EXAMINING THE DYNAMICS OF COOPERATION BETWEEN COMPETING FIRMS IN THEIR R&D ACTIVITIES

(R&D CO-OPETITION)

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Abstract

The relationship between collaboration with competitors and goods innovation performance was investigated along with the moderating effect of the innovating firm's technological capability. The hypothesis that collaboration with competitors has an inverted U-shaped relationship with goods innovation performance was tested using data on new goods introductions from 749 Iranian firms. The results support the balance between competition and collaboration by confirming that collaboration with competitors contributes considerably to successful goods innovation. The positive influences of co-optation certainly seem consistent with the cooperative arguments that collaboration with competitors increases absorptive capacity, improves information exchange and facilitates joint problem solving. The results also show that unnecessary collaboration with competitors can have a negative influence on innovation performance, raising concerns about opportunistic exploitation. The results support the existence of a bell-shaped relationship between co-opetition and goods innovation performance. Technological capability and alliances with universities were shown to weaken the relationship.

Keywords: co-opetition, technological capabilities, R&D collaboration, goods innovation, emerging market

Abstrak

Hubungan antara kolaborasi dengan pesaing dan kinerja inovasi barang diinvestigasi bersamaan dengan efek moderasi kapabilitas inovasi teknologi perusahaan. Hipotesis bahwa kolaborasi dengan pesaing memiliki hubungan berbentuk U terbalik dengan kinerja inovasi barang diuji menggunakan data pada produk baru dari 749 perusahaan Iran. Hasil menunjukkan bahwa keseimbangan antara persaingan dan kolaborasi berkontribusi pada kesuksesan inovasi barang. Pengaruh positif dari kooptasi terlihat konsisten dengan argumentasi bahwa kolaborasi dengan pesaing meningkatkan absorptive capacity, meningkatkan pertukaran informasi dan memfasilitasi penyelesaian masalah bersama. Hasil juga menunjukkan bahwa kolaborasi yang tidak penting dengan pesaing dapat berpengaruh negatif terhadap hubungan berbentuk bel antara koopetisi dan kinerja inovasi barang. Kapabilitas teknologi dan aliansi dengan universitas juga mampu melemahkan hubungan tersebut.

Keywords: co-opetition, kapabilitas teknologi, kolaborasi R&D, inovasi barang, pasar berkembang

To survive competitive environment, firms are increasingly occupied in cooperative alliances with various partners ranging from universities (Wu, 2011), suppliers (Nieto and Santamaría, 2007), customers (Belderbos, Carree and Lokshin, 2004), service intermediaries (Pangarkar and Wu, 2012) and government officials (Wu and Chen, 2012) to competitors (Luo, Rindfleisch and Tse, 2007). Therefore, collaboration with competitors (so called "co-opetition") has attracted increasing research interest over the past decade (Bengtsson, Eriksson and Wincent, 2010; Gnyawali and Park, 2009, 2011; Ritala, 2012). While the impacts of co-opetition of innovation and firm performance seem quite clear, there are two deficiencies in previous research which limit our understanding. First, research in collaboration with competitors has revived our argument about its positive and negative effects on strategic behavior and firm performance. While many researchers support that collaboration with competitors, serious about the inefficiencies of competition, improves information exchange, reduces uncertainty and risks and speeds up new goods development (Gnyawali and Park, 2011; Ritala and Hurmelinna-Laukkanen, 2012), others highlight to the downside of the co-opetition such as unplanned knowledge leakage, management difficulties, and loss of control (Nieto and Santamaría, 2007; Wu, 2012). But academic studies have previously tended to treat these two influences separately, rather than demonstrating both the positive and negative sides of the co-opetition (Luo, Rindfleisch and Tse, 2007). Due to the parallel cooperative and competitive interactions confusion, recent researchers have recognized the value of the tensions arises, and emphasized that firms in such relationships have a stimulus to cooperate in the pursuit of mutual interests and normal benefits while competing in the pursuit of their own interests at the price of competitors (Bengtsson, Eriksson and Wincent, 2010; Gnyawali and Park, 2009). However, there are very few empirical studies which reflect the dynamic process. Luo, Rindfleisch and Tse (2007) have stated that the traditional rivalry view is not well suited to understanding the complexity of engaging in allied activities with competitors. Bengtsson, Eriksson and Wincent (2010) suggested that because of the differences in focus between paradigms focusing on cooperative and competitive, respectively, it is difficult to achieve such an integration within one of these fields. Moreover, they stated that as there is a lack of knowledge about the effects of co-opetition and different types of interactions, systematic empirical research that goes beyond our conceptual advancements. The present research is studding these weaknesses by examining the dynamics of collaboration between competing firms in their R&D activities. Collaborating with competitors ranges from joint research and development (R&D) arrangements (Ahuja, 2000), to shared market assets or brand names (Hagedoorn and Schakenraad, 1994), to shared manufacturing process (Uzzi, 1997). This makes the knowledge base of the competitor firm more appropriate, and competing partners can improve their knowledge and skills and improve their absorptive capacity through the co-opetition. Meanwhile, the strongest motive for opportunistic behavior can lead to information leakage, changes

in the objectives and core technology for individual gain (Gnyawali and Park, 2009). The relative difficulty of achieving a balance in the interactions makes R&D co-opetition and useful setting for studying the dynamics that underlie complex relationships. This research is studying the twin effects of R&D co-opetition on firm goods innovation. Goods innovation refers to a firm's successful introduction of new goods, which is a primary way firms achieve a position of competitive advantage (Wu, 2012). However, a firm engaged in R&D co-opetitionshould be positively related with its good innovation performance, but, that any positive effect would decline collaboration with competitors. This research also explored the limits of effective R&D co-opetition arising from firm capabilities and external linkages. Moreover, the study tested contradictory hypotheses about the moderating effects of firm-specific technological capability and ties with universities or research institutes.

LITERATURE REVIEW

The Concept of Co-opetition

There are many examples of manufacturing and service industries where competing firms 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 operate systems in the battle over whether mobile phone operators will take the lead on integrating the internet with mobile telephone (Bengtsson, Eriksson, and Wincent, 2010). The competition and the collaboration paradigm take account of such complicated relationships. The competition literature illustrates the neoclassical and industrial organization theories, emphasizes the desirable effects of competition for society and firms, and suggests that collaboration between competitors may breed implicit or explicit complicity and thus harm customers (Podolny and Scott Morton, 1999). Collaboration with competitors is viewed as a market deficiency which abstructs competitive dynamics and its resulting benefits. Scholars who studied the cooperative literature, based on the network and game theories, have argued that collaboration with competitors improves firm performance by the negative effects of competition and improving information exchange (Uzzi, 1996). But competitive influences on a relationship are usually ignored and the negative influences of competition are merely mentioned. In fact, the two different interactions must co-exist when competitors cooperate due to their conflicting interests, and at the same time they must cooperate due to the interests they have (Das and Teng, 2000). The concept of co-opetition has been introduced to describe and analyze such phenomena, as a solution for the weaknesses of the conventional paradigms. Scholars have conceptualized co-opetition as parallel collaboration and competition, which transcends the choices and highlights the interaction between competition and collaboration (Bengtsson, Eriksson and Wincent, 2010).

Different Views of Co-opetition

Collaborating with competitors' displays two different lines of thinking about dynamic co-opetition. First, the argument focuses on the environmental interaction in the co-opetition and argues that the competitive and coop-

erative relationships and interdependencies in the environment influence the behavior of individuals, groups or organizations, determining whether or not they engage in co-opetition (Lado, Boyd and Hanlon, 1997). Co-opetitionemerges as a contextual characteristic influencing firms' competitive behavior. In this view, two competitors can cooperate with each other to better compete with a third firm. Research adopting this perspective has focused on how individual units and organizations act, or should act, towards their environment in an co-opetitionsetting. Therefore, they describe the competitive and cooperative parts of the relationship as divided between the actors; that is, a firm with a network can have a cooperative relationship with some firms in the network and a competitive relationship with others. An alternative argument describes the co-opetitionas a mutual interaction involving more entities (Bengtsson, Eriksson and Wincent, 2010). In an co-opetition relationship, the expected benefits of collaboration are predicated on trust, and the parallel competition suggests that the benefits of the collaboration may be constrained by the conflicting interests of the two parties. Such interactions are on the intra-organizational and inter-organizational levels (Tsai, 2002), but co-opetition between colleagues competing for promotion is probably a normal form of all (Hatcher and Ross, 1991; Smith and Bell, 1992). The process view of the co-opetition suggests that the competitive and cooperative parts of an co-opetition relationship are separated among activities rather than among actors (Bengtsson and Kock, 1999). The process view can be further classified into two different approaches based on whether the co-opetition should be looked upon as occurring along one or two separate continua (Padula and Dagnino, 2007). One continuum ranges from complete competition to complete collaboration. In between is the possibility of different degrees of co-opetition relationship. Relationships displaying stronger collaboration will have more restricted competitive behavior, and vice versa (Bengtsson and Kock, 2000). But this single continuum approach does not take interactions confused in any co-opetition relationship. The two-continuum approach suggests that collaboration and competition are two different interactions proceeding in parallel within an co-opetition relationship, and the relationship should be treated as having two continuums rather than just one (Bengtsson, Eriksson and Wincent, 2010). Therefore, two-continuum approach at different levels of collaboration and competition can co-exist. This two continuum approach was the point of this study. The interactions of competitive and cooperative aspects of co-opetition should have important implications for partnering firms' innovation performance.

Hypotheses

Co-opetition and Goods Innovation

Good innovation, which a firms adapt and creates a restless environments and achieve sustainable competitive advantage (Eisenhardt and Tabrizi, 1995). Among various factors which identified as an innovation successful, absorptive capacity is a central one (Cohen and Levinthal, 1990). Absorptive capacity refers to a firm's ability to recognize knowledge which has value, and apply it to commercial

ends (Cohen and Levinthal, 1990). 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 goods innovation (Wu and Wu, 2013b). However, technological capability is embedded in organizational routines, making it firm-specific if separated from the creating firm (Dierickx and Cool, 1989; Prahalad and Hamel, 1994). A firm can improve its technological capability by cooperating with competing firms that have developed their own technological capabilities. In comparison with non-competing firms, competing firms have useful and specific knowledge to possess similar strategic resources, and to be pursuing normal goals (Gnyawali and Park, 2009). Improved information exchange is another advantage of the firm's cooperating with competitors. As Uzzi (1997) has suggested, information exchange in embedded ties was more proprietary and tacit than the price and quantity data. A plenty of empirical evidence supports the idea that competitors as innovation partners may get benefits from their normal understanding in terms of greater value-creation potential. 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 (Ingram and Roberts, 2000). So partnering firms benefit from information transfer, based on which each can more accurately forecast market changes and adapt to them (Uzzi, 1996, 1997). Collaboration with competitors not only improves technological capability and facilitates information exchange; it can also entail joint problem-solving arrangements. Such joint problem-solving makes negotiation and mutual adjustment routine, helping the partners flexibly resolve problems and improves organizational responses by reducing shortage of goods and speeding up goods development (Gnyawali and Park, 2009; Kang and Kang, 2010). Moreover, such arrangements help firms work through problems together, receive direct feedback and increase the chance of discovering new solutions (Uzzi, 1997). Collaboration with competitors would expect to positively influence a firm's goods innovation performance. However, this positive influence may decline as collaboration with competitors becomes large. Due to the parallel existence of a competitive dimension in an co-opetition relationship, partnering firms still have strong stimulus to compete in the pursuit of their own interests at the price of their partner (Gnyawali and Park, 2011; Ritala and Hurmelinna-Laukkanen, 2009). Therefore, parties should be quite capable of understanding each other's technology and knowledge, too much collaboration may improve the competitor's ability to copy a firm's technology and improve its own absorptive capacity (Ritala and Hurmelinna-Laukkanen, 2012), making the competitor firm even more competitive. In addition, unnecessary inter-organizational collaboration and trust (especially with a firm's competitors) may put the firm at risk and opportune exploitation by its alliance partners (Selnes and 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 and Hur-

melinna; Laukkanen, 2012). As Zeng and Chen (2003) warn, trusting partner can become an easy target for exploitation by its greedy partners. Moreover, firms that are overly cooperative with their competitors may need to allocate actual resources to safeguard their investments (Luo, Rindfleisch and Tse, 2007). The actual investment in creating an appropriate co-opetition framework and monitoring systems may increase the rigidity of the collaboration and decrease its innovation efficiency (Kang and Kang, 2010; Lhuillery and Pfister, 2009). Rindfleisch and Moorman (2003) suggest that co-opetitive partners devote to monitoring hamper their ability to maintain a strong customer focus. Therefore weak collaboration with competitors can sacrifice some of the potential benefits of working with competitors and hamper innovation, but unnecessary collaboration can also be harmful because of the risk of exploitation opportunity. Therefore a moderate level collaboration with competitors appears to be optimal.

H1: Collaboration with competitors has an inverted U-shaped relationship with a partnering firm's goods innovation performance.

The Role of Technological Capability

Firms with strong technological capabilities are able to generate more value from collaboration with competitors, although permission to information about a partner's technology and knowledge base should be useful (Luo, Rindfleisch and Tse., 2007). Because such capabilities are important components of absorptive capacity–a firm's ability to recognize the value of new information, incorporate it and apply it to commercial ends–they should help a firm understand and learn from a competitor's technological expert. This can be helpful in realizing the potential of R&D collaboration with competitors. The firms with strong technological capabilities can easily incorporate knowledge from outside sources, and there are chances that such knowledge will prove useful in creating innovative new goods (Ritala and Hurmelinna-Laukkanen, 2012). Moreover, a firm with strong technological capabilities may be more able to select trusting, capable partners to help the firm avoid technology leakage and opportunistic behavior (Gnyawali and Park, 2009). The innovation benefits of cooperating with a competitor should therefore improve with a firm's strong technological capability.

H2a: Strong technological capability positively moderates any positive relationship between collaboration with competitors and good innovation performance.

Capabilities can be built in-house, and through collaboration with universities and research institutes (Hamel, 1991). Firms choose between different styles of capability based on the tradeoffs involved. Therefore, cooperating with competitors is not the only way in which a firm acquires and develops goods innovation capabilities. It also does not change the fact that a firm and its competitors still remain competitors in the market, 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 strong technology, then it does not need to rely on its competitors to develop

new goods (Ahuja, 2000), and at the same time it is interested in revealing its core technologies to the other party (Kale, Singh and Perlmutter, 2000). This is serious when the two parties are direct competitors. A learning race stimulates each party with appropriate knowledge contributed by the others, but a manager interviewed by Hamel (1991) explained that, whatever they learn from us, they will use against us worldwide. Hence firms with strong technological capability may have fewer stimuli to cooperate with competitors in developing new goods. The disposition to reject new ideas from outsiders will weaken a firm's ability to gain innovation benefits from collaboration with competitors.

H2b: Strong technological capability negatively moderates any positive relationship between collaboration with competitors and good innovation performance.

The Role of Research Collaboration

A firm's innovation benefits of collaboration with its competitors mostly depend on external linkages. Collaboration with competitors is less important for firms which already collaborate with universities or research institutes. Collaboration with a university or research institute gives a firm permission to scientific knowledge and complementary assets for its good innovation with much less risk of educating its competitors (Belderbos, Carree and Lokshin, 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, Zahra and Wood, 2002). Moreover, collaboration with a university or research institute can help a firm reduce its R&D expenditure. This is useful for firms which maintain extensive R&D facilities. Collaboration with a university or research institute can give them permission which they need for new goods development and the expertise of the institution's personnel (George, Zahra and Wood, 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) stated, alliances with universities pose lower threats to a partnering firm in terms of the appropriation of their skills or creating future competitors, and successfully reduces the high risk related to alliances with competitors. As the university or institute is the source of the knowledge and innovation, this gives firms and stimulus to collaborate with a university or research institute rather than a competitor in goods innovation wherever possible. The value of collaboration with competitors in goods innovation declines accordingly.

H3a: Research collaboration with universities and research institutes negatively moderates any positive relationship between collaboration with competitors and good innovation performance.

According to Jiang, Tao and Santoro, (2010), also Pangarkar and Wu, (2012), 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 uni-

versities can benefit a firm in several different ways, including legitimacy, source of knowledge in the basic sciences, and links with local businesses which might open up possibilities for further collaboration. Similarly, Jiang, Tao and Santoro, (2010) stated that partnering with organizations outside the industry can improve value chain coordination. Stuart (2000) suggests that firms innovate more and grow faster when their alliance partner is larger. Based on that logic, collaboration with universities and research institutes may generate beneficial synergies which could strengthen the linkage between an co-opetition and innovation performance.

H3b: Research collaboration with universities and research institutes positively moderates any positive relationship between collaboration with competitors and good innovation performance.

RESEARCH METHOD

Data and Sampling

The empirical analyses employed data of this study were gathered via a mailed survey. The survey covered a wide range of industries including five manufacturing sectors (i.e. electronic equipments, electronic components, consumer goods, vehicles and vehicle parts, apparels, and leather goods), five service sectors (i.e. accounting, advertising and marketing, business logistics, communications, and information technology), and Iranian firms with more than 8 employees. These firms were randomly selected from five provinces (Azerbaijan, Kermanshah, Qazvin, Elam, and Hamadan). The information regarding firm age, number of employees, sales and goods innovation in 2012 were gathered from archival sources and compared with the information from the sampled firms. The data were therefore taken as correctly describing each firm's R&D collaboration with its competitors, and this information was used to test the proposed relationships. Prior to the questionnaire design, a pilot test was designed as semi-structured through 34 random exploratory interviews conducted with executive's business managers. The completed questionnaires were sent to a research team that went through every question to determine whether these managers had understood the questions correctly. Based on their feedback, some final processing of the questionnaire was made to improve the accuracy of the questions. 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 four weeks. They were reminded of the survey and invited to participate in the study. To minimize problems about normal 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. The study employed information on the dependent and independent vari-

Table 1. Key Success Factors in HADR Missions: Summary of Literature Review

Correlation matrix

Variables	Mean	S.D.	1	2	3	4	5	6
New goods	1.00	4.05	1.00					
Co-opetition	0.03	0.05	0.23*	1.00				
Technological capability	0.23	0.42	0.03*	0.03	1.00			
Research collaboration	0.42	1.25	0.15*	0.42*	0.14*	1.00		
Firm age	15.55	15.05	0.04	−0.03	0.03	0.06*	1.00	
Firm size	0.15	0.35	0.07*	0.06*	0.24*	0.22*	0.23*	1.00

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

ables provided by two different respondents from each firm answering at different times. This decreased the risk of normal method bias. After deleting incomplete questionnaires, the final sample comprised of 749 firms (including accounting and related services sectors, advertising and marketing, apparel and leather goods, business logistics services, communication services, consumer goods, electronic components, electronic equipment, information technology services, vehicle and vehicle parts industries). Of the 749 firms, 41 % were of medium size with employees between 50 and 250 people and 48.09% were smaller with less than 50 employees. About 42% had been in business between 5 and 10 years, with another 25.50% aged between 10 and 30 years, 15.59% were older and 17.68% were aged less than 5 years. This study used several statistical techniques to evaluate 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 ($\chi^2 = 14.99$, $p = 0.33$). Second, we followed Wooldridge's (2009) acclaim 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 reduce the concern about possible heteroscedasticity related with pooling of the data (Greene, 1993).

Measures

Goods Innovation

We measured a firm's goods innovation by the number of new goods. Prior studies have shown that the number of new goods successfully introduced to the market is an important indicator of goods innovation (Katila, 2002). Chaney and Devinney (1992) showed that the introduction of new goods increases market share and market value, and Roberts (1999) found that successful new goods introductions increased a firm's performance. Banbury and Mitchell (1995) also suggested that a firm that successfully introduced new goods increased its survival chances.

Dynamic Co-opetition

Quantifying co-opetition requires information about whether a firm engages in parallel competition and collaboration in an alliance, and the length of collaboration in the alliance. Among the competitors identified, they were asked to indicate whether their firm cooperated with any of them in R&D. A

dummy variable co-opetition was then coded 1, or 0 otherwise. Extensive studies have suggested that a firm's disposition to develop its new goods through collaboration with competitors is determined by the competitive intensity (Ritala, 2012; Wu, 2012). The length of collaboration a firm allocates to in an co-opetition relationship was therefore measured as:

$$P(y=1I\times) = G(\alpha+\beta 1 \text{ competitive} + \beta 2 \text{ experience} + \sum_{k=\beta k\ industry}^{12}) \quad 1)$$

Here y is a dichotomous variable reflecting a firm's disposition in developing new goods (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-opetition experience, which was measured by the number of years that a firm formed an 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). Equation (1) reflects the length 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 (Oczkowski, 2002). Previous studies about strong technological capability (Wu and 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. 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. In prior studies about research collaboration (George, Zahra and Wood, 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. 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.

As large firms have more resources to allocate goods innovation (Eisenhardt and Tabrizi, 1995), the study controlled for firm size using the logarithm of the number of employees. Prior studies have provided about the effect of firm age on innovation performance (Sorensen and Stuart, 2000), so the logarithm of firm age was included in the analyses. In addition, because the sample included firms from ten industries, nine industries 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 Qazvin province as the base group in the analysis.

Statistical Modelling

The dependent variable (number of new goods) ranges from zero to a

Table 2. Regression Analysis for Successful New Product Introductions

Variables	M1	M2	M3	M4	M5	M6	M7
Constant	−0.12	−*0.4*	−0.63	−0.72*	−0.72*	−0.72*	−0.75*
	(0.33)	(0.33)	(0.32)	(0.34)	(0.34)	(0.34)	(0.35)
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	0.96***	0.621*	0.63*	0.34	0.34	0.34	0.33
	(0.26)	(0.28)	(0.31)	(0.27)	(0.26)	(0.27)	(0.26)
Advertising and marketing	−0.06	−0.12	−0.23	−0.37	−0.52	−0.38	−0.47
	(0.48)	(0.48)	(0.46)	(0.45)	(0.45)	(0.45)	(0.45)
Apparel and leather goods	−0.28	−0.23	−0.19	−0.22	−0.18	−0.18	−0.19
	(0.48)	(0.53)	(0.53)	(0.52)	(0.53)	(0.54)	(0.52)
Communication services	−0.34	−0.75	−0.79*	−0.73	−0.84*	−0.78	−0.86
	(0.47)	(0.38)	(0.38)	(0.41)	(0.41)	(0.42)	(0.41)
Consumer goods	−0.24	−0.48	−0.46	−0.52	−0.52	−0.51	−0.51
	(0.41)	(0.38)	(0.37)	(0.37)	(0.36)	(0.37)	(0.39)
Electronic components	−0.37	−0.37	−0.37	−0.48	−0.45	−0.49	−0.44
	(0.41)	(0.42)	(0.41)	(0.43)	(0.42)	(0.42)	(0.40)
Electronic equipment	−0.35	−0.43	−0.52	−0.58	−0.66	−0.58	−0.65
	(0.37)	(0.38)	(0.37)	(0.37)	(0.36)	(0.37)	(0.38)
Information technology services	0.06	−0.03	−0.11	−0.17	−0.22	−0.17	−0.22
	(0.38)	(0.42)	(0.42)	(0.43)	(0.43)	(0.43)	(0.43)
Vehicles and vehicle parts	−0.58	−0.687	−0.56	−0.76	−0.77*	−0.75	−0.76*
	(0.37)	(0.37)	(0.36)	(0.38)	(0.37)	(0.38)	(0.39)
Qazvin	0.07	−0.08	−0.12	−0.02	−0.06	0.02	−0.04
	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)	(0.25)
West Azerbaijan	−0.01	0.06	0.11	0.18	0.18	0.22	0.23
	(0.24)	(0.24)	(0.25)	(0.24)	(0.24)	(0.24)	(0.24)
East Azerbaijan	−0.03	−0.05	−0.00	−0.15	−0.14	0.16	0.16
	(0.28)	(0.29)	(0.29)	(0.29)	(0.29)	(0.29)	(0.29)
kurdistan	−0.19	−0.22	−0.12	0.04	0.03	0.03	0.02
	(0.33)	(0.34)	(0.34)	(0.35)	(0.35)	(0.35)	(0.35)
Co-opetition		12.23***	25.86***	25.83***	28.09***	24.34***	27.95***
		(2.08)	(4.57)	(4.55)	(4.78)	(4.54)	(4.99)
Co-opetition^2			−59.62***	−51.67***	−77.18***	−43.89***	−68.95***
			(12.35)	(12.57)	(14.74)	(12.14)	(13.96)
Technological capability				0.36*	0.34*	0.35*	0.35*
				(0.18)	(0.18)	(0.18)	(0.18)
Research collaboration				0.18**	0.19**	0.23**	0.18**
				(0.06)	(0.06)	(0.08)	(0.08)
Co-opetition× Technological capability					−21.85***		−23.48***
					(4.68)		(4.53)
Co-opetition× Research collaboration						−0.77*	−0.84*
						(0.36)	(0.36)
Log-likelihood	−1674.15	−1656.98	−1626.12	−1646.49	−1641.62	−16234.52	−1618.39
AIC	3345.36	3367.89	3345.39	3327.98	3294.89	3288.06	3267.89
BIC	3479.93	3432.78	3422.60	3421.82	3414.64	3410.22	3405.23
d.f.	15	16	17	21	22	22	23
χ^2	31.96	65.17	105.93	105.69	120.99	112.79	114.31
Prob. > χ^2	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Note. N = 749. Robust standard errors are given in parentheses

M 1 includes the controls, M 2 adds the main effect of co-opetition, and M3 includes its squared term. M 4 include the effects of technological capability and collaboration with universities or research institutes (research collaboration), 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.

* 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).

positive value. Such a non-negative dependent variable violates the assumptions underlying linear regression techniques. Therefore negative binomial or Poisson regression models are adopted to deal with such variables. The large variance in the number of new goods that the firms have 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 and 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 firms' characteristics and not governed by the same process at all. We thereby employed zero-inflated negative binomial (ZINB) regression models in the data analysis. We used the number of new goods the firm introduced in the prior year to estimate the zero counts, taking into consideration a possible delay before the effects of co-opetition, technological capability, and research collaboration would be reflected in goods innovation performance.

RESULT AND DISCUSSION

Table 1 reports the descriptive statistics for the variables used in the analyses. A study 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 1.32 to 3.03, well below the cutoff threshold of nine, which indicates that there were no serious multicollinearity problems in the models (Hair, Anderson, Tatham and Black, 1998). Table 2 provides the estimation results testing the hypotheses (M1 includes the controls, M2 the main effect of co-opetition, M4 research collaboration). To reduce multicollinearity problems, the moderator variables were mean-centered before creating the interaction terms (Aiken and West, 1991). 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 compared to the previous ones.

Hypothesis 1 deals with the relationship between co-opetition and good innovation performance. The coefficients of co-opetition in M3 (includes its squared term) and M7 (the full model, including all the variables) is positive and significant ($\beta = 26.87$, $p \leq 0.001$ in M3; $\beta = 27.95$, $p \leq 0.001$ in M7), and the coefficients of (co-opetition) ^{2} are negative and significant ($\beta = -59.62$, $p \leq 0.001$ in M3; $\beta = -68.95$, $p \leq 0.001$ in M7). Therefore, these results support Hypothesis 1; and there is an inverted U-shaped relationship between co-opetition and good innovation performance. Hypotheses 2a and 2b evaluate the moderating effect of firm's technological capability. As M5 (includes the interaction of co-opetition with technological capability) and M7 show, the coefficients of the interaction of co-opetitionwith technological capability are negative and significant ($\beta = -21.85$, $p \leq 0.001$ in M5; $\beta = -23.82$, $p \leq 0.001$ in M7), indicating that strong technological capability weakens the positive

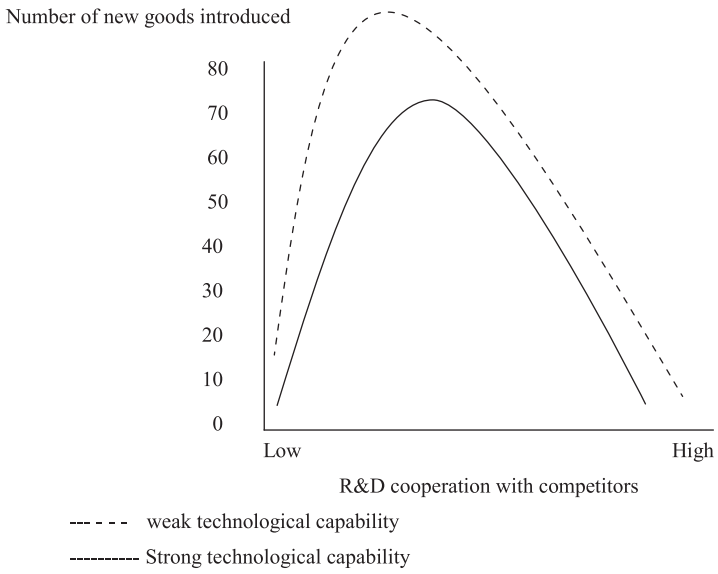

Figure 1. The Impacts of Co-opetition and Technological Capability on Goods Innovation

relationship between co-opetition and good innovation performance.

Figure 1 shows the interpretation effect by using a method from Aiken and West (1991) for the interaction model. In Figure 1 the horizontal axis represents the length of collaboration a firm allocates in its co-opetition with competitors in R&D and the vertical axis represents the number of new goods successfully introduced. The firms were broken into two groups: low (where the technological capability takes the value of 0) and high (where it takes the value of 1). This figure shows that the degree of collaboration with competitors has an inverted U-shaped relationship with the number of new goods successfully introduced. Strong technological capability eliminates the inverted U-shaped effect of collaboration with competitors on the number of new goods introduced. Therefore, hypothesis 2a was rejected and hypothesis 2b was supported. This could reflect the fact that Iranian firms with strong technology have emerged as a local competitor 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.

Hypothesis 3a predicts that the positive relationship between co-opetition and good innovation performance is negatively moderated with a university or research institute collaboration, whereas hypothesis 3b predicts a positive moderation. The coefficients of the interaction term for co-opetition and research collaboration are negative and significant in M6 (includes the interaction term of co-opetition with research collaboration) and M7 ($\beta = -0.77$, $p \leq 0.05$ in M6; $\beta = -0.84$, $p \leq 0.05$ in M7), showing that collaboration with a university or research institute weakens the positive relationship between co-opetition and good innovation. Figure 2 shows the

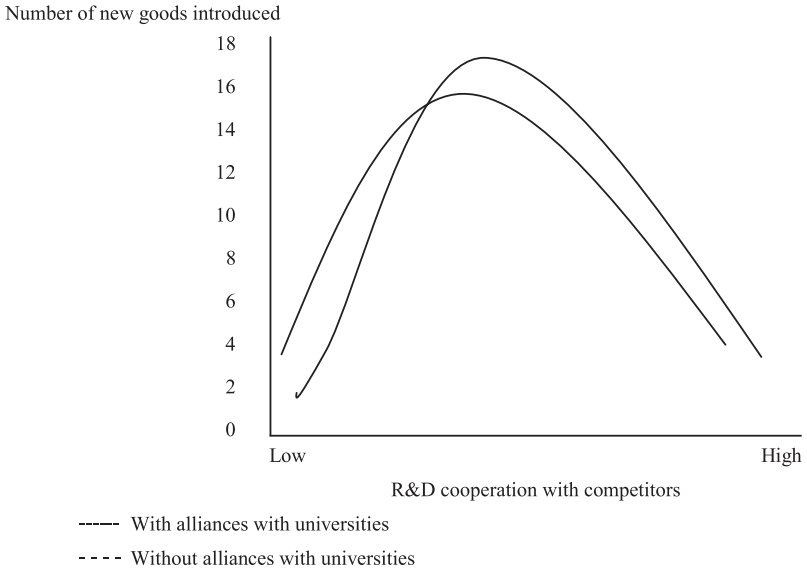

Figure 2. The Impacts of co-opetition and Research Collaboration on Goods Innovation

interpretation effect following the procedure discussed above. The firms were again broken into two groups, those without such alliances (where research collaboration takes the value of 0) and those with alliances (where research collaboration takes the value of 1). This figure again shows that the degree of collaboration with competitors has an inverted U-shaped relationship with the number of new goods. The inverted U-shaped relationship between collaboration with competitors and the number of new goods introduced is stronger for firms without an alliance with a university than for those with alliances. These results support hypothesis 3a, whereas hypothesis 3b was rejected. This could be explained by the imperfect status of the firm–university collaborations in Iran.

To reduce any concerns that the sample contained observations without any new goods, a limited sub-sample constructed was to firms reporting at least one new goods, and the models were then re-estimated with that sub-sample of 432 firms. The results did not change. Another concern could be that while this study used the co-opetition as a predictor variable, all the firms did not have the same chance of cooperating with their competitors. Firms which reported collaboration may be systematically different from those reporting. To reduce this concern, a method was employed to correct this endogeneity problem (Hamilton and Nickerson, 2003). The analysis proceeded in two stages. In the first stage, probit regression was used to estimate the firm engagement in the co-opetition as a function of firm age, and the firm's innovation performance in the previous 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 new best innovation (Hamilton and Nickerson, 2003). The results generated from this two-stage procedure remained consistent with the earlier findings. In addition, manufacturing and service industries may exhibit dif-

ferent innovation patterns (Sirilli and Evangelista, 1998), so an 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.

CONCLUSION

This study hypothesized and empirically showed that collaboration with competitors has an inverted U-shaped relationship with successful goods innovation. Strong technological capability and collaboration with universities or research institutes negatively moderates the relationship between co-opetition and goods innovation success. These results have several important implications. The tension has previously been assumed, but the resulting dynamics have important implications for South East Asian firms regarding firm innovation and performance, which have not been validated before. 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.

This study has addressed two weaknesses in the previous research on co-opetition. First, the tensions arising from parallel collaboration and competition have implications for firm innovation and performance. Second, the limited evidence documented the twin effects of co-opetition on innovation outcomes. The results provide a shad on the balance between competition and collaboration by confirming that collaboration with competitors contributes to successful goods innovation, but also showing its dark side. The positive influences of co-opetition are consistent with the cooperative arguments, that collaboration with competitors increases absorptive capacity, improves information exchange, and facilitates joint problem solving. However the results also show that unnecessary collaboration with competitors can have a negative influence on innovation performance, supporting opportunistic exploitation. The positive and negative influences of co-opetition highlight the need to balance competition and collaboration to optimize innovation returns. This study theoretically explained and empirically demonstrated the moderating effect of firm-specific technological capability on the relationship between collaboration with competitors and innovation performance. This study tested 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 goods innovation is negatively moderated by strong technological capability and alliances with universities. This finding advances the context-dependent view of co-opetition. This study complements such findings by emphasizing the substantive effects of different external linkages in firm goods innovation. 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.

The findings of this study suggest that managers need to pay more attention to how collaboration with competitors can contribute to the success of their firms' goods innovation. Managers thus should realize that collaboration with competitors cannot be unimportant as a moderator in the mechanisms governing business exchanges. They should also revise their logic of competition accordingly by incorporating the logic of collaboration. Managers are encouraged to consider the potential benefits of not only competing with their competitors but also building alliances with them. However, in South East Asian firms, collaboration with competitors needs to be carefully considered because an over-reliance on collaboration in R&D may be just as harmful as endorsing that strategy. Unnecessary collaboration may lead to opportunistic exploitation, and increased rigidity and inefficiency in the innovation process. Therefore, it is critical for a firm to what might be termed an co-opetition capability - a balance between collaboration and competition. The results also show that firms should still aim to develop strong technological capability along with other forms of external linkages between the South East Asian firms and reduce their dependence on others and increase their bargaining power in alliances with competitors. Instead of firm-to-firm competition, collaboration between a pair or small group of competitors may promote group competition, which may be an even more intense form of rivalry.

Like all research, this study has some limitations that 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. The tests performed in this study need to be replicated using data from firms in other countries (e.g. South East Asian 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. It would be interesting to examine vertical ties with customers and/or suppliers to see how firm-specific technological capability, marketing capability or operations capability affect the importance of such ties. Furthermore, further research could examine other aspects of innovation performance, at the South-East Asian firms, such as process innovation.

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