

Co-opetition and Technological Innovation in Small and Medium-Sized Enterprises: A Multilevel Conceptual Model

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Small and Medium-Sized Enterprises (SMEs) face tremendous challenges in their attempt to pursue technological innovations. This paper argues that co-opetition strategy—simultaneous pursuit of competition and collaboration—helps SMEs to develop their ability to effectively pursue technological innovations. We developed a multilevel conceptual model consisting of factors at the industry, dyadic, and firm level to understand the drivers of co-opetition and discuss benefits and costs of co-opetition for SMEs. We believe that this paper will stimulate future conceptual and empirical research on this important topic and has implications for SME managers and policymakers.

The phenomenon of co-opetition, that is, simultaneous cooperation *and* competition between firms, has become increasingly popular in recent years (Gnyawali, He, and Madhavan 2008, 2006; Chen 2008; Luo 2007; Ketchen, Snow, and Hoover 2004; Bengtsson and Kock 2000). Research shows that over 50 percent of collaborative relations (strategic alliances) occur between firms within the same industry or among competitors (Harbison and Pekar 1998). Recent business press (Coy 2006, pp. 96–97) sug-

gests that “Sleeping with the Enemy” or learning to work with rivals is becoming very important. As SAP CEO Henning Kagermann stated, “power of co-opetition will only grow as products become more complex and as competition widens globally” (Coy 2006). Co-opetition helps to increase technological diversity and combine complementary resources of rival firms in developing new technologies and products (Quintana-García and Benavides-Velasco 2004). Co-opetition seems to be

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particularly important for innovation in industries that are knowledge-intensive, dynamic, and complex (Carayannis and Alexander 1999).

The importance of co-opetition seems to be even greater in the context of Small and Medium-Sized Enterprises (SMEs). As technological battles have intensified and technologies have become more complex, SMEs face numerous challenges such as rising R&D costs, high risk and uncertainty in technological development, as well as a lack of resources to pursue large-scale innovation projects (BarNir and Smith 2002; Gomes-Casseres 1997). Recently, scholars have suggested that SMEs in an industry need to collaborate with competitors so that they can create economies of scale, mitigate risk, and leverage resources together (Morris, Kocak, and Özer 2007). Competitors are likely to face similar challenges and possess resources and capabilities that are directly relevant to each other as they have high market commonality and resource similarity (Chen 1996). SMEs could more effectively compete against large players if they collaborate with each other (competitors) and access, acquire, and use relevant resources held by each other. Along those lines, some scholars suggest that SMEs' tendency to engage in co-opetition is likely to positively relate to financial performance (Levy, Loebbecke, and Powell 2003). Thus, though the importance of co-opetition as a strategy for SMEs has been recognized, much of the current research on co-opetition has focused mainly on large companies and neglects the SMEs. Therefore, we know very little about drivers and consequences of co-opetition in SMEs. An examination of co-opetition is important for the literature on SMEs for two major reasons. First, because it is an emerging concept with increasing practice in high-technology sectors, a basic understanding of co-opetition and its implications

helps to stimulate and advance co-opetition research in the context of SMEs. Second, managers of SMEs need to be prepared to face opportunities and challenges wrought by the increasing popularity of co-opetition and prepare themselves accordingly. Managers need to pay attention to the forces in their industries that may lead to co-opetition in their industry, be proactive and adept in pursuing co-opetition, and benefit from it. Availability of a conceptual framework is a natural starting point to more systematically examine co-opetition in SMEs and to provide practical guidelines for managers. Accordingly, the goal of this paper was to develop a conceptual framework that helps to understand factors influencing co-opetition strategies in SMEs and implications of co-opetition in the context of technological innovation.

We built several of our conceptual arguments using the resource-based view (RBV), game theory, and network theory. Developing and leveraging resources is a key goal of co-opetition; the RBV therefore provides a useful lens for developing arguments related to resources and technologies. Because a win-win relationship is critical for SMEs, we discuss the issues of partners' goal alignment and balance of value creation (common benefits) and value appropriation (private benefits) based on the game theory (Brandenburger and Nalebuff 1996). Perspectives of the network theory help to explain and articulate how to access and extend knowledge and resources outside the firm, how to leverage them, and what types of relations are appropriate for doing so.

This paper makes several noteworthy contributions. First, it helps to understand major industry-level forces that may be driving co-opetition for technological innovation in a particular industry. Second, it identifies and articulates several key factors that increase the likelihood of a given pair of firms engaging

in co-opetition to pursue technological innovations. It also explains firm-specific drivers and illustrates benefits and challenges. Third, the paper provides practical guidelines to managers of SMEs in their efforts to understand co-opetition and devise their co-opetition strategy. Finally and more broadly, we not only encourage SME managers to consider co-opetition as a key part of their strategic agenda but also provide ideas for analyzing their industry and competitors to better understand the forces of co-opetition and their effects. We suggest that SME managers need to monitor and analyze environmental changes to assess the need to engage in co-opetition and, if co-opetition is intensifying in the industry, they should explicitly consider competitors when pursuing technology-intensive alliances.

Conceptual Background **Challenges of SMEs and the Importance of Co-opetition**

Research suggests that SMEs face numerous challenges. Morris, Kocak, and Özer (2007, p. 38) argue that “compared to their medium- and large-sized counterparts, small ventures are more vulnerable to environmental forces.” Sources of vulnerability include a niche customer base, limited market presence, and demand fluctuations. Similarly, Winch and Bianchi (2006) demonstrate that SMEs, due to their limited resources and capabilities, face numerous pressures in their R&D and innovation efforts. Strategic collaborations are very important for technological development because small firms cannot develop technologies on their own due to high costs, uncertainties, and risks involved in the process. As a result of such challenges, scholars have suggested that collaborative relationships and networks play an important role in the strategy and performance of SMEs. Alliances help SMEs improve their capability to outmatch a stronger competitor, help facilitate entry

into new markets, and provide access to external resources (BarNir and Smith 2002). Merrifield (2007) is even more forceful and suggests that collaborations are critical for the survival of SMEs.

An early discussion of collaboration among competitors in SMEs was provided by Gomes-Casseres (1997). He argued and demonstrated through examples that firms that are small relative to their rivals need to form alliances with each other so that they can achieve economies of scale and scope in R&D, as well as work together to develop technological standards. He argued that Mips Computer Systems, a small firm employing less than 1,000 people, was able to take on well-established players such as IBM and Hewlett-Packard by creating a constellation consisting of several small semiconductor firms in the reduced instruction-set computing industry. More recent research suggests the need for SMEs to collaborate with competitors to create economies of scale, mitigate risk, and leverage resources (Morris, Kocak, and Özer 2007). Eikebrokk and Olsen (2005) demonstrate empirically that co-opetition in e-business helps SMEs to enhance the novelty of their business and to combine complementary strengths in products and technologies. With a focus on the development of institutional standards, Mione (2008) argues that small firms work together to create common norms and technologies and compete against each other to promote their own technologies and products. Finally, Levy, Loebbecke, and Powell (2003) suggest that SMEs’ tendency to engage in co-opetition is likely to positively relate to financial performance.

Taken together, these studies suggest that SMEs need to be very strategic in their approach to collaboration and suggest the importance of collaborating with competitors as a key strategy for technological innovation and for bottom-line performance of SMEs. Strictly speaking, co-opetition means to

simultaneously collaborate and compete with the same partners at the same time (Gnyawali, He, and Madhavan 2008; Luo 2007). More broadly, however, the notion of co-opetition includes collaboration at one time and competition at a different time with the same competitor or collaboration with some competitors to develop strengths to compete against other competitors. For example, Lechner, Dowling, and Welpel (2006) insist that a firm can use competitors as subcontractors (collaborate with them) when it has temporarily reached full capacity. Firms can form alliances with competitors in order to handle large projects. Using longitudinal data of bidding contracts in the Taiwan simulator industry, Chien and Peng (2005) demonstrate that companies compete against each other while bidding, and after they win the bid they cooperate and work together to complete the projects. While co-opetition in the SMEs context thus far seems to be in rather basic forms such as constellations or networks (Gomes-Casseres 1997), subcontracts of large projects, and cross-licensing of technologies, SMEs in the future are likely to be involved in collaborating and competing simultaneously with the same partners, either with other SME competitors or with bigger competitors. Also, because of changing dynamics in high-technology sectors, collaborative relationships and networks may become more co-opetitive, which means that the networks will include direct competitors or that some existing collaborators may become competitors over time. While co-opetition is a rather complex strategy, SMEs might be able to pursue this strategy more easily than can bigger companies because unlike large firms, SMEs can experiment with new business models because they are less constrained by existing structure and formal procedures and policies. Also, if SMEs use the strategy wisely, co-opetition may be a useful risk management tool when

uncertainties of markets and technologies are high.

Co-opetition for Technological Innovation

Jorde and Teece (1990) discussed the importance of collaborating with competitors for technological development. They suggested that the simultaneous innovation model (as opposed to the traditional serial model) "recognizes the existence of tight linkages and feedback mechanisms which must operate quickly and efficiently, including links between firms..." (p. 77). The simultaneous innovation model provides a foundation for understanding why competitors need to bring together each other's resources to pursue innovations. With a focus on the informal exchange of technology among competing firms, Von Hippel (1987) suggested that collaboration for knowledge sharing among competitors occurs when technological progress may be faster with collective efforts rather than through individual efforts, when combined knowledge offers better advantages than does solo knowledge, and when solo knowledge does not provide any major competitive advantage. As a result, co-opetition is likely when technological standards are being developed and when combining multiple bodies of knowledge provides more advantages than solo knowledge does.

More recently, Quintana-García and Benavides-Velasco (2004) empirically showed that collaboration with direct competitors is important not only in acquiring new technological knowledge and skills from the partner but also in creating and accessing other capabilities based on an intensive exploitation of existing ones. Powell, Koput, and Smith-Doerr (1996) argue that a network of external linkages serves as a locus of innovation because it provides timely access to knowledge and resources that are otherwise unavailable. Senior executives seem to be paying greater

attention to co-opetition. For example, Morgenstern (2006) reports that in the semiconductor industry, with the complexity of technologies, rising costs, and shrinking product life span, co-opetition might be a viable strategy for lowering cost and boosting production speed.

The previous review suggests that SMEs face numerous challenges and that SMEs may benefit by collaborating with competitors in order to develop their ability to compete in their industries. Moreover, the challenges seem to be even greater when SMEs try to pursue innovation and new technology development, hence the need to pursue co-opetition to develop their ability to innovate. Three critical issues suggest the importance of SMEs' cooperation with competitors as opposed to any kind of cooperation: first, competitors are likely to have relevant resources and capabilities because they operate in similar markets. Second, because SMEs face resource constraints and a strong threat from large competitors, it makes sense for them to collaborate with each other to overcome the resource constraint and develop a collective ability to compete. Finally, SMEs with similar products and technologies (i.e., competitors) can work together to create common technologies and a uniform voice in the marketplace.

Theoretical Frameworks Related to Co-opetition

The following three theoretical streams provide the conceptual basis to discuss co-opetition: RBV including the knowledge-based view, game theory, and network theory. Based on the RBV framework, Lado, Boyd, and Hanlon (1997) propose a syncretic model, arguing that "success in today's business world often requires that firms adopt both competitive and cooperative strategies simultaneously." The best partner for a firm in a strategic alliance is sometimes one of its strong competitors. The

dynamic capability-based perspective, focusing on how asset stocks are accumulated, mobilized, and deployed to generate a sustainable competitive advantage (Lado, Boyd, and Wright 1992; Nelson 1990), provides a basis upon which to examine the accumulation of resource stocks, such as technological resources and capabilities, through both competition and collaboration (Lado, Boyd, and Hanlon 1997).

Game theory provides another conceptual lens with a dynamic picture of the interactive process of cooperation and competition (Gnyawali, He, and Madhavan 2008; Clarke-Hill, Li, and Davies 2003). Diverging from the pure competitive perspective of game theory, Brandenburger and Nalebuff (1996) illustrated how a firm can use game theory to achieve positive-sum gains by changing the players, the rules of the game, and the scope of the game. Cairo (2006) says that the co-opetition approach in business relies on the premise that companies' activities involve two central elements—creating value and capturing value. The former refers to the establishment of new or the enlargement of existing value, whereas the latter refers to the "dividing up of the pie." Brandenburger and Nalebuff (1996) emphasize that the recognition of these two different processes requires companies to adapt a new mindset. A win-win approach is the most effective way to create a large pie and, in turn, obtain a bigger slice (Cairo 2006). Firms should seek out opportunities to create new values together, achieve synergy effects, and make a positive sum game (Zineldin 2004).

Network theory also provides very useful explanations. Cooperative ties with competitors provide a firm with opportunities to learn about its partners (as well as indirectly about the partners' partners) and afford access to resources of the partners and their partners (Powell, Koput, and Smith-Doerr 1996). Scholars have noted that external

resources are critical in shaping a firm's competitive behavior and suggest that the following three types of resource flows take place between partners: information flows, asset flows, and status flows (Gnyawali and Madhavan 2001). Moreover, firms differ in their ability to access and use external resources. Though rivals are expected to be cautious in entering into cooperative ties and sharing resources, which could possibly dampen asset flow, partnerships will mean some access to each other's resources, which enables better-positioned firms to more swiftly access network-based resources and use them to aggressively pursue competitive opportunities (Gnyawali and Madhavan 2001). As collaborative relationships become more popular, scholars suggest that firms need to orchestrate their network of relationships and leverage network resources so that they can create and extract value from the network (Dhanaraj and Parkhe 2006). Gnyawali, He, and Madhavan (2006) examined co-opetition and its effects using the network perspective and empirically found that differential network configurations and structural positions among firms in a co-opetitive network reflect resource asymmetries among them and that such asymmetries lead to differences in firm competitive behavior.

Conceptual Framework and Propositions

In the following discussion, we draw upon the literature reviewed previously to develop our conceptual arguments and propositions. As noted earlier, the notion of co-opetition is rather broad, so we focus on why and how SMEs that are currently competing against each other are likely to collaborate for technological innovation. It is important to emphasize that the context of this conceptual development is technological innovation. The conceptual model and propositions

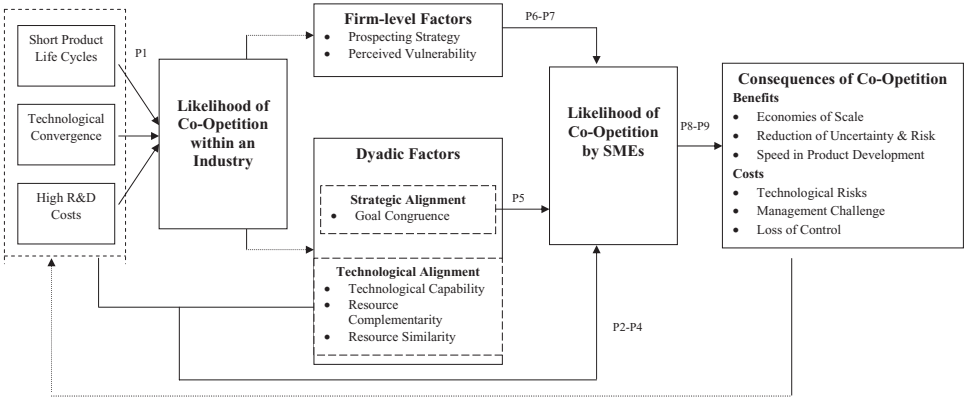
relate mainly to the industry context and SMEs that are experiencing rapid technological changes and the need to develop capability to innovate and successfully bring new technologies to the market.

Figure 1 depicts the multilevel conceptual model developed in this paper. A multilevel model is particularly useful as it provides a richer and deeper portrait of organizational phenomena (Klein, Tosi, and Cannella 1999) and allows an integrated inquiry on the topic (Kostova 1999). Such a model also allows us to more deeply investigate the complex, multifaceted, and paradoxical nature of co-opetition (Chen 2008). As indicated in Figure 1, we argue that increasing R&D costs, shrinking product life cycles, and convergence of technologies are the main drivers of co-opetition in a given industry. By building on the notions of resource complementarity and resource pooling, we suggest that the interface of industry factors and dyadic factors determines the likelihood of a given pair of firms to engage in co-opetition. At the firm level, we suggest that SMEs that are very proactive in building technological strengths or feel challenged by large players are likely to engage in co-opetition. We argue that co-opetition brings several benefits—mainly speed of product development, economies of scale, and reduction of uncertainty and risk in technology development. At the same time, co-opetition is costly as it creates the risk of technology leakage, brings unique management challenges, and can lead to the loss of control. In the following sections, we develop our conceptual arguments and offer propositions.

Industry Forces Shaping the Likelihood of Co-opetition

The term "likelihood of co-opetition" refers to the probability that SMEs that have traditionally competed against each other will collaborate for technological purposes. Based on two major criteria,

Figure 1
Co-opetition for Technological Innovation in SMEs:
A Conceptual Framework



SME, Small and Medium-Sized Enterprise.

we identify three key relevant industry-level factors that tend to increase the likelihood of co-opetition among SMEs. First, because we are focused on the high-technology context, the constructs should represent key technological changes. Second, for modeling the multilevel phenomenon, the interplay of industry factors and pair-level or dyadic factors is an important consideration. Based on prior research (Sampson 2007; Palmberg and Martikainen 2006; Quintana-García and Benavides-Velasco 2004; Chen and Li 1999), we identify three major forces that are likely to shape co-opetition in high-technology industries: short product life cycle, convergence of technologies, and increased costs of R&D. We selected two dyadic factors based on Emden, Calantone, and Droge (2006): partner technological alignment and partner goal alignment. We first discuss the role of industry factors and then discuss the interplay of industry and dyadic factors.

Short Product Life Cycles. Research shows that product life cycles are dramatically shrinking (Chen and Li 1999), mainly because of rapidly changing customer preferences as well as the speed and magnitude of technological changes. Speed-to-market is becoming more and more essential to new product success (Lynn and Akgün 1998). Oxley and Sampson (2004) suggest that profitability depends critically on firms' abilities to create and commercialize new technologies quickly and efficiently. Short product life cycles require companies to reduce time-to-market in order to launch their products at the right time to get reasonable profits during the useful lifetime of a product. As a result, the likelihood of cooperation with competitors having excellent exploration capabilities increases. Gnyawali, He, and Madhavan (2006) suggest that co-opetitive networks might provide benefits of reducing time-to-market through earlier access to technology and information.

Technological Convergence. Technological convergence refers to the presence of a vast array of different types of technologies to perform similar tasks and the trend of technologies to merge into new technologies that bring together a myriad of media. Game theory (Brandenburger and Nalebuff 1996) provides a useful basis for understanding how technological convergence leads to changes in the players, the rules of the game, and the scope of the game. First, convergence may demand more complex, broad, and sophisticated technical developmental tasks (the scope of the game). Due to high uncertainty in terms of both market and technology, companies tend to increase diversity; therefore, reducing failure rate is a key factor in the formation of alliances. SMEs will therefore need to look for partners that have complementary resources and expertise. Second, technological convergence offers companies opportunities to set industry standards (the rules of the game). Research suggests that competitors (especially first movers) can cooperate with each other to win in a battle for industry standards (Gomes-Casseres 1994) and create industry-wide norms (Mione 2008). But an SME, due to its weak position in the industry compared to a large firm, has difficulty in pushing its technology to achieve the industry standard alone. Working with other firms within the industry therefore seems to be a useful way for SMEs to develop, push, and aim to raise the quality of the technology to make it more competitive for the industry standard. Third, when technologies are converging, SMEs may cooperate with previous competitors that have relevant technologies to deal with the threat of large firms entering their industry (the change of players). New opportunities created by convergence may also cause previous collaborators to become competitors, thereby increasing the chance of co-opetition.

High R&D Costs. Average R&D intensity (R&D expenditures as percent sales) is very high in high-technology sectors such as pharmaceuticals and biotechnology, software and computer services, and technology hardware (DIUS 2008). Massive R&D costs provide a strong incentive for companies to cooperate with competitors with a large resource base. Creating a co-opetitive relationship is an effective way to combine R&D expenses and expertise (Zineldin 2004). Small firms on their own cannot spend a large amount of money and resources on R&D, especially when the outcomes are uncertain. Working together with other competitors with similar resources is an effective way to pursue large-scale R&D projects and share risks associated with the technologies.

Overall, most SMEs, given their constraints in financial and technological resources and lack of market strength, cannot address the previously mentioned challenges by just using their own limited resources and capabilities. Therefore, SMEs have to reach out to their competitors who have the requisite resources and capabilities and are willing to collaborate to address the challenges. Resources and capabilities of competitors are likely to be directly relevant to each other, and the common challenges they are facing could be minimized by working together. Therefore, we propose that

P1: SMEs operating in industries characterized by short product life cycle, technological convergence, and high R&D cost are more likely to engage in co-opetition than SMEs operating in other industries.

A logical question, then, is what factors make two existing competitors in an industry collaborate with each other? We suggest that the answer lies at the interplay of industry forces discussed earlier and partner-specific factors such

as the technological capabilities and goal alignment of potential partners. The propositions focus on the most relevant combinations of the industry forces and dyadic factors.

Partners' Technological and Strategic Alignment as Dyadic Forces

As noted earlier, it is very costly to develop new products or technologies, both of which seem to mature and “die” rather quickly. As a result, competing firms are forced to bring together their mutual resources and competencies and combine them to speed up the product development task and to develop unique products or technologies. However, co-opetitive relations are not easy and involve high costs and risks. Firms therefore need to consider critical factors when selecting their competitor-partners. By building on Emden, Calantone, and Droge (2006), we suggest that a firm's decision to collaborate with a particular competitor will depend on the technological alignment in terms of technological capability, resource complementarity, and resource similarity and the interplay of the technological factors with the industry factors discussed earlier.

Technological Capability. Emden, Calantone, and Droge (2006) suggest that the potential partner's unique competencies, such as innovative technology and expertise in a certain field, are very important factors in partner selection. This is consistent with the RBV, which claims that firms search for partners who have unique technological resources (Barney 1991) that they can leverage (Hitt et al. 2000). In the RBV, a desire of participants to acquire capabilities from an external source is the primary motive for the formation of alliances (Das and Teng 1998; Mowery, Oxley, and Silverman 1998) and for the selection of specific alliance partners (Hitt et al.

2000). Resources and capabilities, especially when they are tacit and complex, cannot be easily traded through market channels; therefore, alliances and other interfirm collaborative mechanisms are devices that enable firms to gain access to these capabilities (Mowery, Oxley, and Silverman 1998; Barney 1991; Kogut 1988).

Partnering with competitors having strong technological capabilities seems to be especially critical when the window of time-to-market is rather short, making it difficult for a single firm to develop the technology on its own in a timely manner. A company might be motivated to collaborate with a competitor when it faces gaps in critical capabilities that are too expensive or will take too long to develop internally but the potential partner has the requisite capabilities. Because close competitors have a high degree of market commonality and resource similarity (Chen 1996), they are likely to have resources and capabilities that are highly relevant to each other. Research shows that upstream alliances have become quite popular in the semiconductor industry as they help to develop a firm's technological capability and ability to quickly bring products to market (Roberts 2005).

Partners' technological capabilities seem to be critical for SMEs as well. In the biotech industry, for example, small firms seeking strategic alliances were more likely to be motivated by R&D time-span reduction than larger firms (McCutchen and Swamidass 2004). When firms have limited time available for pursuing R&D, they will be more motivated to combine each other's expertise and resources and work together for the common goal. It is important to note that larger firms are also competitors if they are in the same industry and that the trend of co-opetition may cause large firms to change their partners from SMEs to other large firms. Therefore, SMEs will get fewer opportunities to cooperate

with larger firms; that may mean that either they should partner with other SMEs or develop technologies internally. Collaboration with competitor-SMEs with capabilities will provide them better opportunities for competing (or catching up) with larger firms and for attracting better potential partners in the future. Therefore, we propose that

P2: In industries characterized by short product life cycle, SMEs are likely to collaborate with competitors having strong technological capabilities.

Resource Complementarity. Research indicates that resource complementarity is crucial for collaborative success (Bleeke and Ernst 1991; Harrigan 1985) mainly because of synergy and economies of scope. Partners with complementary resources can combine their strengths and create synergy, and engage in codevelopment of new products and technologies. Hagedoorn (1993) proposes that R&D alliances can be most beneficial in unrelated diversification toward complementary, noncore fields. Research on new product development suggests that significant innovations are likely to emerge from a combination of complementary skills (Glaister 1996). Emden, Calantone, and Droge (2006) insist that the potential partners should have technical resources that are distinct yet complimentary to one another for the opportunity foreseen, which would allow the partners to exploit or to create opportunities by integrating their complementary skills and resources. Based on their analysis of joint ventures with convergent (the parent firms' intangible skills become alike) and divergent (the parent firms' intangible skills become dissimilar yet complementary) developments, Nakamura, Shaver, and Yeung (1996) demonstrate that partner competitive capabilities become dissimilar but complementary in long-lasting joint ventures.

Resource complementarity is important for several reasons. First, due to reciprocal commitment, partners with complementary resources are less likely to be opportunistic with each other and learn more from the relationship (Sarkar et al. 2001). Second, though rapid convergence of technologies adds risk and uncertainty to firms, collaboration with competitors having complementary resources is likely to help firms mutually reduce the risks and uncertainties by working together. Research shows that because the information and communication technologies are converging, firms in these industries tend to seek R&D alliances with firms having complementary resources (Palmberg and Martikainen 2006). Quintana-García and Benavides-Velasco (2004) suggest that collaboration with direct competitors contributes to technological diversity and adoption of a complementary approach to product development. Third, in emerging industries, companies (especially first movers) will search for opportunities to set the standards, and they are more likely to cooperate with competitors having complementary resources to win battles with other competitor groups.

In the context of SMEs, the combination of complementary resources and expertise and cocreation of new technologies are likely to help SMEs create synergy and face the stronger and larger rivals. Similarly, SMEs can reduce uncertainty by increasing the business scope through partners' complementary resources. Unlike large firms, SMEs tend to be specialized rather than diversified in their technological competencies and product range (Tidd, Bessant, and Pavitt 2005) and therefore have a greater need to look for partners with different but complementary capabilities, especially when the technologies are converging. Based on the previous reasoning, we propose that

P3: In industries characterized by technological convergence, SMEs are likely to collaborate with competitors that have complementary resources and technologies.

Resource Similarity. Resource similarity, or the extent to which resources of potential competitors overlap in various dimensions, is an important determinant for co-opetition for several reasons. First, resource similarity helps to increase the economies of scale in technological development. As technologies become more complex and sophisticated, firms need more resources, including financial resources and human resources, to develop technologies. As noted earlier, due to high market commonality and resource similarity between competitors, resources and capabilities of competitors are directly relevant to each other. Therefore, competitor firms can pool their resources and capabilities to pursue common projects. Also, competitors typically have common interests in developing certain technologies and therefore may be ready to invest a substantial amount of money in the projects.

Lechner, Dowling, and Welpé (2006) argue that relationships with competitors can give access to temporarily needed resources or enable them to pool resources. After developing the technologies through cooperation, the participating firms might compete to commercialize the technologies in the final market. R&D cost, one of the main determinants of co-opetition as discussed earlier, can be shared if each partner can jointly invest and benefit from the economies of scale in R&D. Research by Miotti and Sachwald (2003) shows that high cost is a main determinant of R&D cooperation among rivals. In high-tech contexts, the costs of product development and manufacturing are prohibitive for small firms. "With the cost of a new fab heading above \$3 billion, manufacturers needed to find ways to quickly recoup

the investment in the plant. And a solution to the challenge of this quick production cycle: 'co-opetition,'" said DuBois, vice president of Strategic Projects at STMicroelectronics Group (Morgenstern 2006).

Second, resource similarity is important in sharing risks in technological development. In many industries, standardization limits the possible paths for future technologies, and so firms concentrate their R&D activities on the same fields (Kultti, Takalo, and Toikka 2006). Though multiple firms might be pursuing a particular technology for patenting, a patent for the same development is granted to only one firm, and therefore, other firms' efforts to develop the same technology will not lead to fruition. Working together on key technological developments can help to share costs and risks in the process of technological development.

Third, resource similarity is essential for partner search and subsequent organizational learning and knowledge transfer. Similarity of resources provides the necessary common ground to realize the technology's potential and to communicate with each other (Emden, Calantone, and Droge 2006). Mowery, Oxley, and Silverman (1998) argue that alliances that focus on joint R&D or product development should involve firms with ex ante technology-based capabilities that are similar in scale and scope and that technology-based alliances are likely to favor the choice of partners with similar technological portfolios. Further, the notion of relative absorptive capacity suggests that some similarity between partner firms' knowledge and knowledge-processing systems is critical for partners to learn from each other and take advantage of the collaboration (Lane and Lubatkin 1998; Mowery, Oxley, and Silverman 1996).

It is important to note that resource similarity can increase the threat of a partner's opportunistic behavior, but

research suggests that this threat can be mitigated by reducing the alliance scope and by having joint ventures as opposed to nonequity alliances (Oxley and Sampson 2004). Based on the previous reasoning, we propose that

P4: In industries characterized by high R&D costs, SMEs are likely to collaborate with competitors having similar or overlapping resources.

The earlier discussion focused on key aspects of technological alignment as a key driver for SMEs' collaboration with competitors. In addition, we suggest that strategic alignment is a critical factor in determining the likelihood of collaboration among two competitor SMEs. We focus on goal congruence as a key strategic factor.

Goal Congruence. Goal congruence refers to the extent to which firms in a co-opetitive relationship believe that they can gain a competitive advantage from the relationship. Such an advantage can stem from pursuing common benefits (or enlarge the size of the pie, enabling all involved parties to reap benefits), or some unique benefits to the individual partners, which may or may not be applicable to the other party. An example of the former is the creation of a new technological standard by working together, and an example of the latter is the partners' beliefs about how much they can individually benefit from the newly created standard. Though technological alignment is very important in increasing the probability of having a co-opetitive relationship for technological purposes, strategic alignment is necessary to ensure that the technological goals are compatible with strategic goals. Because alliances with competitors are likely to have a very high threat of opportunistic behavior, which is often a cause of their inherent instability (Das 2004), rivals

are unlikely to collaborate without being sure that the collaboration will help their strategic priorities.

As noted earlier, co-opetition is based on the premise that companies' activities involve two central elements: creating value and capturing value. Brandenburger and Nalebuff (1996) emphasize that a win-win approach is the most effective way to create a large pie and, in turn, obtain a bigger slice. Creating value is an inherently cooperative process, whereas capturing value is inherently competitive (Luo 2005). This issue of creating and dividing up the pie makes the process of co-opetition quite uncertain and dynamic. Hamel, Doz, and Prahalad (1989) argue that "the partner's strategic goals converge while their competitive goals diverge," which is one of the conditions under which mutual gain is possible. Further, Morris, Kocak, and Özer (2007) also argue the importance of mutual gain, especially when collaboration involves resources the firms will acquire or the market position they will assume.

The issue of strategic alignment or balance of value creation and appropriation is especially critical when SMEs partner with larger firms because as research shows, SMEs are often in danger of being appropriated by larger firms (Alvarez and Barney 2001) and of losing control (Gomes-Casseres 1997; Forrest 1990). The dangers will be even greater when SMEs collaborate with competitive large firms; therefore, SMEs pursuing co-opetition strategies will have to seriously consider potential value creation and appropriation.

A different way of looking at goal congruence or strategic alignment is the situation where net benefits of co-opetition outweigh costs. This can be examined in several ways, such as more value creation and more value appropriation, same value creation but more value appropriation, or more value appropriation by a focal firm than that by the

partners. It is important to note that more value appropriation by the focal firm does not necessarily mean loss to its partner. Firm A's value appropriation does not have to be at the expense of firm B's value appropriation. If firm A has more relevant internal resources and capabilities and can more effectively blend and bundle external and internal resources, then it will more likely benefit greatly from the partnership. In the meantime, firm B will be better off through the co-opetition but not as much as firm A will. In this scenario, both firms A and B are likely to have congruence of goals for the partnership, albeit the extent of benefits will be different.

Based on the previous reasoning, we believe that SMEs may form co-opetitive relationships when they predict a positive gain from the relationship after considering both value creation and value appropriation. We therefore propose that

P5: The likelihood of co-opetition by SMEs will be high when the degree of goal congruence or mutual value creation is high or when partners believe that they can appropriate more value from the relationship.

Firm-Level Factors as Drivers of Co-opetition

We focus our discussion of firm-level drivers on two key aspects, one proactive and one reactive: prospecting strategy and perceived vulnerability. As we explain in the following discussions, the proactive reason is to advance the focal firm's own competitive position and gain greater bargaining power in the relationship, whereas the reactive reason is to reduce its strategic vulnerability in its market.

Prospecting Strategy. Firms with prospecting strategies, that is, those that strive to be the first mover or close follower in their industry, are likely to constantly look for opportunities for

co-opetition so that they can combine their resources and capabilities with those of others to create and maintain their competitive advantage in the industry. Firms with prospecting strategy will be motivated to form ties with competitors for three reasons: a strong desire to learn, to increase and solidify bargaining power, and to increase overall competitive capability. Firms will be greatly motivated to learn from their competitors because competitors possess valuable knowledge. The mainstream organizational literature (Gnyawali and Stewart 2003; Grant 1996; Nonaka 1994) suggests that learning and generating knowledge are important to the creation of competitive advantage. Because knowledge is a critical determinant of firm bargaining power (Mudambi and Navarra 2004), firms will be motivated to collaborate with some competitors to increase their bargaining power against others. An SME can increase its bargaining power vis-à-vis other firms when its stock of knowledge and its knowledge creation capabilities are higher compared to its partners. Combined with the idea that both inducements and opportunities influence a firm's alliance formation (Ahuja 2000), co-opetition may provide the focal firm with better potential partners and enhanced bargaining power to the potential partners in the subsequent alliance opportunities. If a small firm can effectively learn through co-opetitive ties, it can become a better partner and avail itself of more attractive opportunities in the long run. A prospecting firm often looks for opportunities to enhance its knowledge, bargaining power, and overall capabilities so that it can become more successful in competing against larger rivals.

Overall, a firm with prospecting strategy is likely to be proactive and engage in innovative projects, which will call for more knowledge-seeking and knowledge-building initiatives. Because prospectors continuously develop their

market and knowledge domains (Miles and Snow 1978), SMEs pursuing prospecting strategy usually engage in processes of exploration and attempt to build links with a range of external knowledge providers (Zhang, MacPherson, and Jones 2006). As we discussed earlier, knowledge and capabilities of competitors are likely to be directly relevant due to high market commonality between them. Therefore, all else being equal, a firm with prospecting strategy will attempt to collaborate with competitors to learn from them and enhance its competitive strengths. Therefore, we propose that

P6: A firm pursuing a prospecting strategy is more likely to engage in co-opetition than other firms.

Perceived Vulnerability. Vulnerability as a driver for the formation of co-opetitive ties can originate from a company being challenged with a reduction in its competitive advantage, which, in turn, may endanger its profitability and reputation in the short run and/or its sustained survival in the long run. Vulnerability can stem from both external and internal sources. External vulnerability can arise if new competitors are entering the market or if the firm itself is trying pioneering technologies (Eisenhardt and Schoonhoven 1996). Internal vulnerability can occur due to poor performance relative to targets set by the firm (March and Simon 1958) or due to lack of resources. In addition, vulnerability can be in both absolute and relative terms. A firm may not be able to achieve its intended or specified performance outcomes (absolute vulnerability) or the performance may be worse than its peers or worse than its own prior performance (relative vulnerability). Because each firm operates in unique environments, the dynamics of its competitors, suppliers, customers, or other industry factors create pressures

that play a key role in affecting the focal firm's vulnerability.

Then the natural question will be "Who will cooperate with highly vulnerable firms?" This is especially critical when a firm's attractiveness to potential partners depends on the value that it can add to the partnership (Ahuja 2000). As discussed earlier, firms in partnerships should be able to provide technological capabilities, complement each other's technological needs, or share costs for technological development. Vulnerability does not necessarily mean the firm has no resources or capabilities, but instead suggests that the firm feels challenged and needs to do something in response to the challenge and therefore looks for opportunities. Also, firms may feel vulnerable in a certain area while having competencies in other areas. For example, the firm feeling vulnerable, say firm A, can be an attractive partner as long as firm B benefits from what A has to offer or A and B collectively create new technologies. To confront large dominant firms, vulnerable SMEs may join hands with each other and try to develop collective capability by pooling their resources and expertise. Because SMEs are more vulnerable compared with large firms as discussed earlier, this perceived vulnerability is a very critical factor driving co-opetition in SMEs.

Another question will be "Who may take advantage of the vulnerability?" The answer will be related to value appropriation. A firm with a higher level of vulnerability will have weak bargaining power and will be at risk of being unequally appropriated by the partners. However, the perceived level of vulnerability will be different across the firms. Though firm A feels vulnerable due to unique challenges it is facing, that does not mean that firm B knows A's vulnerability or feels the same way about A. SMEs partnering with larger firms to commercialize new technologies can be able to keep bargaining power if they

have capabilities to offer additional technologies or if they have inventive capabilities (Alvarez and Barney 2001).

In a nutshell, both external and internal vulnerabilities will likely push SMEs to form ties with competitors so that they can combine their resources and capabilities and, in turn, deal with the external threats, especially those posed by large firms. We therefore propose that

P7: The greater the perceived vulnerability felt by SMEs, the greater the likelihood that the SMEs will collaborate with competitors to increase their ability to compete against the stronger players.

Consequences of Co-opetition

In this section, we examine how co-opetition impacts the focal firm in both positive and negative ways. Though our context is technological innovation, the consequences of co-opetition go beyond technologies and encompass management challenges as well. Our attempt here is to identify some key implications—both positive and negative—rather than be exhaustive. Moreover, because our discussion earlier highlighted several benefits and costs, we will be brief here in developing our arguments.

Benefits of Co-opetition. As noted earlier, collaboration with competitors enables the firm to develop or use technologies it otherwise could not develop on its own (Morris, Kocak, and Özer 2007). Because most of the competitors in an industry face similar issues and compete in similar markets, their resources and capabilities are directly relevant or applicable to each other (or require limited modification before they are used); therefore, firms can get better or direct benefits by leveraging the resources and capabilities of the competitor-partner. Furthermore, as competitors might have had the common

goal (or more focused), the firms can invest more resources in certain projects together. As a result, SMEs that pool each other's resources and pursue common innovation projects are likely to gain economies of scale in R&D and innovation and be able to compete against large payers.

Another benefit comes from reduced uncertainty and risks. When firms collaborate with one another, they can reduce the risks in the process of innovation by distributing costs and possibly increasing the likelihood of success. In a related manner, when firms combine their complementary technologies, they have a broader set of technological capabilities to "fight" against competing technologies and products. Moreover, because SMEs are small and fragmented, they do not have a strong voice in the industry; co-opetition is likely to enable SMEs to develop a strong common voice and institute relevant norms. Finally, firms involved in co-opetition can reduce the time span of R&D. By working together with partners who have overlapping knowledge, firms can effectively pursue simultaneous innovations (Jorde and Teece 1990). They can also learn to enhance their knowledge and competencies and to improve their absorptive capacity. Overall, by leveraging intelligence, experiences, human resources, networks, and other capabilities of their competitor-partners, SMEs can reduce risk, lessen costs, and be more efficient in their innovation efforts. We therefore propose that

P8: SMEs that engage in co-opetition are likely to achieve economies of scale, reduce uncertainty and risks, and speed up the product development process.

Costs of Co-opetition. Though co-opetition may provide lots of benefits, firms should recognize the costs of co-opetition as well. The first downside

of co-opetition is technological risks. If a firm is not quite careful or happens to get an opportunistic partner, it could lose its secret and proprietary knowledge to the competitor-partner. When partnering with larger firms, SMEs might be appropriated unequally by the partners (Alvarez and Barney 2001). If the partner happens to be an opportunistic one, the SME might also confront legal issues. A dilemma SMEs face is that though it is better to select a capable partner for resource-based reasons, the selection of a trusting partner (who may not be the most capable partner) is necessary to avoid technological leakage and opportunistic behavior by the partner.

Loss of control of the partnership and its operation is another downside of co-opetition. SMEs are likely to face this challenge when they partner with a larger firm. Rothaermel and Deeds (2004) argue that due to their initially weak bargaining position, new technology ventures tend to cede a disproportional amount of control rights to the financier of the R&D alliance. The larger partners have more power and control and can force smaller ones to take on more of the risk (Sulej, Stewart, and Keogh 2001). Also, increased dependency on a dominant partner (overdependency) will limit the flexibility.

Finally, management of co-opetition is a very challenging task. Co-opetition requires managers to redefine the competition with a more complex and multifaceted manner and walk the fine line between collaborating in good faith and competing to enhance own strategic outcomes (Gnyawali, He, and Madhavan 2006). Due to competing expectations from both cooperative and competitive relationships, managers engaged in co-opetition, especially in boundary positions, may feel role conflicts (Bengtsson and Kock 2008). Furthermore, over time, the incentive to invest more in cooperating or competing with a given firm will change (Morris, Kocak,

and Özer 2007; BarNir and Smith 2002). SMEs may be less adept at deciphering these changes, estimating the evolving costs and benefits, and making the necessary adjustment to the co-opetition-based relationship (Morris, Kocak, and Özer 2007). Therefore, we propose that

P9: SMEs that engage in co-opetition are likely to face technological risks, management challenges, and loss of control.

SMEs might be able to mitigate the previously mentioned costs by having multilateral relationships rather than bilateral ones. Lavie (2007) argues that bilateral competition between the firm and its partners exacerbates some of the negative effects, whereas multilateral competition among partners in the alliance portfolio attenuates them. Multilateral ties may be an effective way for SMEs to enhance their collective strength and reduce the risks of being controlled by large firms.

Discussion and Implications

We have argued that firms, especially SMEs, in high-technology industries need to explicitly consider co-opetition as a part of their strategy tool set. Just as strategists think about how to outcompete a rival in their industry (competitive strategy) and about how to pursue and manage collaborations (cooperative strategy), they need to pursue ways in which they can simultaneously engage in collaboration and competition with other firms in the industry. Collaboration with competitors, as opposed to other firms, is unique and important in several ways: because competitors have high degrees of market commonality and resource similarity, they will find that competitors' resources are most useful to each other. Also, competitors' resources are likely to be directly useful (with little further development and adaptation), whereas

resources of noncompetitors are less relevant. Moreover, because competitors face similar external pressures (such as changing technologies and massive R&D costs) and have built resources to deal with such pressures, they can more effectively deal with the pressures if they work together by combining their own resources. Because of resource constraints and ongoing challenges from large competitors, SMEs are most likely to benefit if they engage in co-opetition.

A key implication of the criticality of co-opetition is that executives need to develop a co-opetition mindset. Firms led by executives with a co-opetition mindset are more likely to perceive co-opetition opportunities and help other managers develop a co-opetition mindset and therefore more effectively manage the dynamics of co-opetition. Elements of a co-opetition mental model might include recognizing the importance of co-opetition, scanning the environment for co-opetition opportunities, and developing ways to effectively engage in actual collaborative relationships with competitors.

We contribute to the literature in several important ways. First, this is the first paper that systematically discusses co-opetition in SMEs, identifies key drivers at multiple levels and discusses major consequences of co-opetition. The conceptual model helps to understand forces that may be driving co-opetition in a particular industry and among a set of firms. As we argued, the key motivation for co-opetition is to create common benefits and to overcome industry pressures such as increasing R&D costs, shrinking product life cycles, and convergence of technologies. Second, by building on the notions of resource complementarity and resource pooling, we suggested that the interface of industry factors and firm-level resource factors determine the likelihood of a given pair of firms being engaged in co-opetition. Thus, we provide a concrete basis in which schol-

ars could look at dyadic factors while evaluating the likelihood of co-opetition between a given pair of firms. Third, we provide practical guidelines to managers of SMEs in their efforts to understand co-opetition and devise their co-opetition strategy. We suggested that SME managers must monitor and analyze environmental changes to assess the need to engage in co-opetition, and if co-opetition is intensifying in the industry, they should explicitly consider competitors when pursuing technology-intensive alliances. More broadly, we urged SME researchers to systematically examine the emerging phenomenon of co-opetition and provided a framework to do so. In addition, we not only urged managers to make co-opetition a major strategic agenda but also provided concrete ideas to analyze the industry and key competitors in better understanding the forces of co-opetition and their effects. Overall, we believe that this paper will stimulate more systematic research on co-opetition in SMEs and will help SME managers in their efforts to evaluate co-opetition in their industries and develop their strategy for co-opetition.

Implications for Future Research

Though our conceptual framework is a rather preliminary one, we believe that it provides useful guidelines for future research. First, as noted earlier, co-opetition is an emerging phenomenon, and limited research has been conducted to systematically examine the co-opetition, including its antecedents and consequences. Given the novelty of the construct/phenomenon, appropriate and well-developed measures do not exist to perform large sample studies and conduct statistical analyses of co-opetition. Therefore, we suggest that researchers conduct in-depth case studies to more systematically and deeply examine factors that are driving co-opetition at both the industry and firm

levels. We believe that our model provides a way to implement in-depth case studies to better understand the phenomenon and develop measures for large sample studies. When conducting case studies, researchers need to focus on high-tech industries where technologies are rapidly changing and converging. Second, further attempts are needed to more deeply examine the paradoxical nature of co-opetition (Chen 2008). Within an industry or a pair of companies, the intensity of co-opetition may vary depending on contextual and firm-level factors. It appears that co-opetition would be most intense between two firms of approximately equal size and high market overlap. Similarly, it is important to understand the causes and consequences of mergers and acquisitions versus co-opetitive relationships. Finally, by building on the core ideas developed in this paper, future research should develop more complex models with the interplay of multiple factors. For example, how would the nature of co-opetition be if we examine combined effects of the multiple industry drivers, dyadic drivers, and firm-specific factors? How would a focal firm's factors such as its absorptive capacity and internal resources and capabilities interface with competitor-partners' absorptive capacity and internal capabilities in dyadic co-opetition (between a pair of competitors) versus multiparty co-opetition?

Managerial Implications

From this study, managers may better understand how companies use a co-opetition strategy to deal with rapidly changing technology development, and it is expected that companies should analyze more systematically the new phenomena and establish appropriate strategies. In this sense, managers need to look at a confluence of factors (industry, dyadic, and industry-dyad interface) at the same time as determining the co-opetition strategy. The first step for

pursuing co-opetition strategy is that managers need to look at technological characteristics in their industries, and if the industries show the characteristics of short product life cycle, technological convergence, or high R&D costs, managers should prepare to cooperate with suitable competitors. Second, it is important to develop a co-opetitive mind-set for the effective management of the paradoxical nature of co-opetition (Chen 2008). Lado, Boyd, and Hanlon (1997) clearly suggest that a top management team's posture in promoting or discouraging employees' co-opetitive behaviors affect the firm's ability to engage in co-opetitive behavior. Because managers' mental models influence behaviors (Hambrick and Mason 1984), it is important to develop systematic efforts in developing co-opetition mental models. SME executives with a co-opetition mind-set can be more proactive in identifying opportunities to improve their competitiveness by evaluating forces of co-opetition and by pursuing the strategy of co-opetition. Third, from a practical standpoint, it is important that managers systematically analyze benefits and costs before entering into a co-opetitive relationship. Key benefits of co-opetition, as noted earlier, include a combination of expertise and resources to create synergy and economies of scale, reduction of uncertainty and risk, and reduction of lead time in developing technologies and products. Meanwhile, the most critical challenge that co-opetition gives managers is the paradox of knowledge sharing and knowledge control. Co-opetition entails the sharing of knowledge that may be a key source of competitive advantage. However, there is the paradox that the very knowledge shared for cooperation could also be used in competition. Because SMEs tend to be weak in leveraging synergy (Levy, Loebbecke, and Powell 2003), SMEs particularly need to develop their ability to acquire the knowledge created through

co-opetition and effectively use it for internal technological developments.

Public Policy Implications

The growing popularity of co-opetition brings challenges to anti-trust regulators. It is possible that co-opetition in the end market or the downstream aspect of the value chain is problematic, but co-opetition in upstream aspects, including R&D and technological innovation, may not be problematic from the standpoint of anti-trust regulators. Also, when players are small and fragmented, such as SMEs, co-opetition is unlikely to be problematic because firms cannot easily build collective strengths to dictate price and competition in the industry. Jorde and Teece (1990) suggest that cooperation among competitors in technological innovation may not be anticompetitive. This could be true for several reasons. First, co-opetition is likely to help bring unique products and create new markets for them. It may also develop more integrative technologies so that consumers can buy fewer but better-functioning products (convergence of technologies), which would mean that more multifeature products would be in use. Second, co-opetition is a different kind of competition. Instead of firm-to-firm competition, cooperation among firms (collaboration between a pair or small group of competitors) may lead to group versus group competition (Gomes-Casseres 1994), which may be an even more intensified form of competition. As a result, it is possible that U.S. antitrust regulators may need to use newer approaches/lenses to look at antitrust issues. In fact, this seems to be happening. Levin and McDonald (2006) suggest that though the U.S. Supreme Court has long relied on the perfect competition model of the Chicago School of Economics, the Supreme Court has recently rejected some of these assumptions and philosophies of the Chicago School. As

Levin and McDonald (2006) argue, co-opetition could be beneficial to consumers by lowering costs and improving the value of market offerings. In the context of SMEs, it may in fact be better to encourage collaboration among them because this could be a way to help small firms develop their innovation capabilities and be able to compete against the large players in the industry. Thus, it appears that policymakers need to take a more nuanced approach to antitrust issues. The notion of creating value and appropriating value discussed earlier may be relevant here. It is possible that co-opetition to create value (or bring major new technologies and products) among small players is not that problematic, but cooperation among a set of large competitors to take customers directly away from another set of large competitors may be problematic.

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