

# Compete at the expense of responsibility? Firm's alliance responsibility in innovation process for SMEs

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**Abstract** This paper attempts to investigate the impact of a firm's social responsibility on its level of competition, cooperation and co-opetition using the game theory approach. We consider a duopoly market that comprises the focal firm which undertakes the responsibility of alliance and peripheral firm that represents all other firms within the technological innovational alliance of Small and Medium Enterprise (SME). Both the focal firm and the peripheral firm conduct technological innovation to overcome the constraints of technology, talent and fund. The study concludes that competitive efforts could substitute alliance responsibility, and cooperation efforts are contingent upon the market demand and/or alliance responsibility.

**Keywords** Small and medium enterprises · Corporate social responsibility · Technology innovation · Game theory · Case study

## Introduction

Corporate Social Responsibility (CSR) expects an enterprise to take responsibility not only for shareholders but also for other people such as employees, consumers and even the environment. CSR is often divided into responsive and strategic responsibility. The former refers to meeting the requirements of stakeholders and taking the responsibility for them, while the latter means investing the critical social factors in terms of philanthropic or other strategic causes, product innovation, technology innovation, and process innovation so as to increase the social and economic outcome

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(Fang 2009). According to Schumpeter (1912), innovation refers to applying factors that have never been used before into the production system, such as introducing new products, new technology and new methods, entering the new market or using the new raw materials. Therefore, both social responsibility and innovation are meant to benefit people, society and environment. On the one hand, the leading firm in the strategic alliance takes more social responsibility and leads its peers in technology innovation. It can be inferred that CSR benefits technology innovation. On the other hand, technology innovation expects firms to consider more for the customer and society, especially making full use of positive rather than negative effects while developing and implementing the new technology or new process. What is the role of alliance's responsibility the leading firm plays? And what is the impact of the leading firm on other firms during the technology innovation? This paper will study such intriguing questions using game theory approach.

The structure of the study is arranged as follows: after reviewing the related literature in the next section, we will model and study the impact of the alliance's responsibility on the competition and/or cooperation adopting a game theory approach based on Ngo and Okura (2008). Following that will be one specific example in China to illustrate the impact. Finally, we draw conclusions, and point out future research direction.

As for the contribution, this paper is the first to analyze the impact of alliance responsibility on the competitive, cooperative and co-opetitive strategy in terms of technology innovation alliance. We are the first to propose that the competitive effort of focal firm is always less than that of the peripheral firm. If two firms compete simultaneously, the alliance responsibility of focal firm could substitute for the competition or cooperation effort, and is contingent upon co-opetition effort. While two firms compete alternatively, the alliance responsibility could usually substitute for cooperative effort, and is contingent upon cooperation and co-opetition.

## Literature review

CSR could be viewed from different perspectives (Freeman 1984; Donaldson and Dunfee 1994; Donaldson and Preston 1995). Carroll and Buchholtz (2000) divided it into economic, legal, ethical and benevolent responsibility. Elkington (1997) proposed three bottom lines approach, which includes economic, environmental and social lines that correspond to three types of corporate social responsibilities. Brummer (1991) classified the CSR into four kinds of responsibilities, i.e., economic, legal, ethical and social responsibilities. No matter how CSR was defined, each dimension affects the firms' behavior, and further its performance as the firm conducts technology innovation.

Technology innovation cannot go without strategy. Previous strategy studies focused more on competitive strategy (e.g., Porter 1985) and the grim competition resulting from the zero-sum games called for positive-sum cooperation in the process of mergers and acquisition (M&A) and strategic alliance. A new type of strategy, co-opetition, which combines the competition and cooperation simultaneously, has been found and implemented in airplane transportation (Chen 1996), IT (Brandenburger and Nalebuff 1996), and technology innovation (Gnyawali and Byung-Jin 2009,

2011). This has drawn attention from both academic and practitioner worlds during the past two decades (Bengtsson and Kock 1996; Chen 2008; Gnyawali and Byung-Jin 2009; Luo et al. 2006; Xu and Xu 2012). In the process of technology innovation, Gnyawali and Byung-Jin (2009) indicated that competition helps increase the input of human resource, fund and technology, while cooperation integrates and complements each other with various resources which otherwise a firm could not access. García and Carlos (2004) suggested that competing with the direct competitors could help a firm acquire the technical knowledge and expertise, as well as expedite knowledge creation and distribution.

Recent research shows that technology innovation has a close relationship with corporate social responsibility. Most research studied the relationship between the CSR and technology innovation in terms of financial performance. MacGregor and Fontrodona (2008) found that CSR is related with technology innovation significantly. Based on a sample of companies with investments in R&D for the 2003–2007 period worldwide and using the bidirectional model, Isabel et al. (2011) found that the effect of the sustainable practices undertaken by companies listed on the Dow Jones Sustainability Index on innovative efforts is statistically less significant and that the relationship between innovation and corporate social responsibility practices depends on the nature of the different sectors. Hull and Rothenberg (2008) examined the possibility that corporate social performance might enhance a firm's financial performance, and this effect may be moderated both by innovation and the level of differentiation in the industry. The results suggest that corporate social performance most strongly affects performance in low-innovation firms. Jiang (2009) and Huang (2010), using a sample of Chinese agriculture firms, analyzed the positive relationship between the CSR and financial performance mediated by the technology innovation. Wu (2009) analyzed the specific mediation in terms of study commitment and shared vision. In fact, the target firms of above analysis so far have focused on large scale enterprises rather than SMEs.

Roughly 99 % of all firms are SMEs. These small and medium sized firms tend to establish the strategic alliance and share the resources within the alliance due to their size and limited technology. It is also found that many SMEs are clustered around the leading firms which have enjoyed comparative advantage of knowledge, technology and talents. The leading firms usually were nominated or recommended to be the focal firm who took more alliance responsibility by leading and coordinating others to conduct technological innovation, which seems to manifest the leading firms' Corporate Social Responsibility (CSR). The question remains how the responsibility of focal firm influences the technology innovation of its partners? In other words, what is the impact of alliance responsibility on the competitive, cooperative or co-opetive strategy? This paper attempts to throw some light on this question.

## Model and analysis

There are several approaches to conduct the technology innovation research, such as the normative analysis, empirical study and model building (e.g. Aspremont and Jacquemin 1998; Krishnamurthy 1999; Dearden and Lilien 2001; Bárcena and Garzón 2003; Ngo 2006; Ngo and Okura 2008). Ngo and Okura (2008) specifically

analyzed the strategy variance and its influence on the revenue when two firms made their competition decision at the same time. Based on Ngo and Okura (2008), this paper attempts to study and compare the impact of the alliance responsibility on the firms' effort in competition, cooperation and co-competition when two firms make their competition decision alternatively and simultaneously.

### The framework of analysis

Many small and medium enterprises produce similar products, or provide similar services in a local or regional market, and they usually form the strategic alliance to conduct technology innovation. Among these firms, one acts as “quasi-public enterprise” (Ngo and Okura 2008), as it not only takes part in the competition but also takes responsibility of leading, advancing and promoting the technology progress. As for other enterprises, they cooperate with each other to pursue the mutual interest, and compete with each other to pursue their own interests. Due to the similar strategy and status in the technology alliance, technology innovation of SMEs could be simplified as the game with two players, the focal firm and peripheral firm who conduct the technological innovation by means of competition and cooperation (Merrill and Schneider 1966; Harris and Wiens 1980; Bös 1991; Vickers and Yarrow 1988; De Fraja and Delbono 1990). The focal firm undertakes alliance responsibility, and the peripheral firm takes no responsibility. On account of different cost and effort of competition and cooperation, both utility functions vary differently which triggers the difference of cooperative and competitive strategy accordingly.

For simplicity, suppose two firms play a three-stage game. In the first stage, two firms cooperate to enlarge the market size for the mutual interest. In the second stage, two firms compete simultaneously or alternatively for the benefits of themselves, and in the third stage, two firms either cooperate or compete for their benefits, hence we have the strategic path of “cooperation—competition—cooperation/co-competition.”

Following the Ngo and Okura (2008), both firms cooperate to enlarge the market in the first stage. Let  $a$  be the initial demand without any cooperative effort,  $\lambda_1$  and  $\lambda_2$  denotes the cooperative effort of focal and peripheral firm, respectively. For the convenience of calculation, suppose the enlarged market size is as the same as the effort, so the overall market is  $a + \lambda_1 + \lambda_2$ , accordingly, the inverse demand function is  $p(\cdot)$ , where  $p = p(a + \lambda_1 + \lambda_2)$ .

In the second stage, both firms choose their competitive effort  $\theta_1$  and  $\theta_2$ , respectively, where  $0 \leq \theta \leq 1$  holds. Usually, competitive effort could be classified as low level ( $0 \leq \theta \leq 1/2$ ) and high level ( $1/2 < \theta \leq 1$ ). Due to the fact that the market share is usually the result of competition, the market share of focal and peripheral firm denoted by  $s_i$  is as follows:

$$s_i = \begin{cases} 1/2 & \text{where } \theta_1 = 0, \theta_2 = 0 \\ \theta_i / (\theta_1 + \theta_2) & \text{otherwise} \end{cases}$$

The competition and cooperation ask for resources input which is also the coordinating cost determined by the effort and difficulty of competition and cooperation denoted by  $k_\theta$  and  $k_\lambda$ , respectively. For the convenience of comparison, we use the

same functions,  $C_{\theta_i} = k_{\theta}\theta_i$  and  $C_{\lambda_i} = k_{\lambda}\lambda_i^2$  as Ngo and Okura (2008) did, so the revenue function for both firms is as follows.

$$\pi_i = (p - c)(a + \lambda_1 + \lambda_2) \frac{\theta_i}{\theta_1 + \theta_2} - k_{\theta}\theta_i - k_{\lambda}\lambda_i^2$$

According to the assumption, the peripheral firm takes no responsibility in the alliance, its revenue is just its utility; as for the focal firm, it not only cares individual revenue, but the total revenue of technology alliance also, so its utility function is  $U_1 = \alpha W + (1 - \alpha) \pi_1$ , where  $W$  represents the alliance surplus, the parameter  $\alpha \in (0, 1)$  refers to the alliance responsibility of the focal firm.

Now let's study the surplus of alliance. On account of the total market capacity, the revenue of technology innovation alliance is  $\int_0^{a+\lambda_1+\lambda_2} p(q) dq$ , the alliance direct cost is the product of cost and market size, and indirect cost is the sum of competitive and cooperative cost, so the surplus of alliance can be written as  $W = \int_0^{a+\lambda_1+\lambda_2} p(q) dq - c(a + \lambda_1 + \lambda_2) - k_{\theta}(\theta_1 + \theta_2) - k_{\lambda}(\lambda_1^2 + \lambda_2^2)$ . Thus, the utility function of focal firm is as follows:

$$U_1 = \alpha W + (1 - \alpha)\pi_1 = \alpha \left( \int_0^{a+\lambda_1+\lambda_2} p(q) dq - c(a + \lambda_1 + \lambda_2) - k_{\theta}(\theta_1 + \theta_2) - k_{\lambda}(\lambda_1^2 + \lambda_2^2) \right) + (1 - \alpha) \left( (p - c)(a + \lambda_1 + \lambda_2) \frac{\theta_1}{\theta_1 + \theta_2} - k_{\theta}\theta_1 - k_{\lambda}\lambda_1^2 \right)$$

### Two firms compete simultaneously

When two firms compete simultaneously, according to Ngo and Okura (2008), the competition effort is  $\theta_1^{cs} = (1 - \alpha)^2 \Delta / k_{\theta}(2 - \alpha)^2$  and  $\theta_2^{cs} = (1 - \alpha)\Delta / k_{\theta}(2 - \alpha)^2$ , respectively, where  $\Delta = (p - c)(a + \lambda_1 + \lambda_2)$ , the superscript *cs* denotes *two firms compete simultaneously*. It is not difficult to find that  $\theta_1^{cs} = (1 - \alpha)\theta_2^{cs}$ , which means that the competitive effort of focal firm is less than that of peripheral firm; maybe it is the alliance responsibility that distracts the energy of focal firm.

Differentiating the cost of competition effort with respect to  $\alpha$  yields  $\partial\theta_1^{cs} / \partial\alpha = -2(1 - \alpha)\Delta / k_{\theta}(2 - \alpha)^3$  and  $\partial\theta_2^{cs} / \partial\alpha = -\alpha\Delta / k_{\theta}(2 - \alpha)^3$ . We could find that no matter what about the alliance responsibility,  $\partial\theta_i^{cs} / \partial\alpha < 0$ . This is to say, when alliance responsibility  $\alpha$  increases, the competitive effort of both firms decreases accordingly. This result is plausible.

In the third stage, two firms choose either cooperation or co-opetition. Once choosing cooperation, we could get the cooperation effort by maximizing the expected revenue of both firms,  $\lambda_1^{ts} = \frac{(1-\alpha)^2}{2k_{\lambda}(2-\alpha)^2} \Omega + \frac{\alpha(p-c)}{2k_{\lambda}}$  and  $\lambda_2^{ts} = \frac{1}{2k_{\lambda}(2-\alpha)^2} \Omega$ .

Where  $\Omega = p' \cdot (a + \lambda_1 + \lambda_2) + p - c = p \left( \left(1 - \frac{1}{e}\right) - c \right)$ ,  $e = -\frac{\partial(a+\lambda_1+\lambda_2)}{\partial p}$ .  $\frac{p}{a+\lambda_1+\lambda_2}$  is the price elasticity of demand. Ngo and Okura (2008) proved that  $\lambda_1^{ts} > \lambda_2^{ts}$ , which means that the cooperation effort of focal firm is always larger than that of

peripheral firm, which is consistent with the reality. Maybe the focal firm is always to try coordinating or communicating with the rival which in turn consumes lots of effort of cooperation.

Differentiating the cost of cooperation effort with respect to  $\alpha$  yields  $\frac{\partial \lambda_i^{ts}}{\partial \alpha} = \frac{-(1-\alpha)}{k_i(2-\alpha)^3} \Omega + \frac{p-c}{2k_i}$  and  $\frac{\partial \lambda_i^s}{\partial \alpha} = \frac{1}{k_i(2-\alpha)^3} \Omega$ , respectively. To maximize the effort of cooperation, we could get up to four intervals in which the cooperative effort of focal firm varies positively or negatively with the alliance responsibility, whereas the cooperative effort varies positively with the alliance responsibility if the price elasticity of demand is sufficient, and vice versa.

Now let's turn to co-opetition. If two firms co-opete rather than cooperate in the third stage, to differentiate the competition effort with respect to cooperation effort, respectively, we could find the variance of direction as  $\frac{\partial \theta_1^{fs}}{\partial \lambda_1^{ts}} = \frac{\partial \theta_1^s}{\partial \lambda_2^s} = \frac{(1-\alpha)^2}{k_\theta(2-\alpha)^2} \Omega$  and  $\frac{\partial \theta_2^s}{\partial \lambda_2^{ts}} = \frac{\partial \theta_2^{fs}}{\partial \lambda_1^{ts}} = \frac{(1-\alpha)}{k_\theta(2-\alpha)^2} \Omega$ . Now let's discuss what will happen next.

If the price elasticity of demand is insufficient, it is easy to know  $\Omega < 0$ ,  $\partial \theta_i^{ts} / \partial \lambda_i^{ts} < 0$  and  $\partial \theta_i^{ts} / \partial \lambda_j^{ts} < 0$ , which means both efforts spent by the same or different firm are substitute; it is concordant with our institution. Given the total energy of the firm, the more the competition effort, the less the cooperation effort for the same firm, and vice versa. And we find further that the competitive effort of one firm is substitute to the cooperation effort of the other, that is to say, the more the cooperation effort of focal firm, the less the competitive effort of peripheral firm, and vice versa. This is easy to understand, that focal firm chooses more competitive effort means peripheral firm chooses more competitive effort too, because of the given energy of peripheral firm, more competitive effort means less cooperative effort accordingly.

On the contrary, if the demand function is sufficiently price elastic, it is easy to find  $\Omega > 0$ , then we have (1)  $\partial \theta_i^{ts} / \partial \lambda_i^{ts} > 0$ ,  $i=1,2, j=1,2$ , which implies both kinds of effort spent by a firm are complements; (2)  $\partial \theta_i^{ts} / \partial \lambda_j^{ts} > 0$ , means both types of effort spent by two different firms are complements also, in other words, the more the competition effort for one firm, the more the cooperation effort for the other firm, and this contradicts to our intuition. Usually, the competition and cooperation are considered as two extreme situations, a higher level of competition inevitably leads to a lower level of cooperation. While on the scenario of co-opetition, whether the relationship between the competition and cooperation is positive or negative depends on the price elasticity of demand absolutely.

The focal firm competes first

Ngo and Okura (2008) assumed two firms compete simultaneously; in fact, most often they make competition decision alternatively, its decision is thus based on the action of peripheral firm so as to maximize its utility, so we have the effort of competition as  $\theta_1^{ff} = \frac{(1-2\alpha)^2 \Delta}{4k_\theta(1-\alpha)^2}$ ,  $\theta_2^{ff} = \frac{(1-2\alpha)\Delta}{4k_\theta(1-\alpha)^2}$ , where the superscript *cf* stands for case in which the focal firm competes first. Obviously,  $\theta_1^{ff} = (1 - 2\alpha)\theta_2^{ff}$ ,  $\theta_1^{ff} < \theta_2^{ff}$ .

The highlight for the management is that if the focal firm competes first, its competitive effort is less than that of the peripheral firm.

To differentiate the effort of competition with respect to the alliance responsibility, we have  $\frac{\partial \theta_1^{ff}}{\partial \alpha} = \frac{2\alpha - 1}{2k_\theta(1-\alpha)^3} \Delta$  and  $\frac{\partial \theta_2^{ff}}{\partial \alpha} = \frac{-\alpha}{2k_\theta(1-\alpha)^3} \Delta$ . It follows that (1) for the focal firm, if it takes higher alliance responsibility, saying,  $1/2 < \alpha < 1$ , we have  $\partial \theta_1^{ff} / \partial \alpha > 0$ , which means the alliance responsibility is substitute to its competitive effort. Why? Given the higher alliance responsibility, the focal firm should work hard so as to thrive for itself and the others as well. If the alliance responsibility is lower,  $0 < \alpha < 1/2$ ,  $\partial \theta_1^{ff} / \partial \alpha < 0$ , which means under such circumstance, the higher the responsibility, the lower the competitive effort.

(2) For the peripheral firm, no matter what about the alliance responsibility, we always have  $\partial \theta_2^{ff} / \partial \alpha < 0$ , which means the alliance responsibility of focal firm is substitute to competitive effort of peripheral firm. Actually, the alliance responsibility is not very higher,  $0 < \alpha < 1/2$ , so  $\partial \theta_i^{ff} / \partial \alpha < 0$  stands for both firms, we have the following proposition.

**Proposition 1:** Given the focal firm competes first, its competitive effort is substitute (complementary) to (with) higher (lower) alliance responsibility. While for the peripheral firm, its competitive effort is always substitute to the alliance responsibility.

What about the impact of alliance responsibility on cooperation effort? Similarly, we could get the cooperation effort for both firms as  $\lambda_1^{ff} = \frac{\alpha}{2k_\lambda} (p - c) + \frac{(1-2\alpha)^2}{8k_\lambda(1-\alpha)} \Omega$  and  $\lambda_2^{ff} = \frac{1}{8k_\lambda(1-\alpha)^2} \Omega$ . To differentiate the cooperation effort with respect to alliance responsibility, we have  $\frac{\partial \lambda_1^{ff}}{\partial \alpha} = \frac{(1-2\alpha)(2\alpha-3)}{8k_\lambda(1-\alpha)^2} \Omega + \frac{p-c}{2k_\lambda}$  and  $\frac{\partial \lambda_2^{ff}}{\partial \alpha} = \frac{1}{4k_\lambda(1-\alpha)^3} \Omega$ . It is easy to find that the cooperation effort depends not only on price elasticity of demand but also on the alliance responsibility for the focal firm, whereas for the peripheral firm, only on the price elasticity. So we have the proposition as following.

**Proposition 2:** Given the focal firm competes first, for the focal firm, the relationship between the competitive effort and alliance responsibility mediates by both the price elasticity of demand and alliance responsibility, while for the peripheral firm, the relationship only by the price elasticity of demand.

If the two firms co-opete rather than cooperate in the third stage, what about the relationship between the effort of cooperation and the effort of competition? Similarly, we have  $\frac{\partial \theta_1^{ff}}{\partial \lambda_1^{ff}} = \frac{\partial \theta_1^{ff}}{\partial \lambda_2^{ff}} = \frac{(1-2\alpha)^2}{4k_\theta(1-\alpha)^2} \Omega$  and  $\frac{\partial \theta_2^{ff}}{\partial \lambda_2^{ff}} = \frac{\partial \theta_2^{ff}}{\partial \lambda_1^{ff}} = \frac{1-2\alpha}{4(1-\alpha)^2} \Omega$ .

It follows that, (1) for the focal firm, the co-opetition behavior depends on the price elasticity of demand. If the price elasticity is insufficient, we always have  $\partial \theta_1^{ff} / \partial \lambda_i^{ff} < 0, i=1, 2$ , which means the competitive effort of focal firm is substitute to the cooperation effort of both firms. On the contrary, if the price elasticity is sufficient, we could come to the opposite conclusion.



(2) For the peripheral firm, given the focal firm takes higher alliance responsibility, that is to say,  $1/2 < \alpha < 1$ , then  $\partial\theta_2^{ff} / \partial\lambda_i^{ff} > 0, i=1,2$ , which means that the competitive effort of peripheral firm is complementary with its cooperative effort of both firms. Similarly, we have the following proposition.

**Proposition 3:** Given the focal firm competes first, the relationship between its competitive effort with both cooperative efforts depends only on the price elasticity of demand; while for the peripheral firm, on both the price elasticity demand and alliance responsibility.

The proposition above highlights that the focal firm had better adjust its competition strategy to the market situation, whereas for the peripheral firm, the adjustment depends on both the market and alliance responsibility, which is consistent with reality.

The peripheral firm competes first

If the peripheral firm competes first, its decision making is on the basis of the potential behavior of focal firm who compete afterwards. Similarly, the competitive effort for both firms is  $\theta_1^{pf} = \frac{(1-\alpha)^2\Delta}{k_\theta(2-\alpha)^2}$  and  $\theta_2^{pf} = \frac{(1-\alpha)\Delta}{k_\theta(2-\alpha)^2}$ , where the superscript *pf* means the *peripheral firm competes first*. Obviously, these are the same with the results when two firms compete simultaneously. Why? Although so many firms unite together to compete with the one focal firm, it seems like all the firms make their decision at the same time. Whether this is true or not, it needs to be studied further.

Comparing the equation  $\theta_1^{pf} = (1-\alpha)\theta_2^{pf}$  and  $\theta_1^{ff} = (1-2\alpha)\theta_2^{ff}$  which denoting the scenario of competition effort while the focal firm competes first, we could come to the conclusions as following. Firstly, no matter who competes first, the competitive effort of focal firm is less than that of peripheral firm; secondly, due to the fact  $(1-2\alpha) < (1-\alpha)$ , compared with the peripheral firm, the competitive effort of focal firm when it competes first is less than that of the peripheral firm when it competes first.

Similar with the case of two firms compete at the same the time, we have  $\frac{\partial\theta_1^{pf}}{\partial\alpha} = -\frac{2(1-\alpha)\Delta}{k_\theta(1-\alpha)^3}$  and  $\frac{\partial\theta_2^{pf}}{\partial\alpha} = -\frac{\alpha\Delta}{k_\theta(1-\alpha)^3}$ . It's easy to find that  $\partial\theta_1^{pf} / \partial\alpha < 0, \partial\theta_2^{pf} / \partial\alpha < 0$ , which means the competitive effort for both firms is substitute to the alliance responsibility, which yields the following proposition.

**Proposition 4:** Given the peripheral firm competes first, both competitive efforts are substitutes to the alliance responsibility regardless of the firm.

Next, we could calculate the cooperative effort for both firms as  $\lambda_1^{pf} = \frac{\alpha}{2k_\lambda} \times (p-c) + \frac{(1-\alpha)(1-3\alpha+\alpha^2)}{2k_\lambda(2-\alpha)^2} \Omega$  and  $\lambda_2^{pf} = \frac{1}{2k_\lambda(2-\alpha)^2} \Omega$ . To calculate the first order condition of both cooperative efforts, we have  $\frac{\partial\lambda_1^{pf}}{\partial\alpha} = \frac{1}{2k_\lambda}(p-c) + \frac{\alpha^3-6\alpha^2+12\alpha-6}{2k_\lambda(2-\alpha)^2} \Omega$  and  $\frac{\partial\lambda_2^{pf}}{\partial\alpha} = \frac{1}{k_\lambda(2-\alpha)^3} \Omega$ , respectively, and it is not difficult to find that  $\frac{\partial\lambda_1^{pf}}{\partial\alpha} = \frac{\partial\lambda_2^{pf}}{\partial\alpha}$ . Accordingly, we come to the following conclusions: (1) the cooperative effort of



focal firm is independent with that of peripheral firm; (2) for the focal firm, the impact of alliance responsibility on its cooperative effort depends on both the responsibility and price elasticity of demand; whereas for the peripheral firm, the impact only on market demand.

**Proposition 5:** Given peripheral firm competes first, the impact of alliance responsibility on the cooperative effort of focal firm depends on both price elasticity of demand and alliance responsibility, and while for the peripheral firm, it depends only on the price elasticity of demand.

If the two firms co-opete rather than cooperation, we could obtain  $\frac{\partial \theta_1^{pf}}{\partial \lambda_1^{pf}} = \frac{\partial \theta_1^{pf}}{\partial \lambda_2^{pf}} = \frac{(1-\alpha)^2}{k_\theta(2-\alpha)^2} \Omega$  and  $\frac{\partial \theta_2^{pf}}{\partial \lambda_2^{pf}} = \frac{\partial \theta_2^{pf}}{\partial \lambda_1^{pf}} = \frac{1-\alpha}{k_\theta(2-\alpha)^2} \Omega$ . It follows that if the price elasticity of demand is sufficient, both efforts spent by the same or different firm are complements; as for the insufficient elasticity, both efforts are substitute. So we have the following proposition.

**Proposition 6:** Given the peripheral firm competes first, both efforts taken by the same or different firm is mediated by price elasticity of demand only.

Based on three situations pertain to who competes first shown as Appendix 1, we could compare different efforts and the impact of alliance responsibility on competition, cooperation and co-opetition, respectively, which benefits for academic researcher as well as for practitioner.

### Example of technology innovation alliance

We will illustrate what the technology innovation alliance of SMEs looks like and how the alliance responsibility influences the strategy of firms using the example of Yanjiang knife and scissor alliance in Guangdong province, China.

The history of Yangjiang knife and scissor could date back to 1,400 years ago. It was well known before the establishment of China, P. R., 1949, and has been developing extraordinarily fast because of the country's reform and open policy during the past three decades. The leading firm of the alliance, SHIBAZI Group takes most alliance responsibility, and many small firms gather around it. Because the quality of steel failed to meet the requirement of special knife and scissor, and the steel plants didn't produce the high-quality steel, SHIBAZI decided to build the steel plant and refine the steel itself. Although not a rational decision, SHIBAZI Group was determined to do it because of its alliance responsibility. "If I don't go to hell, who will?" the chairman of SHIBAZI said, "being a pioneer of Chinese knife and scissor, we have the responsibility to promote advanced technology and handicraft. We have and should take such a great responsibility" (Wang and Ren 2008, pp162). Once the steel plant was put into operation, it provided supplies to itself and other firms within the alliance, and even other firms located in other region. At that time, SHIBAZI seldom applied for the intellectual patent to protect its technology and/or know-how. On the contrary, SHIBAZI let others use them for free (Wang and Ren 2008, pp166–168).

Using archival data one can outline three stages of development for the companies (SHIBAZI a 2003; Wu et al. 2005, pp133). The first stage began from the early 1983 to the middle of 1990s, the second stage from the middle of 1990s to the early of 2000s, and the third from the early of 2000s till now.

The first stage began in the early days of national economic reform. Most firms made the knife or scissor just for the peasants nearby, though some took advantage of convenient transportation and marketing in the east coast of China. At that time, many firms mainly competed. With the gradual establishment of market system, the local government encouraged the firms to unite to strengthen the knife and scissor industry. As a matter of fact, a so-called union was built under the guidance of government. It was just nominal alliance, and the firms made their decisions actually by themselves without thinking about other firms. Especially those state-owned enterprises had no incentive to cooperate with the rivals because of too much burden they would take (in some senses, such a burden is just their social responsibility). The more burden there is, the less the effort devoted to the market competition.

During the second stage, the SHIBAZI, which was the leading firm after 10 years of competition, produced cutting-edge knives and scissors in the local and national market (SHIBAZI b 2004). The knife and scissor alliance was gradually established. Being a pioneer in the industry, SHIBAZI invented many new products and built the steel plant at that time. During the first half of the second stage, SHIBAZI took more alliance responsibility by leading other firms, and it showed less of competitive effort than other members of the alliance members. In the second half of the stage, it paid less attention as more firms were engaged in the technology innovation. For other firms, as many managers said, their competitive effort is just opposite to the responsibility. This is partially illustrated in the case of Proposition 1.

What about the cooperation and/or co-opetition? Annual reports and transcripts from visiting with senior managers suggested that both cooperation effort of SHIBAZI and other firms depended mainly on the market demand. It supports partially the proposition 2 and 3. As for whether the alliance responsibility works or not, it was not clear.

During the third stage, with more firms conducting the technology innovation and many launching new products, SHIBAZI most often was the spiritual leader and lagged behind others in innovation. It was other firms rather than focal firm that led the competition. As some managers recalled, both firms have less incentive to compete with the rival if SHIBAZI took more social responsibility, which seems to support the proposition 4. As for the cooperation and co-opetition effort, most managers said that nearly all the effort depended on the demand of market regardless the firms, which seems to support proposition 5 and 6.

## Discussion

Based on Ngo and Okura (2008), we use a game theory approach to model the competition and cooperation between the leading firm and peripheral firm along their

technology innovation alliance process. We developed a total of six propositions on co-competition and its impact on firms' social responsibilities. To further the topic, future studies could either simply convert our propositions into hypotheses and test them, or develop several more-specific hypotheses from our propositions. For example, from Proposition 1 we could have Hypothesis 1a and 1b as:

- Hypothesis 1a If the focal firm competes first, the relationship between its competitive effort and the alliance responsibility is U-curve shaped.
- Hypothesis 1b If the focal firm competes first, the competitive effort of peripheral firm decreases with the alliance responsibility.

Similarly, we could get two or more hypotheses from other propositions shown in Appendix 2.

As far as the method of testing propositions/hypothesis is concerned, both case study and empirical research will be viable options. Case study is commonly recognized as a method of understanding specific phenomena, especially at the beginning stage of the process (Eisenhardt 1989). Case studies are a popular research methodology when organizations or programs often are so new that little information exists (outside the organization) regarding the workings and impacts of the organization. The cases are often seen in understudied areas such as high-tech industries. Individual pieces of the topics (e.g. the competition and/or cooperation and firms alliance, entrepreneurial firms and social responsibility) have been studied here and there. However, putting them together in a Chinese context has been rare to our knowledge. Therefore, case study will likely serve well to help us explore the understudied phenomenon proposed in this paper.

Potential topics for a case study could include how a specific company and other companies in the clusters compete and cooperate with each other, and how this impacts their social responsibilities. To make the case study as effective and efficient as possible, the investigator could follow the guidelines set up by previous researchers (e.g., Stake 2005, p460) and address the following issues: (1) how much to make the report a story; (2) how much to compare with other cases; (3) how much to formalize generalizations or leave such generalizations to readers; (4) how much description of the researcher to include in the report; and (5) whether or not and how much to protect anonymity (Stake 2005, p460). In the process of a case study, the investigator should also be aware of what Guba and Lincoln (1981) called "the unusual problems of ethics" and try to have less bias.

Future research on the topic could also use empirical analysis. Investigators could collect data from many Science and Technology Parks, such as ZJ Innopark in Shanghai and Zhongguancun Park in Beijing. These are government-sponsored parks and research results might generalize to other state-owned enterprises in the country. Another type of firms, called the National Science and Technology Parks of Universities (NSTPU), are sponsored by some well-known universities. As of 2012, there were at least 39 such Science and Technology Parks in China. Of the firms located in NSTPU, most focus on technological innovation where firms compete and cooperate at the same time. Oftentimes, there is one leading firm in the

alliance who undertakes more alliance responsibility to help others speed up the product or service innovation. These firms will make great samples for future studies on the topics suggested in this study. If possible, longitudinal studies could be conducted using these firms over a period several years to get a better picture on how firms change their social responsibilities over time in a dynamic cooptation context. Specifically future studies may want to look at how individual firms progress on their way to become more or less socially responsible and why this occurs. For instance, in 12 months, 24 months, 36 months, 48 months and 60 months respectively, a survey can be sent to some random samples in such parks across the country.

Empirical research will to a large extent rely on self-report data. Whitley (2001) summarizes three potential limitations. A basic issue is people's ability to make accurate self-reports. A second limitation is that people might not be willing to make totally accurate reports. Finally, self-reports depend on the verbal skills of the respondents. In other words, people's ability, willingness and verbal skills may impact the validity of self reports. Given the relatively lower education level of many Chinese entrepreneurs (Djankov et al. 2006), the first and the third limitation might play a role in this study. Given the tradition that Chinese government has had enormous control on everything, people may tend not to tell what they really think.

Besides contributions to the academic world, our study will also benefit the practitioners. Based on our models, practicing managers could decide their roles as the leading firm or the peripheral firm based on their ambitions of social responsibilities. They could also forecast their ability to practice social responsibilities from their orientation on competition and cooperation. Finally, a firm could also use our propositions to help them decide on the extent to which they could or are willing to compete and cooperate with other firms.

## Conclusion

Based on the assumption of Ngo and Okura (2008), this paper studied the impact of alliance responsibility on the competitive effort, cooperative effort and co-opetition from game theory approach. We draw some conclusions as (1) the competitive effort of focal firm is always less than that of the peripheral firm; (2) if two firms compete alternatively, the impact of alliance responsibility on competition and cooperation depends on the responsibility and market; and the relationship between the competitive effort and cooperative effort is contingent upon the market and alliance responsibility alike, which is almost concordance with the scenario of two firms competing simultaneously. The results pertaining to different competition orders are shown in Appendix 2. The discussion and further direction of research are also pointed out. However this paper is just based on the game theory approach which conceptually models the impact of alliance responsibility on competition, cooperation and co-opetition. Whether and how it is applicable to reality needs to be empirically tested.

**Appendix 1**

**Table 1** The comparison of the impact of the alliance responsibility on the competition, cooperation and co-opetition

	Two firms compete simultaneously	Focal firm competes first	Peripheral firm competes first
Competitive effort	$\theta_1$	$(1 - \alpha)^2 \Delta / k_{\theta}(2 - \alpha)^2$	$(1 - \alpha)^2 \Delta / k_{\theta}(2 - \alpha)^2$
	$\theta_2$	$(1 - \alpha) \Delta / k_{\theta}(2 - \alpha)^2$	$(1 - \alpha) \Delta / k_{\theta}(2 - \alpha)^2$
	$\theta_1 / \theta_2$	$1 - \alpha$	$1 - \alpha$
Cooperative effort	$\lambda_1$	$(1 - \alpha)^2 \Omega / 2k_x(2 - \alpha)^2 + \alpha(p - c) / 2k_x$	$\alpha(p - c) / 2k_x + (1 - \alpha)^2 \Omega / 8k_x(1 - \alpha)$
	$\lambda_2$	$\Omega / 2k_x(2 - \alpha)^2$	$\Omega / 2k_x(2 - \alpha)^2$
Impact on competition	$\lambda_1 / \lambda_2$	NA	NA
	$\partial \theta_1 / \partial \alpha$	<0	<0
Impact on cooperation	$\partial \theta_2 / \partial \alpha$	<0	<0
	$\partial \lambda_1 / \partial \alpha$	Depending on price elasticity of demand and alliance responsibility	Depending on price elasticity of demand and alliance responsibility
Impact on co-opetition	$\partial \lambda_2 / \partial \alpha$	Depending on price elasticity of demand	Depending on price elasticity of demand
	$\partial \theta_1 / \partial \lambda_1$	Substitute (sufficient), complementary (insufficient)	Institute (sufficient), complementary (insufficient)
	$\partial \theta_2 / \partial \lambda_1$	Substitute (sufficient), complementary (insufficient)	Institute (sufficient), complementary (insufficient)

For reference the Ngo and Okura (2008) while two firms compete simultaneously

Where  $\Omega = p((1 - 1/e) - c)$ ,  $\Delta = p(-c)(a + \lambda_1 + \lambda_2)$

## Appendix 2 Examples of hypotheses derived from propositions 2 to 6

From the proposition 2, we could come to the hypothesis 2a and 2b as follows.

- Hypothesis 2a: If the focal firm competes first, the competitive effort of focal firm is the function of the price elasticity of demand and alliance responsibility.
- Hypothesis 2b: If the focal firm competes first, the competitive effort of peripheral firm is the function of price elasticity of demand.

Due to the different level of market demand and alliance responsibility, we have the six hypotheses from the proposition 3.

- Hypothesis 3a: If the focal firm competes first, the price elasticity of demand mediates the relationship between the competitive effort and cooperative effort of focal firm.
- Hypothesis 3b: If the focal firm competes first, the price elasticity of demand mediates the relationship between the competitive effort of focal firm and cooperative effort of peripheral firm.
- Hypothesis 3c: If the focal firm competes first, the price elasticity demand mediates the relationship between the competitive effort and cooperative effort of peripheral firm.
- Hypothesis 3d: If the focal firm competes first, the price elasticity demand mediates the relationship between the competitive effort of peripheral firm and cooperative effort of focal firm.
- Hypothesis 3e: If the focal firm competes first, the alliance responsibility mediates the relationship between the competitive effort and cooperative effort of peripheral firm.
- Hypothesis 3f: If the focal firm competes first, the alliance responsibility mediates the relationship between the competitive effort of peripheral firm and cooperative effort of focal firm.

From the proposition 4, we could have hypothesis 4a and 4b.

- Hypothesis 4a: If the peripheral firm competes first, the competitive efforts of focal firm decreases with the alliance responsibility.
- Hypothesis 4b: If the peripheral firm competes first, the competitive effort of peripheral firm decreases with the alliance responsibility.

Similarly, the hypotheses 5a and 5b could be deduced from proposition 5 as follows.

- Hypothesis 5a: If the peripheral firm competes first, the cooperative effort of focal firm depends on alliance responsibility and price elasticity of demand.
- Hypothesis 5b: If the peripheral firm competes first, its cooperative effort depends on alliance responsibility and price elasticity of demand.

Finally, we could get the hypotheses 6a, 6b 6c and 6d as follows.

- Hypothesis 6a: If the peripheral firm competes first, the price elasticity of demand mediates the relationship between the competitive effort and cooperative effort of focal firm.

- Hypothesis 6b: If the peripheral firm competes first, the price elasticity of demand mediates the relationship between the competitive effort of focal firm and the cooperative effort of peripheral firm.
- Hypothesis 6c: If the peripheral firm competes first, the price elasticity of demand mediates the relationship between the competitive effort and cooperative effort of peripheral firm.
- Hypothesis 6d: If the peripheral firm competes first, the price elasticity of demand mediates the relationship between the competitive effort of peripheral firm and cooperative effort of focal firm.

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