COOPETITION IN NEW PRODUCT DEVELOPMENT ALLIANCES: ADVANTAGES AND TENSIONS FOR INCREMENTAL AND RADICAL INNOVATION

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1. Introduction

Coopetition — collaboration between competitors — is increasingly discussed as a strategy for new product development (NPD) (e.g. Gnyawali and Park, 2011; Yami and Nemeh, 2014; Fernandez *et al.,* 2014). Coopetition facilitates the creation of more new products than collaboration between non-competitors (Tether, 2002; Quintana-Garcia and Benavides-Velasco, 2004) by enabling the use of joint market and technological knowledge, leading to more effective innovation generation and diffusion (Ritala and Hurmelinna-Laukkanen, 2009; Yami and Nemeh, 2014). However, the literature lacks concensus on the role of coopetition in incremental and radical innovation (Ritala and Hurmelinna-Laukkanen, 2009; Bouncken and Fredrich, 2012). Several studies find that coopetition is advantageous for radical innovation (Bouncken and Kraus, 2013; Dussauge *et al.*, 2000), and even more beneficial than for incremental innovation (Bouncken and Fredrich, 2012). Conversely, some studies find lower benefits for radical innovation than for incremental innovation (Nieto and Santamaría, 2007; Ritala and Sainio, 2014). The reasons behind these mixed results are not fully understood, and constitute a clear gap in the literature.

In this study, we argue that these mixed results arise from the complex nature of coopetition, creating multiple types of tensions (see e.g. Fernandez *et al.*, 2014). In particular, in innovation-related coopetition firms come together to create value by developing new products, services and processes, while also seeking individually to appropriate a portion of the value (Ritala and Hurmelinna-Laukkanen, 2009; Gnyawali and Park, 2011). We claim that an important and so far overlooked aspect in coopetitive innovation and NPD studies is the phase of the NPD process the particular collaboration focuses on. Innovation researchers acknowledge that the front end of NPD differs significantly from the later launch phase since the early phases involve a lot of uncertainty (Reid and De Brentani, 2004; Bartunek *et al.*, 2007). Similarly, in collaborative innovation, it has also been recognized that collaborative

innovation includes a lot of uncertainty especially in phases where eventual value appropriation is still not visible (Dhanaraj and Parkhe, 2006).

We combine the insights of earlier research in that value creation and appropriation are contradictory, persisting tensions of the coopetitive relationship (e.g. Brandenburger and Nalebuff, 1996; Ritala and Tidström, 2014; Raza-Ullah *et al.*, 2014; Bengtsson *et al.*, 2016; Gnyawali *et al.*, 2016), with the evidence from innovation literature on differences in uncertainty and tensions in different phases of the NPD process and relationships. While the earlier research has discussed the merits of coopetition at pre-commercial phases of innovation (e.g. Gnyawali *et al.*, 2006; Dussauge *et al.*, 2000; Tidd and Trewhella, 1997), the launch phase of product innovation has received less attention. Lack of studies in this regard might be related to that most coopetition relationships (and literature) focus on pre-commercial stages that are far away from the customer (for reviews, see Walley, 2007; Bouncken et al., 2015), which is also a broader tendency in the collaborative innovation and NPD literature (Aarikka-Stenroos and Sandberg, 2012). Given that the different stages of NPD processes are clearly different in terms of uncertainty and tensions (Reid and De Brentani, 2004; Bartunek *et al.*, 2007), we expect that examination of coopetitive NPD relationships in different stages provides important understanding of how firms are able to achieve incremental and radical innovation benefits from coopetition. Thus, in this study we examine the effect of coopetition intensity in different phases of NPD alliances on focal firm's innovation outcomes.

Following an introduction to the main concepts and approaches, we develop hypotheses concerning coopetition in different phases of NPD alliances and innovation outcomes. We test the hypotheses based on a survey of 1,049 NPD alliances in the medical and machinery sectors. Our main finding is that coopetition is beneficial for early and later stages of incremental innovation but in the case of radical innovation, the benefits apply only to the less uncertain later stages. We contribute to the literature by providing better

understanding of the mixed findings in relation to incremental and radical innovation benefits in coopetition, and more generally, to the literature focusing on collaborative innovation and NPD.

2. Theory and hypotheses

2.1 Coopetition and innovation types

Coopetition is defined as simultaneous competition and collaboration within the same relationship (Bengtsson and Kock, 2000). In this study, we focus on *coopetition intensity* within the NPD alliance and its implications to incremental and radical innovation of the focal firm. In conceptualizing and measuring coopetition intensity, we build on earlier studies that have focused on the perception of coopetition intensity within an alliance relationship (Bouncken and Kraus, 2013). Thus, when we formulate the hypotheses, we examine the level of competitive perceptions within a particular collaborative relationship (here: NPD alliance).

Radical innovations entail a major departure from existing technologies and products (Abernathy and Clark, 1985; Utterback and Abernathy, 1975). In the coopetition context, collaboration for radical innovation creates market uncertainties and investment requirements that partners seek to reduce with the help of their coopetition partners (e.g. Ritala, 2012). These uncertainties also bring ambiguity and ambivalence, generating high tensions between coopetition partners (Raza-Ullah *et al.*, 2014). Tensions are likely to be most severe in the early phases of radical product innovation, when uncertainties add to the difficulties of securing proprietary knowledge. At later phases, functionalities become more visible, allowing firms to divide tasks between them (Raza-Ullah *et al.*, 2014; Le Roy and Fernandez, 2015), to define safeguards and to reduce partner opportunism.

Incremental innovations usually involve small changes to an existing product concept or technology (Abernathy and Clark, 1985; Utterback and Abernathy, 1975; Dewar and Dutton, 1986). The process of incremental innovation in coopetition is less ambiguous and

uncertain, allowing partners to more easily understand the underlying mechanisms and enabling better separation of tasks, reducing the risk of knowledge leakage and opportunistic behaviour. Due to this issue, it has been suggested that coopetition might be better suited for incremental technological innovation, even though the results remains broadly mixed (for discussion, see e.g. Ritala *et al.*, 2016).

2.2 Value creation, value appropriation and tensions in innovation-related coopetition

Coopetition-related innovation faces tensions between mutual investment in *value creation* and eventual individual returns from *value appropriation* (see Ritala and Hurmelinna-Laukkanen, 2009). In economics, value defines the end customer's willingness to pay (Brandenburger and Stuart, 1996), and value creation refers to all activities designed to increase this value. Value appropriation refers to all those activities that capture or capitalize the value created. In coopetition research, one baseline assumption has been that value creation is typically a joint process while value appropriation is more firm-specific, as rival firms compete for their share of the created value (Brandenburger and Nalebuff, 1995). However, in coopetitive NPD alliances, joint value appropriation may also occur when product innovations are launched collaboratively. This follows the logic of coopetition in a network context, where firms collaborate with rivals to increase their competitiveness against the rest of the field (Lado *et al.*, 1997; Ritala *et al.*, 2014). There might also be differences related to innovation types in terms of how much tension there is in appropriating value in the end product markets, which we will discuss later when developing the hypotheses.

The recent literature has highlighted the role of coopetition tensions from a number of perspectives (see e.g. Fernandez and Chiambaretto, 2016; Bengtsson *et al.*, 2016; Le Roy and Czakon, 2016). In the broader tensions and paradox literature, tensions are caused by persistent contradictions and involve both negative and positive aspects that are contingent on context, as well as on how they are managed (e.g. Lewis, 2000; Gaim and Wåhlin, 2016).

Among the several reported types of contradictions within coopetitive relationships (see e.g. Gnyawali *et al.*, 2016), we focus on the tension between value creation and appropriation in building the background arguments for differences between the early development phases and product launch, and related innovation outcomes in coopetitive NPD alliances.

In terms of positive tensions, coopetition drives value creation in innovation and NPD because firms' converging targets (Padula and Dagnino, 2007; Giachetti and Dagnino, 2016; Le Roy and Czakon, 2016) allow for increased resource complementarity and effective combination of market- or industry-specific knowledge and market power (Quintana-Garcia and Benavides-Velasco, 2004; Ritala and Hurmelinna-Laukkanen, 2009; Gnyawali and Park, 2009; 2011). Coopetition may improve value appropriation by expanding firms' current markets and facilitating the development of new markets and business models (Ritala *et al.*, 2014; Gast *et al.*, 2015).

However, the paradoxical nature of coopetition becomes visible in how this positive potential also creates possible threats and risks (see Bengtsson and Kock, 2000). Firms in coopetitive relationships have similar resources improving the mutual learning and innovation potential, but also easing knowledge acquisition, increasing the risk of opportunism and unwanted knowledge spillovers (Sampson, 2007). These hazards become more salient when competitive overlap is greater (Li *et al.*, 2008), when ambiguities exist (Raza-Ullah *et al.*, 2014) or when protection of intellectual property is weak (Ritala and Hurmelinna-Laukkanen, 2013). Firms need to manage these tensions and paradoxes, which may appear differently in various business environments (Le Roy and Fernandez, 2015).

These tensions have distinct consequences for radical and incremental innovations and in the following sections we develop hypotheses based on these core insights. Using the NPD phases approach (e.g. Cooper, 1983; Sobrero and Roberts, 2001; Gerwin and Ferris, 2004), we separate the pre-launch and launch phases of coopetitive NPD and suggest that innovation potential and risks in coopetition differ by phase. In doing this, we follow the existing

literature that has suggested that firms often collaborate with different partners in different phases of NPD processes (e.g. Aarikka-Stenroos and Sandberg, 2012).

2.3. Coopetitive NPD in the pre-launch phase

Coopetition in the pre-launch phases facilitates joint value creation through risk sharing and resource complementarity (Gnyawali and Park, 2009) and improves the flow of diverse knowledge needed to identify problems and potential solutions that are often still fuzzy (Reid and De Brentani, 2004). The knowledge comes not only from the competitors themselves but from other actors in their networks. This increases opportunities to combine, discover and create new knowledge that may lead to incremental or radical innovation. Coopetition may also involve collaboration in pre-competitive research programs, forums and projects that help to build a critical mass of ideas, innovations and technical standards (e.g. Gueguen, 2009; Mione, 2009).

The pre-launch phase of coopetitive NPD is pre-competitive, as product markets have not yet formed, and immediate tensions regarding competition itself are lower (e.g. Cassiman *et al.*, 2009). However, from innovation perspective, pre-launch phase entails very high uncertainties especially related to radical innovation pursuits (e.g. Song and Montoya-Weiss, 1998; Reid and De Brentani, 2004). This creates additional tension over the eventual value appropriation.

The low-to-moderate change of existing technologies, products and markets involved in *incremental innovation* (Abernathy and Clark, 1985; Tushman and Anderson, 1986) means that coopetitors may experience less complexity, fuzziness and uncertainty. The underlying combination of resource complementarities is easier to understand, and there is thus less risk of opportunism (e.g. Ritala and Hurmelinna-Laukkanen, 2009). Based on joint assessment of current and future markets and technologies, coopetitors pursue to predict and distribute their actual and future investments in the project. This greater understanding enhances control and

safeguards against opportunism, especially of knowledge leakage. This lowers negative coopetitive tensions, which have been shown to reduce knowledge sharing (Hamel, 1991) and could undermine innovation outcomes. Thus, such tensions over eventual value appropriation are not necessarily strong, and do not hinder value creation in the pre-launch phases of incremental innovation, where collaboration focuses on diffusing and developing path-dependent improvements to existing products in the interests of all parties (see also Ritala and Sainio, 2014).

In summary, joint technological and market understanding coupled with a lowering of competitive tensions by the non-adversarial nature of the pre-launch phase suggests the following hypothesis:

H1a. Coopetition in the pre-launch phases of NPD alliances is positively related to the proportion of incremental innovation in the focal firm's product range.

The challenges and advantages of *radical innovations* differ from those of incremental innovations (Chandy and Tellis, 1998). While joint market understanding, predictability of investments and separable project tasks facilitate incremental coopetitive innovation, radical innovation entails greater process interdependence, task complexity and uncertainty (Song and Montoya-Weiss, 1998). The advantages of coopetition for radical innovation include resource complementarities, partner similarity and critical thinking, which can improve learning and reduce the risk of decision traps (Bouncken and Fredrich, 2012). However, radical innovations require a complex, dynamic, and uncertain development process, in which coopetitors' joint development and sense-making creates higher risks of opportunism (e.g. Im and Rai, 2008), with associated risks of delays and proprietary knowledge leakage that may be exploited outside the coopetition project (Bayona *et al.*, 2001). Firms that cannot prevent

such leakage during coopetition may suffer from lower innovation performance (Ritala and Hurmelinna-Laukkanen, 2013).

All of these issues contribute to a major paradoxical tension. While radical innovation requires openness and broad-based knowledge exchange to facilitate emergence of serendipitous knowledge combinations, the risks of spillover and opportunism increase with openness and knowledge sharing, forming a 'paradox of openness' (Laursen and Salter, 2014). Appropriability mechanisms such as patents, contracts, and secrecy are helpful in NPD alliances, and especially in coopetition context (Ritala and Hurmelinna-Laukkanen, 2013). Yet, those mechanisms are not easy to enforce in the fuzzy context of early-stage radical innovation projects due to the uncertainty over outputs that should be safeguarded and the inefficiency of appropriability mechanisms in radical innovation (see e.g. Hurmelinna-Laukkanen *et al.*, 2008). Even the potential of opportunism can cause competing firms to hold up knowledge (Hamel, 1991). Therefore, competing firms with radical, market-disrupting ideas and inventions may not wish to reveal these to direct competitors but may instead prefer to collaborate with other actors such as key suppliers and customers. The motivation to pursue private benefits from coopetition could be strong and may harm radical innovation where common benefits are smaller than private benefits (Nieto and Santamaría, 2007).

Because of the particular tensions of value creation and appropriation in coopetition for radical innovation, we do not expect the pre-launch phase of such NPD alliances to share the same positive consequences as for incremental innovation. This argument is based on the overlap of competitors' existing market and technological knowledge (which is more useful for incremental innovation), and the high value-creating potential of radical ideas and inventions, which reduces motivation to collaborate in appropriating value. Especially in the early phases, radical innovation requires high inputs, often without hoped-for returns, accompanied by disappointments when targets are not met. Overall, the general uncertainty over future value creation and appropriation, as well as difficulties around protecting

knowledge suggest the likelihood of negative outcomes of coopetition intensity for focal firm's radical innovation in pre-launch phases.

H1b. Coopetition in the pre-launch phases of NPD alliances is negatively related to the proportion of radical innovation in the focal firm's product range.

2.4. Coopetitive NPD in the product launch phase

For incremental and radical innovation NPD relationships, coopetition in the product launch phase can assist quick market entry, availability of distribution channels, fast diffusion of products, joint promotion, and cobranding (see e.g. Gnyawali and Park, 2011; Park *et al.*, 2014; Yami and Nemeh, 2014; Chiambaretto *et al.*, 2016). As competitors encounter the same market conditions and customer needs, they develop useful experiences about innovation launch and new product diffusion. In general, the closeness to markets at this phase changes the dynamics of value creation and appropriation (see e.g. Aarikka-Stenroos and Sandberg, 2012). Launch phases have lesser tensions, as uncertainty is reduced by a clearer sense of end product markets, and less risk of unintended and potentially harmful leakage of proprietary knowledge among competitors. In the launch phase firms can also work on how the innovation can be best marketed in their product portfolio together with their competitors through cobranding and marketing agreements (see Fernandez *et al.*, 2014; Chiambaretto *et al.*, 2016), or by themselves in order to differentiate (e.g. Gnyawali and Park, 2011). For instance, each firm's marketing management can develop a firm-specific marketing mix strategy of specialized product design specifications, packaging, price, and promotion.

While the launch phase brings more clarity about end product markets, increasing levels of coopetition reflects potential market overlap and related value appropriation tensions (Ritala and Hurmelinna-Laukkanen, 2009). However, such tensions could be generally lower for innovation activities in comparison to e.g. regular product distribution or sales

collaboration (for discussion, see e.g. Chiambaretto *et al.*, 2016), since innovation-related coopetition is focused on creating more value to the markets, rather than merely dividing it up (Ritala and Hurmelinna-Laukkanen, 2009). In fact, we argue that the *ex post* market overlap of coopetitors with newly created products might not always reflect the *ex ante* market overlap between them before the NPD relationship. Further differences exist for incremental and radical innovations, which we will address while developing the following three hypotheses.

In launching *incremental innovations*, there are particular benefits for horizontally positioned coopetitive actors in terms of joint resources, legitimacy and bargaining power, accelerating diffusion and market penetration (e.g. Ritala and Hurmelinna-Laukkanen, 2009). For instance, introducing incremental innovation to markets often requires the development of infrastructure, processes, platforms and standards, and coopetition is helpful in these respects (Gueguen, 2009; Mione, 2009), as well as in building common delivery channels and marketing interfaces (Ritala *et al.*, 2014; Chiambaretto *et al.*, 2016). In this sense, competing firms can "embrace the similarity" in their target markets by facilitating customer adoption and fast market diffusion. Further, despite the similarities, firms can still establish their own specific marketing mix and include the incremental innovations in their product portfolio (e.g. Gnyawali and Park, 2011). Thus, firms can build on similarity leverage for incremental innovations and still adapt the innovation further to attract customers, even from other markets such as late adopters.

In sum, while NPD alliance partners who are competitors may also experience value appropriation tensions in the product launch phase due to linkages to their *ex ante* overlap in the product markets, we expect these tensions to be outweighed by the value creation benefits of coopetition for the focal firm's incremental innovation output. Based on these arguments, we advance the following hypothesis:

H2a. Coopetition in product launch phase of NPD alliances is positively related to the proportion of incremental innovation in the focal firm's product range.

Typically, launching a *radical innovation* is a difficult task that requires more than for incremental innovation a network with adequate legitimacy and resources (Aarikka-Stenroos and Sandberg, 2012). By shifting from value creation to appropriation of radically new opportunities, coopetitive NPD involves positive tensions including sharing of joint markets and technological understanding, heightening awareness of how more value can be captured by introducing a radical innovation that changes the logic of existing markets (see e.g. Ritala and Hurmelinna-Laukkanen, 2009). Collaboration between horizontal actors also delivers advantages of fast and strong market penetration, along with the use and further development of distribution channels, marketing tactics and market power (see e.g. Gnyawali and Park, 2011). In this way, coopetition can increase the radical product range by enabling partners to launch innovative products and service solutions to a larger customer base and to more international markets than if acting alone (Bouncken and Kraus, 2013). The greater joint power of competitors helps to push the innovation into the market and more easily overcome thresholds in terms of distribution channels, customer awareness, and using the dynamics of word-of-mouth communication, even through social networks. Additionally, firms will use their marketing and differentiation opportunities and 'customize' the innovation into their targeted markets or niches. For instance, Gnyawali and Park (2011) analyzed the case of Sony and Samsung who brought new LCD technologies to the markets with a differentiated styling and marketing, enabling effectively to differentiate their practically similar offerings in the customer end. Therefore, specifics developed in the launch phase will allow firms to better fit into their specific customer base and to reduce the appropriation tensions that come from the potential market overlap.

In sum, we expect major benefits of coopetition between NPD alliance partners in the product launch phase of radical innovation, along with many possibilities to avoid the downsides of competitive tension. Based on these arguments, we hypothesize a positive relationship as follows.

H2b. Coopetition in the product launch phase of NPD alliances is positively related to the proportion of radical innovation in the focal firm's product range.

So far, we have developed positive hypotheses for NPD coopetition in the product launch phase for both incremental and radical innovation. However, differences in creation-appropriation tensions suggest that radical innovation outcomes benefit more from an increasing level of coopetition within NPD alliances, because certain tensions are likely to arise from the competitive positioning of coopetition partners in the end product markets. In particular, the market overlap between competitors creates negative tensions, as sometimes a 'zero-sum' logic migh be established between competitors' end market offerings (Ritala and Hurmelinna-Laukkanen, 2009). In incremental innovation, the market overlap is likely to be higher due to stronger existing linkages to established products and markets that the coopetition partners are currently operating in. This similarity in competitive position and related resources has suggested to create value appropriation tensions in the joint marketing efforts (see Fernandez *et al.*, 2014; Chiambaretto *et al.*, 2016).

Nonetheless, coopetitors will have developed the core of the innovation before the launch phase leveraging their capabilities to reduce cost and/or improve the innovation design. Joining forces with competitors may be especially helpful for market penetration by radically new products, services and business models because such markets are (by definition) less crowded and offer more potential for growth, even if multiple competitors also launch their products in those markets. Growing or new markets based on coopetition are less prone

to ‘zero-sum’ logic, documented in such cases as the new market in LCD TVs created by Sony and Samsung, where competitors used coopetition to overtake other electronics companies (Gnyawali and Park, 2011). While we would expect coopetition to have positive effects in the product launch phase for both types of innovation, we hypothesize that the effect may be stronger for radical innovation. We assume that the leverage for taking upon the benefits of networks and joint market preparation is higher for more novel and uncertain radical innovation, also allowing better possibilities of creating firm-specific additional value through more effectively using the marketing mix for ‘customizing’ the innovation.

H2c. The positive relationship between coopetition and radical innovation in the product launch phase of NPD alliances is stronger than the positive relationship between coopetition and incremental innovation.

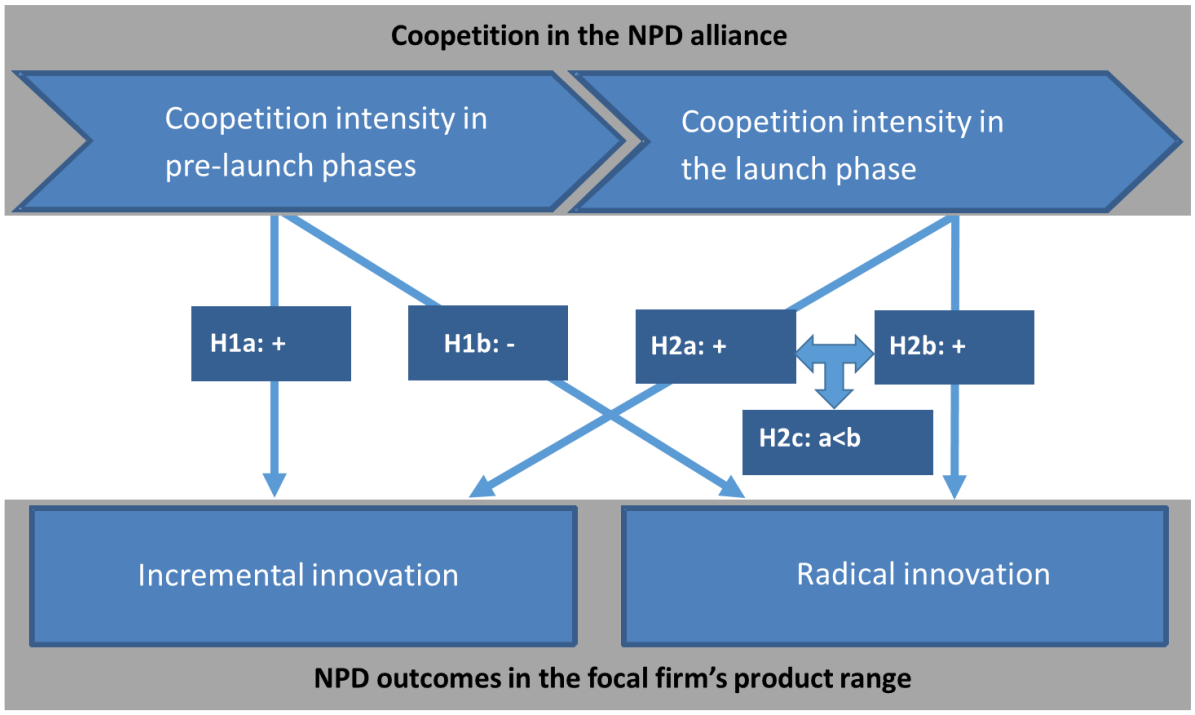
Table 1 and Figure 1 summarize the hypotheses and the overall arguments of our research framework.

Table 1. Research framework: Summary of overall arguments

	Pre-launch in coopetitive NPD	**Product launch in coopetitive NPD**
Incremental innovation	Due to the overlaps in technological and market understanding between coopetitive firms, the inputs to value creation processes, as well as the expected incremental appropriation outcomes are relatively clear, and have low-to-medium level of uncertainty. Coopetition is thus expected to be beneficial for focal firm’s incremental innovation output in pre-launch phase (H1a).	As the uncertainty decreases by moving towards value appropriation, firms in coopetition can utilize their joint bargaining power, cobranding, delivery channels and infrastructure to increase the incremental value appropriation possibilities. Coopetition is thus expected to be beneficial for focal firm’s incremental innovation output in product launch phase (H2a).
Radical innovation	Expected value appropriation possibilities are ambiguous and uncertain and relevant inputs to radical innovation are hard to pre-evaluate. This provides tensions to early value creation processes	Radical innovations provide novel and diverse value creation and appropriation potential in the product launch phase that firms in coopetition can utilize for creating new types of value and appropriating value from newly created radical innovation. As

	among coopetition partners due to difficult-to-predict future value appropriation. Coopetition is thus expected to be negative for focal firm's radical innovation output in pre-launch phase (H1b).	the radical innovation has moved from pre-launch to the launch phase, uncertainties decrease and isolation mechanisms and differentiation opportunities are more observable. Coopetition is thus expected to be positive for focal firm's radical innovation output in pre-launch phase (H2b), and more so than in the case of incremental innovation (H2c).

Figure 1. Illustration of the hypotheses and the empirical model



3. Methodology

3.1. Industry context and sample selection

The advantages of coopetition are critical for small firms (Bengtsson and Johansson, 2012), especially in high-tech industries where firms need to develop new solutions quickly (Gnyawali and Park, 2011; Bouncken and Kraus, 2013). With a €220 billion worldwide market share, one of the most promising industries worldwide is the *medical device industry* (SIC codes 3840-45), in which large firms like General Electric and Siemens as well as many

smaller firms compete and must constantly develop their portfolio of novel technical devices, both radically and incrementally. Rules and structures for product development in the medical device industry are very different across nations. The US for example has a much stronger and more formal and governmentally regulated product development which has several similarities to the pharmaceutical NPD. In Germany, NPD of medical devices is understood to become more complex and expand previous boundaries. At the same time, NPD of medical devices demands following stricter rules, especially before launch and lengthier processes. For several products, firms face similar conditions as in the US demanding long development times including approval and reimbursement permissions through health insurances. The market is still dominated by SMEs. Smaller firms in particular depend on coopetition for complementarities. As the third-largest market worldwide and the third-largest producer of medical devices (€23 billion market share; see Chatterji, 2009; Russell and Tippett, 2008), we chose to collect a sample from Germany.

We also collected another Germany-based sample from the *industrial and commercial machinery and computer equipment* industry (SIC codes 3500), which is also of international importance (Padula *et al.*, 2015). With sales turnover of more than €200 billion and about one million employees, this sector is Germany's largest industrial employer, with an export quota of over 75% (see Kinkel and Som, 2007; VDMA, 2014). Being responsible for more than 10% of all R&D expenses in the overall economy, this sector is one of the most innovation-oriented branches in Germany. In knowledge-intensive industries characterized by process-, material- or product-innovation (Landau and Rosenberg, 1986), collaborative innovation is of great importance (e.g., Arranz and de Arroyabe, 2008), as it can lead to more incremental and radical innovations (e.g., Belderbos *et al.*, 2004). Here, especially smaller firms often collaborate in NPD with larger competitors or form R&D networks or joint institutes together with competitors.

All together, the sample (N=1,049) included a significant proportion of small and medium-sized enterprises (SME≤250 employees) facing high innovation pressures. Thus, both samples relate to industries where coopetition helps firms to compete with the big players worldwide. Also, we believe that utilizing two samples increases the representability of our results.

3.2 Data collection

The final sample of 1,049 NPD alliances was generated from a population of 9,000 firms, taken from multiple databases: *Hoppenstedt*, *Amadeus*, and the German *Bundesanzeiger*. Data were collected between late 2012 and late 2013 by means of a postal paper-and-pencil survey. We achieved a response rate of 12% for our final sample (N=1,049). Adopting a *key informant* approach (Kumar *et al.*, 1993), we contacted top and middle managers and asked them to describe one specific NPD alliance, involving a key-buyer firm, about which they had detailed information. Table 2 provides additional information about respondents' profiles at firm, alliance and individual levels.

Table 2. Sample characteristics

N=1,049 NPD alliances	Mean	Median	SD or frequency	(1) Medicine (N=558) vs. (2) Machinery (N=491)[a]	(1) Pre-launch (N=588) vs. (2) launch phase (N=461)[a]	(3) mixed phases (N=316) vs. (4) launch phase only (N=145)[a]
Number of employees	1,846	65	17,211.5	(1) less (2) **	n.s.	n.s.
Sales in M€	535.2	11	5,142.7	(1) less (2) **	n.s.	n.s.
Firm age in years	36.9	25	32.7	(1) younger (2) **	n.s.	n.s.
R&D intensity in %	17.4	10	21.0	(1) higher (2) *	(1) higher (2) *	n.s.
Duration of alliance in years	9.3	7	8.1	(1) shorter (2) **	n.s.	(3) longer (4) **
Tenure in years	6.4	4	6.2	n.s.	n.s.	n.s.
Frequency of males			81.7%	(1) less (2) **	n.s.	n.s.
CEO, director, owner[b]			25.2%	n.s.	n.s.	n.s.
Marketing director[b]			20.9%	(1) more (2) *	n.s.	n.s.
Operational/sales management[b]			45.7%	n.s.	n.s.	n.s.
R&D[b]			10.7%	n.s.	n.s.	n.s.
Other or missing status[b]			18.0%	n.s.	n.s.	n.s.

[a] Significance (**p<.01, *p<.05, n.s.=not significant) from non-parametric difference testing (median test, Mann-Whitney-U test, and χ^2-test for frequencies).

[b] Sum exceeding 100% due to multiple positions.

For a subsample of N=572 firms (55%), we received second informants' ratings on a short questionnaire of performance measures at firm level. We then assessed the potential threat of single-source bias by checking raters' consistency on a model external latent scale for relative innovation performance yielding a strong inter-rater agreement (Pearson-rho=.37, P<.000). We can therefore assume no significant threat of single-source bias.

Responding firms from the medical devices industry were significantly smaller (mean employees=1,214 vs. 2,564) and younger (mean firm age in years=32.9 vs. 41.5), indicating structural differences. Responding firms from both sectors were predominantly SMEs (78.9% in medicine vs. 71.9% in machinery). The medical device industry is more R&D-intense (mean R&D=18.8% vs. 15.7%), and has relatively shorter alliances (mean duration in years=8.6 vs. 10.0), which may be attributable to firms' younger age (8.6 years younger on average). There were significantly more females and marketing directors in the medical device subsample. Comparisons of pre-launch vs. launch alliances revealed more R&D-intensive pre-launch phases (18.7% vs. 15.7%). Firms in both industries typically follow a stage-gate approach for their NPD projects, where all new product ideas undergo a funnel-shaped screening and development process where only a small proportion of initial ideas reaches full commercialization (Cooper, 1983). Thus, we used the prevalent Stage-Gate approach to examine innovation processes for our study.

Using binary measured multiple choice items, we asked: 'At which stage(s) of the innovation process does your company collaborate with this ally?'—'concept development', 'concept evaluation', 'planning & specification', 'product development', 'testing & evaluation' and/or 'market launch' (Ahmed and Shepherd, 2010). For our final sample (N=1,049), we deleted all cases with no information on any stages. A hierarchical cluster analysis identified the launch phase as highly independent of other phases: (1) NPD alliances

excluding launch phase (N=588) and (2) NPD alliances including launch phase (N=461). The latter subsample was further divided into (3) NPD alliances covering at least one pre-launch phase in addition to the launch phase (N=316) and (4) NPD alliances at launch phase only (N=145) to separate theoretical overlaps of value creation and appropriation mechanisms. Alliance duration is significantly shorter for launch phase only NPD alliances (mean duration in years=8.1 vs. 10.7).

To ensure representativeness, we checked our sample for potential *non-response bias*. The medical subsample (n=558) did not differ significantly from the medical device population (n=4800) in respect of firm size, firm revenue, or firm age. We compared the machinery subsample (n=491) and population (n=4,200) in the same way. Again, we found no significant differences. Both subsamples were therefore representative.

3.3. Measures of constructs

We used established multi-item scales to measure our constructs (see Table 3). All scales were reflectively operationalized on five-point Likert-type items. To measure our independent variable, we built on the idea that intensity of competition within a NPD alliance increases coopetition tension in the coopetition relationship (Bengtsson *et al.*, 2016), and eventually affects innovation outcomes of the focal firm (Park *et al.*, 2014). For this purpose, we would expect a continuous measure that examines the perceived level of coopetition intensity to be especially useful in testing our hypotheses. The measure of *perceived coopetition* (Bouncken and Kraus, 2013) which has been used in a number of subsequent studies was adapted for this purpose. To measure innovation performance, we used the predominant categorization of radical vs. incremental innovation developed by Dewar and Dutton (1986), asking respondents to estimate the proportion of *radical* and *incremental innovation* in their firm's current product range and building a classification of advantages for different aspects such as product design, functionality, features, and quality performance (Gatignon and Xuereb, 1997).

Our measurement models (see table 3) reveal adequate to excellent reliability, with convergent and discriminant validity assessed by common fit criteria of local fit (see Bagozzi, 1988; Nunnally and Bernstein, 1994) and global fit (see Hair *et al.*, 2010).

Table 3. Measures

Latent construct	Std. loading	T-value (MLR)
Coopetition (α=.79, CR=.80, AVE=.58, FL=.07)		
1. We are in close competition with our partner.	.93[a]	37.12
2. An active competition with our collaborator is important to us.	.58	19.96
3. Our partner is also our competitor, with whom we pursue a common goal in the project.	.73	29.02
Think of your current product range: Which proportion is based on...		
Radical innovation (α=.87, CR=.88, AVE=.59, FL=.53)		
... radical/completely new improvements concerning…		
1. …technology.	.81[a]	41.10
2. …performance.	.85	51.08
3. …customer value.	.81	49.01
4. …market.	.67	25.41
5. …design.	.68	28.33
Incremental innovation (α=.88, CR=.88, AVE=.60, FL=.52)		
... incremental/slight improvements concerning…		
1. …technology.	.84[a]	44.93
2. …performance.	.83	42.06
3. …customer value.	.78	32.53
4. …market.	.71	25.53
5. …design.	.70	25.78

[a] Initial loading fixed to 1 to set the scale of the construct.

3.4. Control variables

Relationship duration is an indicator of specific alliance experience and learning (Anand and Khanna, 2000), and trust is usually built through repetitive relationships or relationship duration (Gulati, 1995). Newly established coopetition projects exhibit lower trust and are restrictive in the exchange of specialized and heterogeneous knowledge and markets, which increases risk. Firm size is an important predictor of innovation (e.g. Chandy and Tellis, 2000; Vaona and Pianta, 2008), and R&D intensity also influences innovation outcomes (Artz *et al.*, 2010). Following other alliance and coopetition studies (e.g. Quintana-Garcia and Benavides-Velasco, 2004; Bouncken and Kraus, 2013; Ritala and Hurmelinna-Laukkanen, 2013; Park *et al.*, 2014), we used the following alliance and firm-specific characteristics as control variables: (1) *firm size*, (2) *firm age*, (3) *R&D intensity* and (4) *NPD alliance duration*, based

on natural logarithms of the number of employees, number of years the firm has been in business and number of months the firms in the NPD alliance had been doing business with each other. Further, (5) an *industry dummy* (with machinery as baseline model) was used to control mean industry differences in perceived innovativeness. Finally, we binary control (6) *NPD alliances including launch-phase* in the aggregated sample.

3.5. Modelling

We applied covariance-based structural equation modelling (CB-SEM) with Mplus 7 to test the hypotheses. For this, different models were specified in a build-on approach, starting with a single group and splitting the sample into measurement model invariant groups, with factor means fixed at zero in one group and free in the others (Muthén and Muthén, 1998-2012), based on three coded subgroups of NPD alliances at (1) pre-launch phases only, (2) pre-launch phases and market launch, and (3) market-launch only. The main hypotheses H1a-H2c were tested in a multi-group analysis.

Table 4 shows latent factor correlations in the data, estimated after running a confirmatory factor analysis. Table A1 in the Appendix additionally includes descriptive statistics and a bivariate correlation matrix for all manifest variables.

Table 4. Estimated latent factor correlations

Constructs	1	2	3
1. Coopetition intensity	.58	.01	.04
2. Radical innovation	.12***	.59	.31
3. Incremental innovation	.20***	.56***	.60

Note: Diagonals represent average variances extracted; below are zero-order correlations and above are squared inter-correlations,*** p<.001.

3.6. Robustness checks

Several tests checked the robustness of findings. First, we followed the recommendations of Podsakoff *et al.* (2003) in developing the questionnaire to minimize potential common method bias by assuring respondent anonymity and reducing item ambiguity. A confirmatory

factor analysis allowed all items in the aggregated model to load equally on a common method factor. We constrained all latent factor correlations with this factor to be zero and compared this solution to the original model by performing a scaled chi-square difference test. Global model fit did not improve significantly ($\chi^2_{diff,MLR}$=0.32, df_{diff}=1, P>.10). Further, we applied instrumental variables in a 2-SLS approach to assess potential endogeneity of our final sample selection (Bascle, 2008). All hypothesized relationships remained consistent with our previous findings, indicating absence of such biases.

Additionally, to check the external validity of our subjective coopetition measure, we were able to identify objective SIC code similarity scores for a random subsample (11%). SIC code similarity is an ordinal measure of objective competition intensity between alliance partners (Park *et al.*, 2014). Comparing this subsample (N=119) with the remaining cases (N=930) showed no significant parametric or non-parametric differences in coopetition intensity and other firm characteristics. Both parametric (Pearson-rho=.26, P<.01) and non-parametric (Spearman-rho=.27, P<.01) correlation analyses revealed highly significant positive correlations between SIC code similarity and coopetition intensity, indicating consistent underlying mechanisms.

We also scrutinized the robustness of coopetition's effect for varying relationship durations, firm sizes, firm ages and R&D intensities. Firm size and relationship duration further disentangled coopetition-related effects. Firm size positively interacts with radical innovation throughout both phases. Bigger firms attribute a greater performance effect to coopetition on radical innovation (see below in curvilinear tests). Furthermore, duration positively interacts with coopetition (ß=.17, P<.05) on radical innovation in the pre-launch phases. Long-term relationships also diminish coopetition's effect on incremental innovation in the launch phase (ß= –.14, P<.05). These effects support coopetition as a dynamic process of value creation and appropriation (e.g. Ritala and Hurmelinna-Laukkanen, 2009). Despite

these additional findings, postulated main effects remained consistent after inclusion of latent interaction terms.

We further checked the robustness of our findings to curvilinear trends by adding quadratic terms of manifest control variables and their respective interactions with linearly perceived coopetition intensity, resulting in more realistic models of conditionally monotone rather than conditionally linear relationships (Ganzach, 1998). All findings remained robust after inclusion of these additional parameters (e.g. for firm size: $ß_{size \rightarrow rad}$=–.02, P>.10 and $ß_{size \times coop \rightarrow rad}$=.11, P<.01 yielded in $ß_{size \rightarrow rad}$=–.00, P>.10; $ß_{size \times size \rightarrow rad}$=–.03, P>.10; $ß_{size \times coop \rightarrow rad}$=.10, P<.05 and $ß_{size \times size \times coop \rightarrow rad}$=.06, P>.10).

A post-hoc power analysis revealed that even after adjusting for attenuation bias of imperfect measurements, the achieved power level exceeds 80% for detection of small effects at 5% type-I error rates (f^2 >.02; Cohen, 1988). Finally, we conducted five hold-up samples to check for any potential threat of unobserved heterogeneity, randomly selecting 500 cases for each hold-up sample and re-running model estimations. All hold-up samples revealed variations of findings within a small range (P-values +/–0.05), indicating no serious threat of unobserved heterogeneity.

Further, as an additional cross-validation of results, we utilize a qualitative repertory grid technique, which represents a personal construct theory originally derived from psychology and anthropology disciplines (Kelly, 1955; Lemke *et al.*, 2010). We interviewed 20 respondents from firms with coopetitive NPD alliances from the same population. The main aim of this cross-validation was to examine the sources of potential value creation and appropriation tension in coopetition, as well as the focal firm's incremental and radical innovation outcomes. In Table 5, the numbered rows represent core constructs by which the respondents assess their coopetitive NPD alliances in comparison to either competitive or collaborative relationships.

Table 5. Qualitative cross-validation by using repertory grid technique

construct pole – O		competition		cooperation		coopetitive companies you deal with		contrast pole – X
		O	X	O	X	O	X	
1.	security	-	20	17	3	3	14	uncertainty
2.	shared goals	-	20	18	2	11	9	divergent goals
3.	low-risk	-	6	5	4	3	12	high-risk
4.	incrementally innovative	7	2	15	3	14	6	not innovative
5.	radically innovative	1	16	3	10	13	6	not innovative

Note: The number represents the number of respondents to each pole.

The key constructs in the coopetition context were identified by frequency counts. We used the repertory grid to perform a principal component analysis of coopetition and examine the personal constructs which are grouped into a series of subsystems (Caldwell and Coshall, 2002). The principal components in the coopetitive context are the uncertainty (X=14) as well as high-risk (X=12) nature of the relationship. The goal alignment between coopetitors is quite unevenly distributed between shared and divergent goals (O=11, X=9), which supports our expectation of the tension-laden context. Moreover, respondents related their coopetitive NPD relationships with the increase of both incremental and radical innovations in their product portfolio (O=14 & O=13), which supports the quantitative results of the main study.

4. Results

Table 6 summarizes control variables and their association with incremental and radical innovation outcomes in separate industry subsamples and an aggregated total sample without the postulated coopetition intensity associations. Table 7 shows the results of our hypotheses for aggregated single-group vs. multi-group comparisons.

Table 6. Control variables

Relationship	Aggregated data (N=1,049)		Medicine devices (N=558)		Machinery equipment (N=491)	
	Incremental outcomes	Radical outcomes	Incremental outcomes	Radical outcomes	Incremental outcomes	Radical outcomes
Industry	–.01	–.01	n/a	n/a	n/a	n/a
Launch	–.04	–.05	–.04	–.04	–.03	–.08
Duration	.01	–.01	–.01	.04	.03	–.08
Firm size	.03	–.00	.03	–.02	.04	.05
Firm age	.00	–.15**	.08	–.16*	–.09	–.14**
R&D intensity	.11**	.22***	.16**	.24***	.05	.20***
Residual correlation of endogenous variables	.47***		.42***		.54***	

Overall fit:
Aggregate ML: $\chi^2(90)=356.23$, p<.000, CFI=.93, TLI=.92, RMSEA=.053, SRMR=.038.
Aggregate MLR: $\chi^2(90)=302.75$, p<.000, scaling correction factor=1.18, CFI=.93, TLI=.92, RMSEA=.047, SRMR=.038.

Note: n/a=not available, sup=support, rej.=rejection. *** P<.001;** P<.01; * P<.05; † P<.10.

Table 7. Results: Hypotheses H1a–H2c

Relationship	Aggregated data (N=1,049)	Medicine devices (N=558)	Machinery equipment (N=491)	(1) Pre-launch phases (N=588)	Hyp. results	(2) Pre- and launch phases (N=316)	(3) Launch phase only (N=145)	Hyp. results	$\chi^2_{diff, MLR}$ (d.f.$_{diff}$)
Launch → incremental	–.03	–.03	–.03	n/a		n/a	n/a		
Industry → incremental	–.01	n/a	n/a	–.01		–.03	.02		0.19 (2)
Duration → incremental	.01	–.02	.02	.07		.05	–.22*		7.01* (2)
Firm size → incremental	.01	.01	.01	–.05		.13	–.01		2.97 (2)
Firm age → incremental	.02	.09	–.07	.02		–.06	.03		0.58 (2)
R&D intensity → incremental	.09*	.15**	.03	.05		.06	.25*		3.07 (2)
Coopetition intensity → incremental	.14***	.12†	.17**	.14*	H1a: sup.	.13	.24*	H2a: sup.	0.88 (2)
Launch → radical	–.05	–.04	–.08	n/a		n/a	n/a		
Industry → radical	–.01	n/a	n/a	–.03		.01	–.00		0.22 (2)
Duration → radical	–.02	.04	–.08	.01		.03	–.16†		2.49 (2)
Firm size → radical	–.01	–.03	.01	–.01		–.02	.14		1.64 (2)
Firm age → radical	–.15**	–.15**	–.13†	–.08		–.28***	–.22†		4.58 (2)
R&D intensity → radical	.22***	.24***	.19**	.28***		.12	.23*		3.83 (2)
Coopetition intensity → radical	.06	.05	.07	.02	H1b: rej.	.04	.22*	H2b: sup.	3.16 (2)
							H2a < H2b	H2c: rej.	0.03 (1)
Means of coopetition	.00 (fixed)	.00 (fixed)	.00 (fixed)	.00 (fixed)		–.07 (freed)	.04 (freed)		

Overall fit:
Aggregate ML: $\chi^2(128)=445.90$, p<.000, CFI=.94, TLI=.92, RMSEA=.049, SRMR=.039.
Aggregate MLR: $\chi^2(128)=392.99$, p<.000, scaling correction factor=1.13, CFI=.94, TLI=.92, RMSEA=.044, SRMR=.039.
Medicine devices only ML: $\chi^2(117)=306.25$, p<.000, CFI=.93, TLI=.91, RMSEA=.054, SRMR=.047.
Medicine devices only MLR: $\chi^2(117)=273.13$, p<.000, scaling correction factor=1.12, CFI=.93, TLI=.91, RMSEA=.049, SRMR=.047.
Machinery equipment only ML: $\chi^2(117)=260.77$, p<.000, CFI=.94, TLI=.93, RMSEA=.050, SRMR=.045.
Machinery equipment only MLR: $\chi^2(117)=227.21$, p<.000, scaling correction factor=1.15, CFI=.94, TLI=.93, RMSEA=.044, SRMR=.045.
Multi-group ML: $\chi^2(399)=776.99$, p<.000, CFI=.93, TLI=.92, RMSEA=.052, SRMR=.058.
Multi-group MLR: $\chi^2(399)=709.13$, p<.000, scaling correction factor=1.10, CFI=.93, TLI=.92, RMSEA=.047, SRMR=.058.

Note: n/a=not available, sup.=support, rej.=rejection. *** P<.001;** P<.01; * P<.05; † P<.10.

The results support H1a that coopetition intensity in the pre-launch phase is positively associated with incremental innovation (H1a: ß=.14, P=.02), but is neither positively nor negatively significant for radical innovation (ß=.02, P=.69), rejecting H1b. Hypothesis 2 considered coopetition intensity in the product launch phase of NPD. Results for the product launch phase show that coopetition intensity is positively associated with both incremental innovation (H2a: ß=.24, P=.03) and radical innovation (H2b: ß=.22, P=.02). H2c (that coopetition intensity in the launch phase is more effective for radical than for incremental innovation outcomes) was rejected ($\chi^2_{diff,MLR}$=0.03, df_{diff}=1, P=.86).

The positive relationship of coopetition intensity and incremental innovation outcomes is independent not only of NPD phase but also of underlying industries. The only significant difference in the industry subsamples concerns incremental innovation outcomes through R&D intensity. In the medicine devices subsample, investments in R&D directly improve incremental innovation outcomes (ß=.15, P=.005), whereas in the machinery equipment subsample, there is no direct effect (ß=.03, P=.57). Radical innovation outcomes are directly improved by R&D intensity throughout all NPD phases and in both industry subsamples except for the mixed phases subsample. Firm size shows no linear association with innovation outcomes, whereas firm age diminishes radical innovation outcomes in all subsamples except for the pre-launch phases subsample. NPD alliances solely covering the launch phase are characterized by diminishing innovation outcomes for longer relationship durations indicating highest innovation outcomes directly after product launch.

5. Discussion and implications

Coopetition is a paradoxical, tension-laden relationship (Bengtsson *et al.*, 2016; Gnyawali *et al.*, 2016), with both opportunities and drawbacks in joint innovation efforts (Ritala and Hurmelinna-Laukkanen, 2009). We examined the role of coopetition intensity in pre-launch vs. launch phases of NPD alliances, along with its effects on incremental and radical innovation in the focal firm's product range (see Table 8 for results summary).

Table 8. Summary of the results

Coopetition	**Focal firms' incremental innovation**	**Focal firms' radical innovation**	**Comparison**
Overall	positive	no effect	Coopetition is better for incremental innovation
Pre-launch phases	positive	no effect	Coopetition is significantly better for incremental innovation
Product launch phase	positive	positive	no difference

Overall, when combining all the NPD alliance phases to the analysis, the results show that increasing coopetition intensity has a positive relationship with incremental innovation outcomes in the focal firm's product range. However, when the NPD alliance phases are separated, we find more distinctive evidence. The results show that the benefits of coopetition intensity for incremental innovation holds for both pre-launch and launch phases of NPD alliances, while focal firm's radical innovations only increase along coopetition intensity in the product launch phase of NPD alliances. The implications of these results for coopetition, innovation and NPD research and practice are discussed below.

5.1. Research implications

In general, our findings provide support for the expectation that coopetition intensity influences the outcomes of the relationship (Park *et al.*, 2014; Bengtsson *et al.*, 2016). We

contribute to the coopetition literature by providing additional explanation for the previously mixed results over incremental and radical innovation outcomes (Raza-Ullah *et al.*, 2014; Tidström, 2014; Le Roy and Fernandez, 2015; Bengtsson *et al.*, 2016; Gnyawali *et al.*, 2016; Ritala *et al.*, 2016). Following the arguments of previous innovation research that NPD alliance stages have different levels of uncertainty (e.g. Song and Montoya-Weiss, 1998; Reid and De Brentani, 2004), we examine separately the pre-launch and launch phases of coopetitive NPD alliances, and find observable differences in the implications of coopetition intensity for focal firm's incremental and radical innovation. While coopetition research has suggested generally that activities far away from customer involve less tension (e.g. Bengtsson and Kock, 2000; Walley, 2007), our results show that the high uncertainty of radical innovation activities in the pre-launch phase might lower the potential benefits of coopetition.

In relation to *pre-launch* phases, we theorized tensions due to uncertainty about eventual outcomes and vulnerability to knowledge spillover and opportunism, as well as difficulties in assessing how value creation informs eventual appropriation outcomes. We found that coopetition in the pre-launch phases of NPD alliances is beneficial only for incremental innovation (supporting H1a), which is understandable in light of earlier research suggesting that incremental innovation entails lower risks and tensions than radical innovation (e.g. Ritala and Hurmelinna-Laukkanen, 2009; Gnyawali and Park, 2009; Ritala and Sainio, 2014).

With regard to radical innovation, the negative hypothesis (H1b) was not supported, but the non-significant result points out towards the stronger benefits of incremental innovation. This aligns with some of the earlier findings of Nieto and Santamaría (2007) and Ritala and Sainio (2014), who reported that coopetition is not particularly beneficial for radical innovation. However, a number of other studies have identified benefits from early-phase coopetition for radical innovation (Gnyawali *et al.*, 2006) or for radical innovation in

general (Bouncken and Fredrich, 2012; Bouncken and Kraus, 2013). By examining different stages of NPD alliances, we are able to distinguish when coopetition intensity is beneficial to radical innovation (latter stages), and when it is less beneficial (pre-launch stages). In fact, the early-phase radical innovation development might encounter the 'paradox of openness' (Laursen and Salter, 2014), where knowledge exchange is important for creating the diversity, while at the same time firms see great risks in investments and knowledge flow. Indeed, the negative tensions in early-phase coopetition relate to uncertainty, high inputs without clear vision of appropriable outputs, as well as knowledge sharing and protection challenges (see e.g. Le Roy and Fernandez, 2015), coupled with expectations related to serendipitous findings, open knowledge exchange and creation of new knowledge. As Raza-Ullah *et al.* (2014) put it, "simultaneous experience of both positive and negative emotions forms the basis of tension in coopetition" (p. 17), and this may account for the non-significant results for radical innovation.

In the *product launch* phase of NPD alliances, our hypotheses (H2a-b) were supported, in that coopetition intensity promotes both incremental and radical innovation for the focal firm. This aligned with our theorizing that greater closeness to end markets prompts clarity, reducing uncertainties, and ultimately lowering tensions. As an additional benefit of the product launch phase, competing firms can pool their resources and capabilities to better penetrate markets and facilitate diffusion of jointly developed incremental and radical innovations. These findings align with Bouncken and Kraus (2013), who related the positive effect of coopetition on radical innovation to reduced uncertainty. In this less uncertain launch phase of NPD projects, firms in coopetition can more safely rely on the advantages of shared technological and market understanding, as they have less proprietary knowledge to protect and more to gain from coopetition. Diminished ambiguity allows firms to define sub-tasks and exploit combinative potential, and coopetitors can more easily distribute tasks between them (Thölke *et al.*, 2001; Frattini *et al.*, 2013). We also hypothesised that coopetition

intensity in the launch phase of NPD (H2c) would be more beneficial for outcomes of focal firms' radical innovationa, as the markets are less crowded, and there is more space to create new markets, in partnership as well as individually. However, we found no support for this hypothesis, as coopetition intensity was almost equally beneficial to both types of innovation.

Finally, we found that NPD alliances having both pre-launch and launch phases do not produce significant results in terms of incremental or radical innovation. This supports the relevance of empirically separating between the phases, but also highlights the potential tensions over value creation and appropriation that might emerge in such multi-dimensional relationships.

5.2. Managerial implications

Based on our findings, it seems that firms should seek coopetitive partners for incremental product and technology development initiatives at all phases of NPD. However, firms need to be more cautious about coopetition for radical innovation, if possible selecting the less uncertain later phases of the project. Firms pursuing radical innovation should take account of the necessary knowledge exchange with competitors and how they can safeguard their proprietary knowledge to avoid tensions and reduce risks. To this end, firms should assess the innovation's novelty and then select the appropriate phase of the NPD process. The search for partners may take some time, but this should not be a problem during the early phases. Given the possible leakage of ideas and knowledge to competitors, firms should not approach potential coopetitors too early or unprepared, and choose their partners wisely.

Knowledge sharing tensions can also be handled through appropriate managerial practices and organizational mechanisms. Openness offers tremendous advantages through idea generation, change and recombination, but also brings opportunism. Coopetitors may therefore establish formal and informal agreements (which this study did not consider) to allow openness in pre-launch phases for radical innovation (see e.g. Estrada *et al.*, 2015).

Pursuit of both relational and firm-specific goals requires that firms develop mechanisms for open communication about strategic objectives (see e.g. Le Roy and Fernandez, 2015; Bouncken *et al.*, 2016a). Coopetitors can also use knowledge-related practices, principles and actual knowledge protection mechanisms such as intellectual property rights and contracts (Ritala and Hurmelinna-Laukkanen, 2013). With regard to the individual-level, emotional roots of tensions (e.g. Le Roy and Fernandez, 2015; Gnyawali *et al.*, 2016), firms could develop instruments and practices to make it easier to work under emotional ambivalence (Raza-Ullah *et al.*, 2014), potentially leading to better outcomes for early-stage coopetition in radical innovation.

5.3. Limitations and future research directions

Like all empirical research, the present study has several limitations. First, our data are sourced solely from Germany, which is one of the few European countries thriving economically at the time. The results may also differ for different types of firm (e.g. family-owned, private company, public company etc.). Second, we used key informants (top-level managers) as the only source of information. Although they are usually considered the "single most knowledgeable and valid information sources" (Lechner *et al.*, 2006, p. 525), future research might also seek out a second source, either internally or externally (e.g. the coopetition partner). Third, our sample is not limited to alliances between direct competitors with full market overlap only, as it examines NPD alliances that experience different levels of coopetition intensity. It should thus be noted that also alliances between non-competitors are included to assure a representative sample of NPD alliances in general. The benefit from this approach is that we decrease endogeneity and tautological nature of our perceptional coopetition measure that best describes an alliance partner as a close competitor (λ=.93).

Future research should also look beyond bilateral NPD alliances to multi-actor relationships (e.g., Bouncken *et al.*, 2016b), such as innovation networks and ecosystems in

which coopetition plays a major role (e.g. Gueguen, 2009). In these contexts, the complexity of coopetitive value creation and appropriation increases, requiring new types of analysis. Future studies could also probe more deeply into the dynamics of coopetitive value creation and appropriation. While the present study demonstrated how coopetition in different phases affects focal firms' innovation outcomes, it seems important to investigate the dynamics of value creation and appropriation in coopetition relationships over time and in greater detail. For instance, examining the timing and overlap of product launches by competitors in a coopetitive NPD alliance could provide more understanding of these temporal dynamics. Furthermore, future studies could examine the role of safeguard and appropriability mechanisms (such as patents, contracts and secrecy) in coopetitive NPD, since they might affect the innovation outcomes and value appropriation (e.g. Ritala and Hurmelinna-Laukkanen, 2013).

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