage (Eisenhardt & Tabrizi, 1995). Among various factors identified as determinants of innovation success, absorptive capacity is a central one (Cohen & Levinthal, 1990; Zahra & George, 2002). Absorptive capacity refers to a firm's ability to recognize knowledge which has value, assimilate it, and apply it to commercial ends (Cohen & Levinthal, 1990: 128). Academic researchers have proposed technological capability–a firm's ability to put new technologies to work–as an important component of absorptive capacity that plays a critical role in successful product innovation (e.g., Moorman & Slotegraaf, 1999; Wu & Wu, 2013b). However, technological capability is normally embedded in organizational routines, making it firm-specific and much less valuable if separated from the creating firm (Dierickx & Cool, 1989; Prahalad & Hamel, 1994). A firm can enhance its technological capability by cooperating with competing firms that have developed their own technological capabilities. Compared with non-competing firms, competing firms tend to have accumulated useful, industry-specific common knowledge, to possess similar strategic resources, and to be pursuing common goals (Gnyawali & Park, 2009). As Ritala and Hurmelinna-Laukkanen have noted, "When firms continuously confront similar problem sets in their end-product markets and utilize similar types of resources in addressing them–as is the case with competitive firms–they are likely to possess similar market and technological knowledge" (2009: 823). The common language and processes of competing firms and their similar resources can reduce the causal ambiguity in knowledge acquisition, improve the firms' ability to spot and utilize knowledge generated in the competing partner's technology base and thus enhance their technological capability (Cohen & Levinthal, 1990; Ritala & Hurmelinna-Laukkanen, 2009).

Enhanced information exchange is another advantage enjoyed by firms cooperating with competitors. As Uzzi has observed, "Information exchange in embedded ties was more proprietary and tacit than the price and quantity data that were traded in arm's-length ties." (Uzzi, 1997: 45) The common knowledge inherent in co-opetition facilitates the ease and fluency of sharing and transferring knowledge that is a prerequisite for successful knowledge acquisition and subsequent effective product innovation (Gnyawali & Park, 2009; Ritala & Hurmelinna-Laukkanen, 2009, 2012). An abundance of anecdotes and empirical evidence supports the idea that competitors as innovation partners may reap benefits from their common understanding in terms of greater value-creation potential. For example, managers interviewed by Ingram and Roberts (2000) reported that they acquired important information about market conditions (e.g., how much business and what types of business other companies were conducting or expecting to conduct) from their social ties to friends who managed competing organizations. The benefits of information exchange are especially great when the partners are competitors, because there is a greater overlap of interests among competing firms attempting to apply similar resources to meet the demands of similar customers. "[A manager would] place greater value on the information that flows from a friend if that friend manages a competing firm" (Ingram & Roberts, 2000: 394). Co-opetition increases the breath and quality of the information that is exchanged due to the influence of norms of reciprocity. So partnering firms benefit from fine-grained information transfer, based on which each can more accurately forecast market changes and adapt to them (Uzzi, 1996, 1997).

Cooperation with competitors not only enhances technological capability and facilitates information exchange, it can also entail joint problem-solving arrangements. As competitors tend to have common goals, the pursuit of common innovation projects encourages partnering firms to coordinate functions and work out problems "on the fly" (Uzzi, 1996). Such joint problem-solving makes negotiation and mutual adjustments routine, helping the partners flexibly resolve problems and improve organizational responses by reducing production errors and speeding up product development (Gnyawali & Park, 2009; Kang & Kang, 2010; Teece, 1992). Moreover, such arrangements help firms work through problems together, receive direct feedback and increase the chance of discovering new solutions (Uzzi, 1997: 47). Cooperation with competitors would thus be expected to positively influence a firm's product innovation performance.

However, this positive influence may decline as cooperation with competitors becomes too extensive. First, because of the simultaneous existence of a competitive dimension in a co-opetitive relationship, partnering firms still have strong incentives to compete in the pursuit of their own interests at the expense of their partner (Gnyawali & Park, 2011; Ritala & Hurmelinna-Laukkanen, 2009; Zhang, Shu, Jiang, & Malter, 2010). Given that the parties in co-opetition should be quite capable of understanding each other's technologies and knowledge, too much cooperation may enhance the rival's ability to copy a firm's technology and improve its own absorptive capacity (Ritala & Hurmelinna-Laukkanen, 2012; Wu, Balasubramanian, & Mahajan, 2004), making the rival firm even more competitive.

In addition, excessive inter-organizational cooperation and trust (especially with a firm's competitors) may leave a firm open to the risks of opportunistic exploitation by its alliance partners (Selnes & Sallis, 2003). In co-opetition there is always a high risk of unintended knowledge spillover, and this is especially serious in R&D co-opetition (Ritala & Hurmelinna-Laukkanen, 2012). It is not uncommon that a firm is not careful enough in partnering with its competitors and loses its trade secrets and proprietary knowledge to an opportunistic partner (Gnyawali & Park, 2009; Nieto & Santamaría, 2007). As Zeng and Chen (2003) warn, "An over-trusting partner can become an easy target for exploitation by its greedy partners" (2003: 588).

Moreover, firms that are overly cooperative with their competitors may need to dedicate substantial resources to safeguarding their investments (Luo et al., 2007). The substantial investment in building an appropriate co-opetition framework and monitoring systems may increase the rigidity of the collaboration and decrease its innovation efficiency (Kang & Kang, 2010; Lhuillery & Pfister, 2009). Rindfleisch and Moorman (2003) have found that the efforts that co-opetitive partners devote to monitoring hamper their ability to maintain a strong customer focus. So weak cooperation with competitors can sacrifice some of the potential benefits of working with rivals and inhibit innovation, but excessive cooperation can also be harmful because of the risk of opportunistic exploitation. Therefore a moderate level cooperation with competitors appears to be optimal.

Hypothesis 1. Cooperation with competitors has an inverted U-shaped relationship with a partnering firm's product innovation performance.

3.2. The role of technological capability

Firms with strong technological capabilities may be able to generate more value from cooperation with competitors than firms with weak technological capabilities. Although access to information about a partner's technology and knowledge base should be useful, capitalizing on it is highly dependent on a firm's own technological capabilities (Luo et al., 2007). Because such capabilities are an important component of absorptive capacity–a firm's ability to recognize the value of new information, assimilate it and apply it to commercial ends–they should help a firm understand and learn from a rival's technological expertise. This can be very helpful in realizing the full potential of R&D cooperation with competitors. The stronger a firm's technological capabilities, the more easily it can assimilate knowledge from outside sources, and the greater are the chances that such knowledge will prove useful in creating innovative new products (Ritala & Hurmelinna-Laukkanen, 2012). Moreover, a firm with strong technological capabilities may be better able to select trusting, capable partners who not only provide access to needed resources, but also help the firm avoid technology leakage and opportunistic behavior (Gnyawali & Park, 2009). The innovation benefits of cooperating with a competitor should therefore be enhanced by a firm's strong technological capabilities.

Hypothesis 2a. Strong technological capability positively moderates any positive relationship between cooperation with competitors and product innovation performance.

However, cooperating with competitors is not the only way in which a firm acquires and develops product innovation capabilities. Capabilities can be built in-house, and through collaboration with universities and research institutes (Hamel, 1991). Firms choose among different modes of capability building based on the tradeoffs involved. Cooperation with competitors does not change the fact that a firm and its competitors still remain rivals in the market and there always exists a "race" in which the firm with the greater absorptive capacity will tend to be on the winning side (Hamel, 1991). This leads to a sort of learning race where each firm is trying to learn more than it teaches (Hamel, 1991). If one party has much stronger technology it has less need to rely on its competitors to develop new products (Ahuja, 2000), and at the same time it needs to be more concerned that its core technologies might be revealed to the other party (Kale, Singh, & Perlmutter, 2000). This is particularly serious when the two parties are direct competitors. A learning race stimulates each party to appropriate knowledge contributed by the other but to contribute as little knowledge as possible, or even to mislead the other party (Ritala & Hurmelinna-Laukkanen, 2012; Wu, 2012). Both must respect the danger of turning the partner into a stronger competitor. A manager interviewed by Hamel (1991: 87) explained that, "Whatever they learn from us, they'll use against us worldwide." Hence firms with strong technological capability may have less incentive to cooperate with competitors in developing new products. For such firms the net value of cooperating with their competitors in product innovation is reduced. Furthermore, strong technological capability may result in a tendency of a group of researchers to believe that their firm possesses an unassailable lead in knowledge in its field, which arouses strong internal resistance from a firm's incumbent technical staff—the so called "the not invented here" syndrome (Katz & Allen, 1982). NIH thinking makes a firm allergic to externally sourced technology and counsels it to be strongly self-reliant. The tendency to reject new ideas from outsiders will weaken a firm's ability to gain innovation benefits from cooperation with competitors.

Hypothesis 2b. Strong technological capability negatively moderates any positive relationship between cooperation with competitors and product innovation performance.

3.3. The role of research collaboration

A firm's innovation benefits from cooperation with its competitors will depend not only on its technological capability but also its other external linkages. Cooperation with competitors may be less important for firms which already collaborate with universities or research institutes. Collaboration with a university or research institute gives a firm access to scientific knowledge and complementary assets for its product innovation with much less risk of educating its competitors (Belderbos et al., 2004; Tether, 2002). Links with universities can also offer an opportunity to enter into less direct alliances with other firms while still gaining exposure to their diverse management, marketing, managerial, and innovation systems (George et al., 2002). Moreover, collaboration with a university or research institute can help a firm reduce its R&D expenditure. This is particularly useful for firms that do not have the resources to maintain extensive R&D facilities. Collaboration with a university or research institute can give them access to equipment they need for new product development and the expertise of the institution's personnel, minimizing the expense of sustaining a large, full-time research facility (George et al., 2002). As a result, the firm may be able to support more numerous R&D and new product development projects. And of course a university or research institute is much less likely to try to appropriate the results of the collaboration. As Pangarkar and Wu (2012) noted, alliances with universities pose lower threats to a partnering firm in terms of appropriation of their skills or creating future competitors, and successfully reduces the risk associated with high risk associated with alliances with competitors. Indeed, the university or institute is typically the source of much of the knowledge and innovation. This gives firms an incentive to collaborate with a university or research institute rather than a competitor in product innovation wherever possible. The value of cooperation with competitors in product innovation declines accordingly.

Hypothesis 3a. Research collaboration with universities and research institutes negatively moderates any positive relationship between cooperation with competitors and product innovation performance.

According to literature on alliance portfolio diversity (Jiang, Tao, & Santoro, 2010; Pangarkar & Wu, 2012; Stuart, 2000), research collaboration with universities and research institutes may bring a firm a non-redundant inflow of resources. Pangarkar and Wu (2012) showed that alliances with universities can benefit a firm in a variety of ways, including giving it greater legitimacy (especially if the alliance is with a prestigious university), access to a reservoir of knowledge in the basic sciences, and links with alumni and local businesses which might open up possibilities for further collaboration. Similarly, Jiang et al. (2010) argued that partnering with organizations outside the industry can offer complementary resources and/or improve value chain coordination. Stuart (2000) found that firms innovate more and grow faster when their alliance partner is larger and possess more technology resources. Based on that logic, cooperation with universities and research institutes along with cooperation with competitors may generate beneficial synergies which could strengthen the linkage between coopetition and innovation performance.

Hypothesis 3b. Research collaboration with universities and research institutes positively moderates any positive relationship between cooperation with competitors and product innovation performance.

4. Methods

4.1. Data and sampling

The empirical analyses employed data from a large survey undertaken in 2002 by the World Bank in collaboration with China's National Bureau of Statistics. The survey covered a wide range of industries[1] and included Chinese firms with more than 10 employees. These firms were randomly selected from five cities including Shanghai, Chengdu, Tianjin, Guangzhou, and Beijing (For more details, see World Bank, 2003). The information regarding firm age, number of employees, sales and product innovation in 2010 were gathered from archival sources and compared with the information from the sampled firms.

[1] The survey covered five manufacturing sectors (electronic equipment, electronic components, consumer products, vehicles and vehicle parts, and apparel and leather goods) and five service sectors (i.e. accounting, advertising and marketing, business logistics, communications, and information technology).

There are no significant differences in key firm characteristics, indicating the adequacy and relevance of the data. The data were therefore taken as correctly describing each firm's R&D cooperation with its competitors, and this information was used to test the proposed relationships.

The survey's questionnaire was originally designed in English and then translated into Chinese and then back-translated into English, according to the steps suggested by Brislin (1970) and Sekaran (1983). Scholars who are competent in both languages and with substantial research experience in China checked the back-translated English against the original English version. No apparent anomaly was found between the original and the back-translated version. Before the formal survey, a pilot test designed as semi-structured, in-depth interviews with 17 randomly selected business managers was conducted. The completed questionnaires were sent to a research team that goes through every question to determine whether these managers had understood the questions correctly. Based on their feedback, some final refinement of the questionnaire was made to improve the accuracy of the questions.

To ensure that participants were interested and committed to providing accurate information, a letter of introduction was hand-delivered to top executives (the CEOs or general managers) of each company, explaining the purpose of the study and inviting participation and guaranteeing confidentiality of the information provided. These top executives were contacted by a telephone call within two weeks. They were reminded of the survey and invited to participate in the study. To minimize potential problems of common method bias, the survey was designed as two separate questionnaires that were answered by two different groups of respondents from the same company. Accountants or personnel managers were asked to complete the first part. They provided basic profile information such as firm age, external ties, and labor force size. The general manager was asked to complete the second part. They provided the information on innovation outcomes and other matters. Following Podsakoff, MacKenzie, Lee, and Podsakoff (2003), the study employed information on the dependent and independent variables provided by two different respondents from each firm answering at different times. This decreased the risk of common method bias. After deleting missing observations, the final sample comprised 1,499 firms.

Of the 1499 firms, about half (45.50%) were of medium size with between 100 and 1000 employees and 41.09% were smaller with less than 100 employees. About thirty-nine percent had been in business between 5 and 10 years, with another 27.55% aged between 10 and 30 years, 15.54% were older and 17.68% were aged less than 5 years. About 6.94% of the firms were from accounting and related services sectors, 5.94% in advertising and marketing, 14.81% in apparel and leather goods, 7.34% in business logistics services, 4.74% in communication services, 11.01% in consumer products, 13.54% in electronic components, 12.81% in electronic equipment, 8.54% in information technology services, and 14.34% in the vehicle and vehicle parts industry. Twenty percent of the firms were from each of the five cities (see Table 1).

This study used several statistical techniques to assess heteroscedasticity (whether or not pooling data across industries and cities was appropriate). First, we followed Bowen and Wiersema's (1999) approach to analyze the panel data using White's generalized test. The result of Breusch–Pagan test statistics revealed no heteroscedasticity concerns ($\chi^2 = 15.89$, $p = 0.33$). Second, we followed Wooldridge's (2009) commendation to plot the estimated residuals against the independent variables. There was no evidence of systematic patterns of heteroscedasticity in the data. In addition, we created "dummy" variables representing industries and cities to model coefficient variation, as this statistical technique is suggested to effectively alleviate the concern about possible heteroscedasticity associated with pooling of the data (Greene, 1993).

Table 1
Sample characteristics.

Characteristics	Number of firms	Percentage
Number of employees		
Small (≤100)	616	41.09%
Medium (101–1000)	682	45.50%
Large (>1000)	201	13.41%
Location		
Beijing	300	20.01%
Chengdu	300	20.01%
Guangzhou	300	20.01%
Shanghai	300	20.01%
Tianjin	299	19.95%
Age		
above 30 years	233	15.54%
10–30 years	413	27.55%
5–10 years	588	39.23%
<5 years	265	17.68%
Industry		
Accounting and related services	104	6.94%
Advertising and marketing	89	5.94%
Apparel and leather goods	222	14.81%
Business logistics services	110	7.34%
Communication services	71	4.74%
Consumer products	165	11.01%
Electronic components	203	13.54%
Electronic equipment	192	12.81%
Information technology services	128	8.54%
Vehicles and vehicle parts	215	14.34%
Total	1499	

4.2. Measures

Product innovation. We measured a firm's product innovation by the number of new products each firm had successfully introduced to the market in 2000. Prior studies have showed that the number of new products successfully introduced to the market is an important indicator of product innovation (Katila, 2002). Chaney and Devinney (1992) showed that the introduction of new products increases market share and market value, and Roberts (1999) found that successful new product introductions increased a firm's firm performance. Banbury and Mitchell (1995) also suggested that a firm that successfully introduced new products increased its survival chances. Since product innovation might vary by industry (e.g., electronic components and leather goods may have different rates of new product introductions because of differences in the nature of their new products), this measure was adjusted by dividing the number of new products each firm had introduced by the average number of new products introduced by firms in the industry segment to which the firm belonged.

Dynamic co-opetition. Quantifying co-opetition requires information about (a) whether a firm engages in simultaneous competition and cooperation in an alliance; and (b) the extent of cooperation in the alliance. Measuring the first is straightforward. The respondents were asked to identify their competitors. Among the competitors identified, they were further asked to indicate whether their firm cooperated with any of them in R&D. A firm was considered as engaged in simultaneous competition and cooperation in an alliance if the respondent reported R&D collaboration with any competitor. A dummy variable co-opetition was then coded 1, or 0 otherwise.

Quantifying the extent of cooperation was somewhat more complicated because the necessary information was not covered in the World Bank survey. Extensive studies have suggested that a firm's tendency to develop its new products through cooperation with competitors is determined by competitive intensity (Ritala, 2012; Wu, 2012) and co-opetitive experience (Ritala, 2012; Ritala & Hurmelinna-Laukkanen, 2009). The extent of cooperation a firm devotes to in a co-opetitive relationship was therefore measured as:

$$P(y = 1|x) = G\left(\alpha + \beta_1 \text{competitive} + \beta_2 \text{experience} + \sum_{k=3}^{12} \beta_k \text{industry}\right) \quad (1)$$

Here y is a dichotomous variable reflecting a firm's tendency in developing new products (1 = co-development with competitors; 0 = in-house development); competitive represents the intensity of the competition a firm encounters which was measured by the ratio of increased new competitors among all the competitors the focal firm encountered (Wu, 2012); experience represents a firm's co-opetitive experience, which was measured by the number of years that a firm formed a R&D cooperative relationship with competitors in the past (Ahuja, 2000); and *industry* is an industry dummy. G is a logistic function:

$$G(z) = \exp(z)/[1 + \exp(z)] = \Delta(z) \quad (2)$$

which takes on values between zero and one for all real z. This is the cumulative distribution function for a standard logistic random variable (Wooldridge, 2009).

Eq. (1) reflects the extent to which the firm cooperates with its competitors in R&D activities, after controlling industry heterogeneity. A high value indicates that a firm is likely to cooperate with its competitors, whereas a low value indicates that is unlikely. (See Oczkowski (2003) for a detailed discussion of this procedure.)

Strong technological capability. Previous studies (Morck & Yeung, 1991; Wu & Wu, 2013a) have used R&D intensity as a measure of a firm's technological capability, and this study followed that lead by using the ratio of R&D spending to total sales, designated V_j. Each firm's R&D intensity was compared with the average for its industry and city. For each firm j a dummy variable TK_j was created which took the value 1 if V_j exceeded the average for the firm's city and industry and 0 otherwise.

Research collaboration. Following the lead of prior studies (e.g., George et al., 2002; Wu, 2011), research collaboration was quantified using the information provided by the respondents about whether or not their firms had a contractual or informal R&D relationship with a university and/or a research institute. (Research institutes are numerous in China.) A dichotomous variable was coded 1 if a firm reported R&D collaborating with a university or research institute during the period and 0 otherwise.

Because large firms may have more resources to devote to product innovation (Eisenhardt & Tabrizi, 1995), the study controlled for firm size using the logarithm of the number of employees. Prior studies have provided different predictions about the effect of firm age on innovation performance (e.g., Sorensen & Stuart, 2000), so the logarithm of firm age was included in the analyses without predicting any specific influence. Foreign ownership was also included, because a high level of foreign ownership motivates the foreign partner to actively engage in a firm's management, which may help the firm access advanced knowledge and technology for product innovation (Lyles & Salk, 1996). It was measured by the percentage of equity owned by foreign investors, including foreign individuals, institutional investors, firms, and foreign banks. In addition, because the sample included firms from ten industries, nine industry dummy variables were created using the accounting service industry as the base group. Four city dummy variables were also included to control for location effects with Chengdu as the base group in the analysis.

4.3. Statistical modeling

The dependent variable (number of new products) is a count variable, ranging from zero to a positive value. Such a nonnegative dependent variable violates the assumptions underlying linear regression techniques. Poisson or negative binomial regression models are usually adopted to deal with such variables. The large variance in the number of new products firms has introduced makes a negative binomial regression model (NBRM) preferable to a Poisson regression model (PRM), which requires that the mean to be equal to the standard deviation (Hausman, Hall, & Griliches, 1984). However, a NBRM assumes that all zero counts, as well as positive counts, are generated by the same negative binomial process. This assumption would be unrealistic, because some zero counts may be a function of the firm's characteristics and not governed by the same process at all. Failure to differentiate the processes generating the zero counts would result in biased and inconsistent estimates. To solve this problem, Greene (2000) has proposed using zero-inflated negative binomial (ZINB) regression models. We thereby employed ZINB regression models in the data analysis. we used the number of new products the firm introduced in the prior year to estimate the probability of the zero counts.

Although time subscripts have been omitted here to avoid unnecessary complication of the equation, all explanatory variables were lagged one year, taking into consideration a possible delay before the effects of co-opetition, technological capability, and research collaboration would be reflected in product innovation performance.

5. Results

Table 2 reports descriptive statistics for the variables used in the analyses. A review of the correlations among the independent variables suggests that multicollinearity was not a major concern. This is confirmed by the analysis of variance of inflation (VIF). The VIF values ranged from 1.35 to 3.01, well below the cutoff threshold of ten, which indicates that there were no serious multicollinearity problems in the models (Hair, Anderson, Tatham, & Black, 1998).

Table 3 provides the estimation results testing the hypotheses. M 1 includes the controls, M 2 adds the main effect of co-opetition, and M 3 includes its squared term. M 4 include the effects of technological capability and collaboration with universities or research institutes (research collaboration), M 5 includes the interaction of co-opetition with technological capability, M 6 includes the interaction term of co-opetition with research collaboration, and finally M 7 is the full model including all the variables.

To reduce any potential multicollinearity problems, the predictor and moderator variables were mean-centered before creating the interaction terms (Aiken & West, 1991). The overall chi-squares for these models indicate significant explanatory power and the smaller values of the Akaike information criterion (AIC) and the Bayesian information criterion (BIC) in models 2–7 compared with each previous model suggest that the relative goodness of fit in each model improved significantly on the previous one.

Hypothesis 1 deals with the relationship between co-opetition and product innovation performance. The coefficients of co-opetition in M 3 and M 7 are positive and significant ($\beta = 27.99$, $p \leq 0.001$ in M 3; $\beta = 28.91$, $p \leq 0.001$ in M 7), and the coefficients of (co-opetition)^2 are negative and significant ($\beta = -58.42$, $p \leq 0.001$ in M 3; $\beta = -67.90$, $p \leq 0.001$ in M 7). These results suggest an inverted U-shaped relationship between co-opetition and product innovation performance, in support of Hypothesis 1.

Hypotheses 2a and 2b assess the moderating effect of firm-specific technological capability. As M 5 and M 7 show, the coefficients of the interaction of co-opetition with technological capability are negative and significant ($\beta = -22.63$, $p \leq 0.001$ in M 5; $\beta = -22.46$, $p \leq 0.001$ in M 7), indicating that strong technological capability weakens the positive relationship between co-opetition and product innovation performance. To facilitate interpretation, this effect is plotted in Fig. 1 using a method from Aiken and West (1991) for the interaction model. In Fig. 1 the horizontal axis represents the extent of cooperation a firm devotes in its co-opetition with competitors in R&D and the vertical axis represents the number of new products successfully introduced. The firms were split into two groups—low (where technological capability takes the value 0) and high (where it takes the value 1). This figure shows that the degree of cooperation with competitors has an inverted U-shaped relationship with the number of new products successfully introduced. Strong technological capability eliminates the inverted U-shaped effect of cooperation with competitors on the number of new products introduced. Hence Hypothesis 2a was not supported

Table 2
Correlation matrix.

	Variables	Mean	S.D.	1	2	3	4	5	6	7
1	New products introduced	1.00	4.05	1.00						
2	Co-opetition	0.02	0.04	0.21*	1.00					
3	Technological capability	0.24	0.43	0.04*	0.04	1.00				
4	Research collaboration	0.43	1.28	0.17*	0.43*	0.16*	1.00			
5	Firm age	15.51	15.03	0.02	−0.01	0.05	0.08*	1.00		
6	Firm size	0.16	0.37	0.09*	0.07*	0.22*	0.23*	0.25*	1.00	
7	Foreign ownership	14.78	28.64	0.05*	−0.03	−0.04	−0.04	−0.18*	0.01	1.00

* indicates significance at the $p \leq 0.05$ level of confidence.

and Hypothesis 2b was supported. This could reflect the fact that Chinese firms with strong technology (Huawei, for example) have emerged as global innovators and are competing head-on with global giants rather than local competitors in domestic markets. They are therefore less likely to benefit from cooperating with small local players struggled with weak technological capability. Small local players with weak technology find it difficult to partner with technologically stronger firms because they have little to offer.

Table 3
Regression analyses for successful new product introductions.

Variables	M 1	M 2	M 3	M 4	M 5	M 6	M 7
Constant	−0.11	−0.35	−0.60	−0.70*	−0.71*	−0.71*	−0.73*
	(0.34)	(0.34)	(0.34)	(0.35)	(0.36)	(0.35)	(0.36)
Firm age	0.00	0.01	0.01	0.01	0.01	0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Firm size	0.98***	0.62*	0.62*	0.35	0.33	0.33	0.32
	(0.27)	(0.29)	(0.30)	(0.28)	(0.27)	(0.28)	(0.27)
Foreign ownership	0.01**	0.01***	0.01***	0.01***	0.01***	0.01***	0.01***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Advertising and marketing	−0.07	−0.11	−0.22	−0.38	−0.50	−0.39	−0.49
	(0.49)	(0.47)	(0.46)	(0.46)	(0.45)	(0.46)	(0.45)
Apparel and leather goods	−0.27	−0.22	−0.18	−0.20	−0.19	−0.19	−0.18
	(0.49)	(0.51)	(0.51)	(0.52)	(0.51)	(0.52)	(0.51)
Business logistics services	−0.70	−0.55	−0.49	−0.56	−0.60	−0.55	−0.59
	(0.43)	(0.44)	(0.43)	(0.42)	(0.42)	(0.42)	(0.42)
Communication services	−0.33	−0.76	−0.78*	−0.72	−0.83*	−0.77	−0.85*
	(0.46)	(0.39)	(0.39)	(0.40)	(0.40)	(0.41)	(0.40)
Consumer products	−0.23	−0.47	−0.46	−0.51	−0.51	−0.50	−0.50
	(0.40)	(0.37)	(0.36)	(0.38)	(0.37)	(0.38)	(0.37)
Electronic components	−0.36	−0.38	−0.38	−0.47	−0.44	−0.47	−0.43
	(0.40)	(0.41)	(0.40)	(0.42)	(0.40)	(0.42)	(0.41)
Electronic equipment	−0.34	−0.42	−0.50	−0.59	−0.65	−0.59	−0.64
	(0.36)	(0.37)	(0.36)	(0.38)	(0.37)	(0.38)	(0.37)
Information technology services	0.05	−0.04	−0.10	−0.16	−0.20	−0.16	−0.20
	(0.39)	(0.40)	(0.40)	(0.41)	(0.41)	(0.41)	(0.41)
Vehicles and vehicle parts	−0.57	−0.64	−0.58	−0.74	−0.79*	−0.73	−0.77*
	(0.38)	(0.38)	(0.37)	(0.39)	(0.38)	(0.39)	(0.38)
Beijing	0.06	−0.09	−0.11	−0.01	−0.05	0.02	−0.03
	(0.26)	(0.26)	(0.26)	(0.26)	(0.26)	(0.26)	(0.26)
Shanghai	−0.01	0.07	0.10	0.19	0.19	0.20	0.21
	(0.23)	(0.23)	(0.24)	(0.23)	(0.23)	(0.23)	(0.23)
Guangzhou	−0.02	−0.04	0.00	0.14	0.13	0.17	0.15
	(0.27)	(0.28)	(0.28)	(0.28)	(0.28)	(0.28)	(0.28)
Tianjin	−0.18	−0.21	−0.11	0.03	0.02	0.04	0.03
	(0.32)	(0.33)	(0.33)	(0.34)	(0.34)	(0.34)	(0.34)
Co-opetition		11.24***	27.99***	23.80***	29.08***	23.44***	28.91***
		(2.07)	(4.68)	(4.71)	(4.96)	(4.50)	(4.99)
Co-opetition^2			−58.42***	−50.37***	−76.17***	−42.64***	−67.90***
			(11.53)	(11.56)	(13.72)	(11.13)	(13.96)
Technological capability				0.35*	0.34*	0.36*	0.34*
				(0.19)	(0.19)	(0.19)	(0.19)
Research collaboration				0.17**	0.17**	0.20**	0.19**
				(0.06)	(0.06)	(0.07)	(0.07)
Co-opetition × Technological capability					−22.63***		−22.46***
					(4.68)		(4.50)
Co-opetition × Research collaboration						−0.74*	−0.80*
						(0.36)	(0.36)
Log-likelihood	−1674.15	−1646.92	−1638.18	−1630.47	−1623.22	−16209.52	−1615.38
AIC	3384.30	3331.84	3316.35	3304.95	3292.45	3285.03	3261.76
BIC	3479.93	3432.78	3422.60	3421.82	3414.64	3410.22	3402.26
d.f.	16	17	18	20	21	21	22
χ^2	30.95	67.15	105.84	105.51	120.77	111.78	112.37
Prob. > χ^2	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Notes. N = 1499. Robust standard errors are given in parentheses.
*indicates significance at the $p \leq 0.05$ ($^{**}p \leq 0.01$; $^{***}p \leq 0.001$) level of confidence (one-tailed tests for hypothesized variables, two-tailed tests for controls).

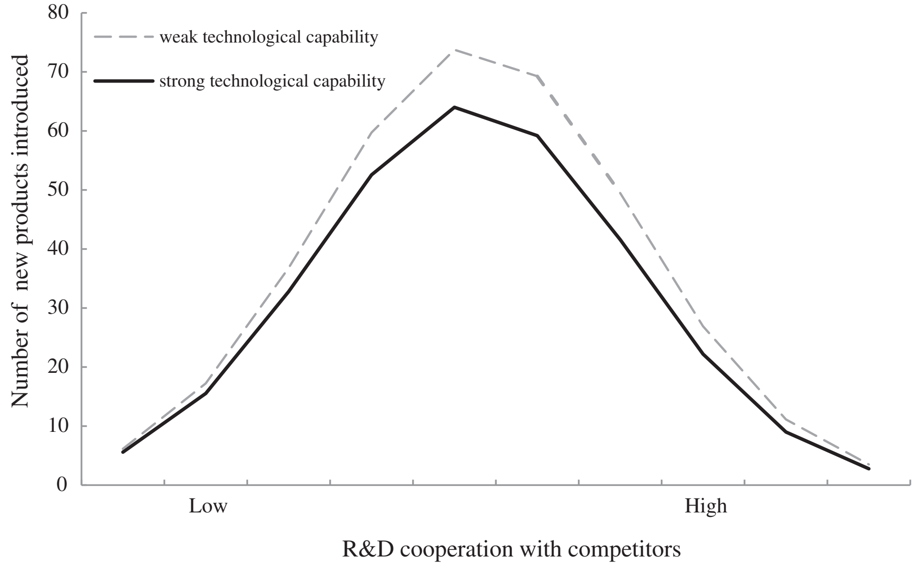

Fig. 1. The impacts of co-opetition and technological capability on product innovation.

Hypothesis 3a predicts that collaboration with a university or research institute negatively moderates the positive relationship between co-opetition and product innovation performance, whereas Hypothesis 3b predicts a positive moderation. In M 6 and M 7 the coefficients of the interaction term for co-opetition and research collaboration are negative and significant ($\beta = -0.74$, $p \le 0.05$ in M 6; $\beta = -0.80$, $p \le 0.05$ in M 7), indicating that collaboration with a university or research institute weakens the positive relationship between co-opetition and product innovation. To facilitate interpretation, this effect is plotted in Fig. 2 following the procedure discussed above. The firms were again split into two groups—those without such alliances (where research collaboration takes the value 0) and with alliances (where research collaboration takes the value 1). This figure again shows that the degree of cooperation with competitors has an inverted U-shaped relationship with the number of new products. The inverted U-shaped relationship between cooperation with competitors and the number of new products introduced is stronger for firms without an alliance with a university than for those with alliances. These results lend considerable support to Hypothesis 3a, whereas Hypothesis 3b was not supported. This could be explained by the immature status of firm–university collaborations in China. Alliances do provide a firm an access to scientific knowledge and equipment, but achieving synergy with competitor cooperation apparently still has a long way to go.

To reduce any concerns that might arise from the fact that the sample contained observations without any new products, a sub-sample was constructed limited to firms reporting at least one new product, and the models were then re-estimated with that sub-sample of 865 firms. The results did not change in any substantial way.

Another concern could be that while this study used co-opetition as a predictor variable, not all of the firms had the same chance of cooperating with their competitors. Firms which reported cooperation may well have differed systematically from those reporting no such co-opetition. To alleviate this concern, a method recommended by Hamilton and Nickerson (2003) was employed to correct this endogeneity problem. The analysis proceeded in two stages. In the first stage, probit regression was used to estimate the probability that a firm engages in co-opetition as a function of firm age, foreign ownership and the firm's innovation performance in the previous

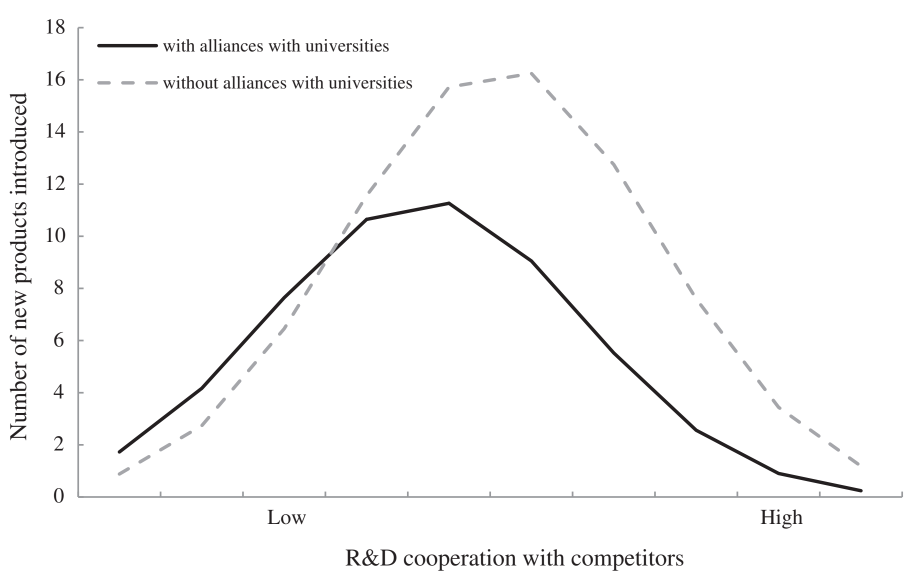

Fig. 2. The impacts of co-opetition and research collaboration on product innovation.

year. The predicted value derived from the first stage was transformed into an inverse Mills ratio[2] (λ), which was then included as a regressor in the second stage model to estimate the probability of new product innovation (Hamilton & Nickerson, 2003). The results generated from this two-stage procedure remained consistent with the earlier findings.

In addition, manufacturing and service industries may exhibit different innovation patterns (Sirilli & Evangelista, 1998), so additional robustness test was conducted to explicitly take this into consideration. The sample was divided into manufacturing and service sub-samples and all the models were re-estimated for each subgroup. There was again no significant difference in terms of the main effect of co-opetition and its interaction with technological capability and research collaboration, providing further evidence of their robustness.

6. Discussion

6.1. Contributions

This study examined the relationship between cooperation with competitors and product innovation and the moderating roles of firm-specific technological capability and alliances with universities or research institutes. It hypothesized and empirically showed that cooperation with competitors has an inverted U-shaped relationship with successful product innovation. Moreover, strong technological capability and collaboration with universities or research institutes negatively moderate the relationship between co-opetition and product innovation success. These results have several important implications.

This study has addressed two weaknesses in the previous research on co-opetition. One is the failure to validate the idea that the tensions arising from simultaneous cooperation and competition have important implications for firm innovation and performance. The other is the previously scant evidence documenting the twin effects of co-opetition on innovation outcomes. The tension has previously been assumed, but the resulting dynamics have important implications for firm innovation and performance which have not been validated heretofore. This study has filled in some of the gaps and more clearly related the dynamics of co-opetition to innovation performance. The inverted U-shaped relationship demonstrated in this study gives new concreteness to the role of the tensions in influencing firm performance.

The results also provide a more nuanced understanding of the balance between competition and cooperation by confirming that cooperation with competitors contributes substantially to successful product innovation, but also by showing its dark side. The positive influences of co-opetition certainly seem consistent with the cooperative arguments (Nieto & Santamaría, 2007; Uzzi, 1996) that cooperation with competitors increases absorptive capacity, enhances information exchange and facilitates joint problem solving. But the results also show that excessive cooperation with competitors can have a negative influence on innovation performance, supporting concerns about "opportunistic exploitation" (Das & Teng, 2000; Gnyawali & Park, 2009; Ritala & Hurmelinna-Laukkanen, 2012; Wu, 2012). This demonstration of the possible liabilities of co-opetition extends prior research which has been enthusiastic about the benefits and has placed relatively less emphasis on the potential negative consequences. The positive and negative influences of co-opetition highlight the need to balance competition and cooperation carefully to optimize innovation returns.

This study enriches the contingent view of co-opetition by theoretically explaining and empirically demonstrating the moderating effect of firm-specific technological capability on the relationship between cooperation with competitors and innovation performance. Some scholars have suggested that the relationship between co-opetition and innovation performance is less straightforward than previously conceived, and they have started examining the limits arising from market uncertainty and competitive intensity (Ritala, 2012), sectoral technological intensity (Wu, 2012), and competitor orientation (Luo et al., 2007). This study has extended that context-dependent view by testing the contradictory hypotheses about the moderating effects of firm-specific technological capability and alliances with universities, which have previously been less explored. The positive effect co-opetition has on product innovation is negatively moderated by strong technological capability and alliances with universities. This finding advances the context-dependent view of co-opetition.

These results also contribute to the innovation literature. Most previous research has found a positive relationship between a firm's external linkages and its innovation performance (Chen & Wu, 2011; Jiang et al., 2010; Pangarkar & Wu, 2012; Wu, 2012). This study complements such findings by emphasizing the substitutive effects of different external linkages in firm product innovation. Many studies have focused on one specific type of social tie and examined its economic and performance implications (e.g., Ahuja, 2000). This study acknowledged that firms are embedded in complex, multiple social ties, and the results confirm that it is important to examine how different social ties interact to predict performance differences. When trading off the risks and benefits of various types of social ties, firms can use one type of social tie to substitute for another.

6.2. Managerial implications

The findings of this study suggest that managers need to pay more attention to how cooperation with competitors can contribute to the success of their firms' product innovation. It can help their firms access useful knowledge and skills and augment their firms' technological capability, leading to better innovation performance. Managers thus should realize that cooperation with competitors cannot be trivialized as a moderator in the mechanisms governing business exchanges. And they should revise their logic of competition accordingly by incorporating the logic of cooperation. Managers are encouraged to eschew the dogma of never cooperating with their competitors and to consider the potential benefits of not only competing with their rivals but also building alliances with them. Indeed, "success in today's business world often requires that firms pursue both competitive and cooperative strategies simultaneously" (Lado et al., 1997).

However, cooperation with rivals needs to be carefully considered and judiciously executed because an over-reliance on cooperation in R&D may be just as harmful as underusing that strategy. Excessive cooperation may lead to opportunistic exploitation, a potential loss of proprietary technology and increased rigidity and inefficiency in the innovation process. Therefore, it is critical for a firm to what might be termed a co-opetition capability (Gnyawali & Park, 2011)—a balance between cooperation and competition. The results also show that firms should still aim to develop strong technological capability along with other forms of external linkages that can help them reduce their dependence on others and increase their bargaining power in alliances with competitors.

The findings also have meaningful implications for public policy makers. Governments in many countries have instituted laws and policies (e.g., antitrust regulations) to regulate the growing popularity of co-opetition. However the difficulty of distinguishing between healthy co-opetition and implicit and explicit collusion among competitors challenges antitrust regulators. Jorde and Teece (1990) suggest that cooperation among competitors in technological innovation may not be anticompetitive. Actually, co-opetition is a different kind of competition. Instead of firm-to-firm competition, collaboration between a pair or small group of competitors may promote group versus group competition (Gomes-Casseres, 1994), which may be an even more intense form of rivalry. Antitrust regulators need therefore to take a new look at the antitrust issues involved. As Gnyawali and Park have noted,

[2] The inverse Mills ratio is then a monotonically decreasing function of the probability that a firm engages in successful product innovation.

"It is possible that co-opetition to create value (or bring major technologies and products) among small players is not that problematic, but cooperation among a set of large competitors to take customers directly away from another set of large competitors may be problematic" (2009:326).

6.3. Limitations and further research

Like all research, this study has some limitations that in turn suggest interesting avenues for future research. First, the study employed panel data to test the hypotheses. It is entirely possible that cooperation with competitors, firm-specific technological capability and product innovation evolve simultaneously. Research using a longitudinal design is needed to confirm the relationships proposed in this research. Then, findings such as these from a single country can be generalized only with great caution. This study has tested the relationship between cooperation with competitors and product innovation using data from Chinese firms. Although the underlying mechanisms observed appear to be applicable in other countries, China may have some particularities with respect to the geographic context, organizational structure or the institutional setting. For example, Chinese academics are strongly constrained from leaving academia to commercialize their knowledge, making cooperation with universities and research institutes less risky than it might be in other economies. The tests performed in this study need to be replicated using data from firms in other countries to obtain greater generalizability.

But the results of this study lead to several exciting questions for future research. The results are based on analysis of a horizontal network ties among competitors and the findings must be seen in that context. It would be interesting to examine other ties such as vertical ties with customers and/or suppliers to see to what extent they operate differently and how firm-specific technological capability, marketing capability or operations capability affect the importance of such ties. Furthermore, rather than product innovation, further research could examine other aspects of innovation performance such as process innovation.

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