Designing coopetition for radical innovation: An experimental study of managers' preferences for developing self-driving electric cars

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Abstract

The major premise of this study is that managers purposefully shape the business context for radical innovation. Particularly, the strategic option of developing radical innovation in collaboration with direct competitors offers opportunities otherwise unattainable. We tap into its cognitive underpinnings by running an experimental study of coopetition design for radical innovation. We have collected 5,760 binary decisions from a sample of 160 managers. Their indications are used to run a choice-based conjoint analysis in order to identify utilities attributed to coopetition shaping decisions in a radical innovation project (using a scenario of self-driving/electric cars produced by VW, Daimler or Tesla). We use Hierarchical Bayes Multinomial Logit Regression to test a set of four hypotheses, each addressing a different coopetition factor to unveil manager's preferences in coopetition design for radical innovation. Our findings pinpoint a clear preference for network coopetition, using formal governance, and based on intensive knowledge sharing. Contrary to prior literature, market uncertainty does not appear to significantly influence coopetition design for radical innovation.

1. Introduction

A fundamental premise of the business network stream of research is that interactions with other parties are crucial to managing the behavior of organizations and to enhancing their effectiveness (Håkansson & Snehota, 2006). This poses a managerial challenge for high technology companies of shifting from a traditional focus on how a firm is organized and how it allocates its resources, or from a focus on ordinary supplier and customer relationships, towards understanding how the firm relates to its environment (Möller & Halinen, 1999). In particular innovation is increasingly seen as an outcome of interactions between a firm and various other organizations (Santoro et al., 2018), rather than isolated single-agent result (Corsaro et al., 2012). If innovations are determined by networks in which high-tech firms are embedded (van der Valk et al., 2011), then it is important to understand how managers design those networks in order to achieve intended outcomes.

This seminal assumption has fostered a vigorous stream of research focused on understanding the various factors that affect the effectiveness of the innovation process in a networked environment. Coopetition, that is cooperation with competitors (Brandenburger & Nalebuff, 1996), has long been recognized as a valuable source of various advantages including fostered innovation (Chiambaretto et al., 2020). Although coopetition firms may be way more beneficial than with non-competitors, it may also be associated with adverse effects (Le Roy & Czakon, 2016). Coopetition opens ways to value misappropriation, opportunistic behaviors or unintended knowledge leakage (Czakon & Czernek, 2016). Additionally, it may have a damaging effect on the innovation process itself by harming extremely novel innovations (Bouncken & Kraus, 2013).

The effectiveness of innovation processes in coopetition depend on several managerial choices (Bouncken et al., 2020). In particular, the way firms design and manage their relationships with competitors determines how the benefits and risks in such relationships are structured (Ritala, 2009). Recent studies examined the impact of governance mechanisms (Bouncken et al., 2016), actors heterogeneity (Corsaro et al., 2012, Yan et al., 2020) or number of actors involved (Bouncken & Fredrich, 2012) separately, in order to shed light on important factors determining the relationship between innovation and coopetition. Our study takes prior literature a step further by considering multiple factors and their alternative values at the same time.

The business network stream of research has shown an interest in the microfoundations of firms' strategic behaviors, by exploring sensemaking or network pictures at team and individual manager levels of analysis (Lundgren-Henriksson & Kock, 2016). The way managers choose to cognitively represent their environment impacts the capabilities that organizations will develop, how connections among firms will shape their actions and in turn will be shaped by firms, which subsequently will impact their performance(Gavetti, 2005). The behavioral view of strategy has benefited from and contributed to simulation, case studies, regression models, and experiments which are perhaps under-utilized as a source of new evidence (Gavetti et al., 2012). Recently, experimental methods gain popularity in understanding firms' decision by addressing preferences or intentions that drive actual choices (Chiambaretto et al., 2020). We run an experimental study of coopetition for radical innovation, as prior studies indicate that coopetition has more merits for radical innovation (Bouncken et al., 2016). We submit a scenario for radical innovation, that is a simplified cognitive representation of their decision problem (Gavetti, 2005), in order to identify individual preferences, which contribute to predict with high accuracy intentions to perform behaviors, and these intentions account for considerable variance in actual behavior (Ajzen, 1991). We identify a list of factors positively influencing coopetition for innovation proposed in prior research in order to address our research question:

"Which design of coopetition for radical innovation is preferred by managers?"

We advance extant research by submitting alternative choices to managers, hence taking account of associated benefits and trade-offs. Furthermore, we advance current understanding on coopetition design by identifying individual manager's preferences, which adds fine-grained insights that complement sensemaking and network pictures (Lundgren-Henriksson & Kock, 2016) stream of research at a microfoundational level.

2. Theory and hypotheses development

One of key issues in the business network stream of research refers to the problems faced by firms regarding the scope of action within existing and potential relationships, and effective operations with others (Harrison et al., 2010). To gain an overview of prior literature on coopetition and innovation, we performed a systematic literature review (Kraus et al., 2020) in order to rigorously identify the state-of-the-art. We focused on peer-reviewed journal articles including "coopetition" or "co-opetition" AND "innovation" or "new product development" in title, abstract or keywords. We identified in total 36 articles dealing with the topic of coopetition and innovation, out of which 23 (64%) publications applied a quantitative, 11 (30.5%) a qualitative, and only 2 (5.5%) a mixed-methods approach. We lay out previous research findings on the coopetition and innovation relationship, and derive our hypotheses by taking account of alternative choices that managers face in designing preferred coopetition settings for radical innovation.

2.1 Coopetition and radical innovation

Coopetition is frequently observed in highly complex, dynamic and innovation- as well as knowledge-intensive industries (Gast et al., 2015) in which firms face short product life-cycles, high research and development (R&D) costs, and an urge to innovate novel technologies (Bouncken et al., 2017; Gnyawali & Park, 2009). In such contexts, the sharing of resources and knowledge under coopetition is important for innovation (Estrada et al., 2016; Brolos, 2009) as firms are typically limited in their internal resources and knowledge which can impede their innovation power (Camison-Zornoza et al., 2004; Yan et al., 2020). Even large, technologically strong firms are not likely to be able to develop and commercialize innovations when acting individually (Teece, 2018). When competitors cooperate, innovation is not a firm-internal process anymore (Lasagni, 2012), but rather a complex, intertwined nexus of action between various individual parties that each add resources and knowledge to the final product, and jointly co-create new knowledge and technologies leading to technological breakthroughs and innovations (Ritala et al., 2014).

Under coopetition, firms can pool their resources and knowledge (Le Roy & Czakon, 2016; Enberg, 2012; Bengtsson & Kock, 2000) as well as their R&D activities (Walley, 2007) to jointly develop common knowledge using all partners' experience and expertise (Ritala & Hurmelinna-Laukkanen, 2009). Direct competitors are firms that typically face the same challenges, share their business understanding, and develop capabilities to serve the same target customer (Bouncken et al., 2020). Empirical research clearly indicates that direct competitors offer immense opportunities of combining close, but not identical knowledge bases (Le Roy et al., 2016). As a result, they can boost their technological diversity (Quintana-Garcia and Benavides-Velasco 2004b), and promote innovation (Ritala, 2012). Additionally, coopetition allows firms to develop new products and services (Le Roy & Czakon, 2016) which they would not have created without the coopetitor, or only much later (Walley, 2007).

For the purpose of this study, we focus on coopetition for radical innovation as we seek to better understand the nature of coopetition design in challenging, discontinuous environmental conditions. In case of radical innovation endeavors, firms find themselves exposed to new, unknown technologies and markets, demanding a large stock of new knowledge and/or technology (Bouncken & Kraus, 2013) as they are radically different from their current technologies. Furthermore, the commercialization of radical innovations often requires firms to address new customer needs or enter new markets (Von Stamm, 2008).

Since competitors typically exploit similar resources, are exposed to similar pressures, and display a similar knowledge about the business environment (Le Roy et al., 2016), coopetition can bear specific benefits for the development of radical innovation. Cooperation between competitors facilitates not only the sharing, integration and recombination of supplementary and complementary knowledge (Estrada et al., 2016) based on all partners' experience and expertise (Ritala & Hurmelinna-Laukkanen, 2009) and but it also allows the partners to exchange their knowledge on markets and customer preferences. As such, cooperation between competitors can be of importance for the creation and market introduction of radical innovation (Belderbos et al., 2004) as it helps to gain access to the required knowledge and technologies for the development of groundbreaking, novel products, services or processes (Yan et al., 2020).

Despite this benefit, however, coopetition is filled with particular challenges and risks (Bouncken et al., 2015) as well as tensions (Tidström, 2014; Fernandez et al., 2018) "due to inherent contradictory and opposing forces" (Fernandez et al., 2014, p. 224). For example, given the duality of cooperation and competition, tensions related to coopetition include the risk of technology imitation or unintentional knowledge leakage (Fernandez et al., 2014; Estrada et al., 2016) resulting in a loss of control over the innovative process (Ritala & Hurmelinna-Laukkanen, 2013). Further, coopetitors may follow "hidden priorities" (Fernandez et al., 2014, p. 223) and the sharing of resources and knowledge may motivate them to develop an opportunistic mindset (Bouncken & Kraus, 2013; Pellegrin-Boucher et al., 2013).

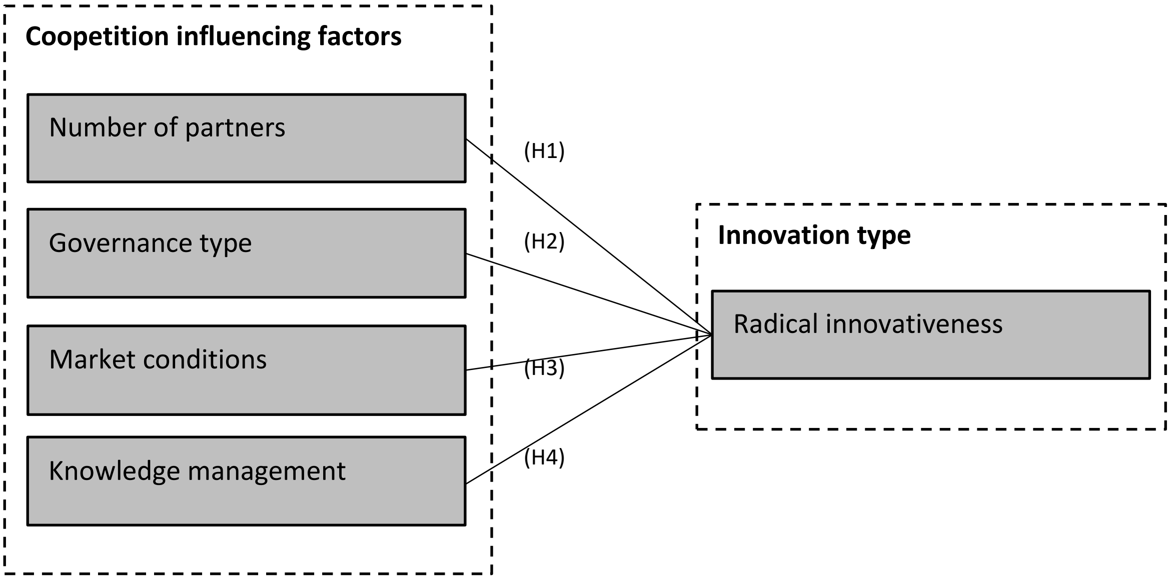
These risks and tensions may play a negative role if coopetition for radical innovation, and may hamper the development of innovations (Cassiman et al., 2009) especially when they are supposed to be radically new and groundbreaking. Therefore, a well-structured coopetition design is needed that aligns coopetitors' incentives and limites the accompanied tensions and risks (Ritala, 2009). Recent studies highlight the role of several factors that may impact the relationship between coopetition and innovation, including organizational learning (Bendig et al., 2018), social cohesion (Strese et al., 2016), technological capabilities (Wu, 2014), competition intensity (Park et al., 2014b), the existence of multiple coopetition partners (Yami & Nemeh, 2014), as well as the application governance (de Resende et al., 2018), knowledge sharing and knowledge protection mechanisms (Estrada et al., 2016). Our study builds upon this research by combining four coopetition-influencing factors that have previously been examined independently. All in all coopetition design offers several options, depicting the combinations of choices managers may prefer. Our study address this gap in extant literature.

2.2. Hypotheses development

In order to identify relevant attributes in designing coopetition for radical innovation, we follow a literature-based approach used in choice-based conjoint coopetition analyses (Chiambaretto et al., 2020): we rely on recent reviews (Gast et al., 2018) as well as on our own literature review. We identify four different clusters of variables, or coopetition design attributes: 1) number of partners (e.g. Schiavone & Simoni, 2011; Yami & Nemeh, 2014); 2) governance types (e.g. Bouncken et al., 2016; Ratzmann et al., 2016); 3) market conditions (e.g., Bouncken & Kraus, 2013); and 4) knowledge management (e.g., Estrada et al., 2016; Hurmelinna-Laukkanen & Ritala, 2010).

Prior research has predominantly adopted a firm-level analysis, linking single factors to innovation through coopetition outcomes. However, the perception of these factors by managers has been largely left beyond the scope of attention. In developing our experiment scenario and associated hypotheses, we identify alternative choices for answering our research question (Figure 1).

Figure 1. Conceptual framework of the study



2.2.1 Number of Partners: Dyadic versus network coopetition

While dyadic innovation alliances become increasingly important (Bouncken et al., 2019), with technology's complexity and interdependency increasing over the last decades, it becomes unlikely that even two strong firms can develop and commercialize major radical innovations alone (Teece, 2018). Therefore multi-sided, multiple or network coopetition (Czakon, 2018) may seem as more promising setting as compared with dyadic coopetition for innovation. As compared to dyadic coopetition, studies on network coopetition are far less numerous, and predominantly based on case studies (Yami & Nemeh, 2014). Also conceptual models (Gnyawali & Park, 2011) overlook the network level of analysis. This gap encourages investigating the manager's preferences as regards the number of partners involved in coopetition for radical innovation.

The dyadic coopetition form constitutes a simple two-firm relationship, whereas the multiple coopetition form refers to a relationship among more than two firms (Yami & Nemeh, 2014). The benefits available through dyadic coopetition involve defining technical standards, internalizing spillovers, sharing risk, and reducing unnecessary duplication of research effort

(Teece, 1992), economies of scale achievement, and speeding up of product development (Gnyawali & Park, 2009). Dyadic coopetition for innovation settings has become pervasive in the literature, both conceptually and empirically (Gnyawali & Park, 2011). A more recent study indicates that in the space satellite industry, dyadic coopetition for radical innovation is quite common between Airbus and Thales (Fernandez et al., 2018).

Yet, the involvement of many actors in coopetition is claimed to unlock the true potential of coopetition (Czakon, 2018). Network coopetition is characterized by overlapping relational linkages, larger resource pools and a complexity much different from dyadic coopetition (Czakon & Czernek, 2016). The advantages of multiple coopetition involve reaching the critical mass fostering innovation, technical standards setting, and business ecosystem development (Teece, 2018). Multiple coopetition reduces the overall risk and costs borne by each coopetitor involved in radical innovation, adding more certainty or control over the development trajectory of technology (Yami & Nemeh, 2014), when a large number of partners is grouped (Schiavone & Simoni, 2011). When aiming at radical innovation, prior case study-based research suggests that coopetition with multiple partners is claimed to be the most suitable (Bengtsson & Kock, 2014), as German IT SMEs (Bouncken & Kraus, 2013) and US corporate bond trading market (Velu, 2016) substantiate. However, it is also way more challenging (Park et al., 2014a). Indeed, network coopetition involves increased likelihood of keeping opportunistic behaviors anonymous, adds to the complexity of partner selection challenge (Chiambaretto et al. 2020), and involve information distribution and spillover risks (Czakon & Czernek, 2016). Knowledge leakage concerns, hold-up problems, competitive intelligence and value misappropriation concerns are more acute when many competitors collaborate for innovation (Yami & Nemeh, 2014). As a result, the advantages of multiple coopetition may be outweighed by risks associated with it, leading to a preference towards dyadic coopetition. Therefore, we test the literature-informed preference:

Hypothesis 1: In coopetition for radical innovation, managers prefer network coopetition over dyadic coopetition.

2.2.2 Governance type: Formal governance versus relational governance mechanisms

Governance structures are vital when considering collaborative innovation strategies with competitors (Teng & Das, 2008), as they influence whether coopetition really improves innovation or not (Cassiman et al., 2009). Facing the previously discussed benefits and risks of coopetition for radical innovation, scholars argue that governance structures help to align incentives and limit risks (Oxley, 1997). Indeed, an adequate choice of governance mechanisms facilitates an effective coordination of cooperation activities and individual resources contributions among cooperating competitors, and protects them from opportunism (Hoetker & Mellewigt, 2009). Coopetition literature typically differentiates between *formal governance mechanisms* based on formal contracts and agreements and *relational governance mechanisms* based on, for instance, trust (Bouncken et al., 2016; Czernek et al., 2017).

Formal governance mechanisms may be preferred in coopetition for radical innovation, as they imply the application of formalized agreements to determine respective coopetitors' duties and obligations (Bouncken et al., 2016). Formal contracts define coopetitors' respective roles and responsibilities as well as rules and punishments (Fernandez & Chiambaretto, 2016; Jiang et al., 2013; Salvetat et al., 2013) to facilitate the management of this knowledge-related tension (Morris et al., 2007). Scholars argue that the key benefits of knowledge sharing and its safe transfer in a competitive environment can only be achieved within formal knowledge protection mechanisms (Ritala & Hurmelinna-Laukkanen, 2013). Formal governance seems to prevail in multiple coopetition settings, as case studies in the wireless telecommunication industry (Yami & Nemeh, 2014), and space satellites industry unveil (Fernandez et al., 2018).

Alternatively, relational governance based on trust building, reciprocal exchanges, cultural similarity, and mutuality in information exchange can improve coordination and minimize opportunism. This governance type requires time to build long-term oriented coopetition strategies (Czakon & Czernek, 2016), and develop reliable future behavioral expectations (Bouncken et al., 2016; Puranam & Vanneste, 2009). Trust allows partners to believe that knowledge is not transmitted at the expense of the other by unintended knowledge disclosure, which leads to increased performance and the development of innovation in coopetition (Park et al., 2014b). A relational governance mechanisms based on trust is important to dyadic coopetition in the design phase, as suggested by prior serial case studies (Czernek & Czakon, 2016). Relational governance has been found to improve product innovativeness in the medical devices industry, while formal governance tends to have a detrimental effect (Bouncken et al., 2016).

Nevertheless, prior research reveals that coopetition in high-tech industries and coopetition that particularly aims to develop R&D relies on specific formalized borders when it comes to intellectual property protection, which deters opportunistic behaviors (Li et al., 2008). Theoretical arguments suggest that relational governance is unable to provide useful mechanisms for dealing with uncertainty and has limited enforceability in radical innovation settings (Grandori, 2006). Therefore, we hypothesize that competitors who cooperate in view of developing radical innovations will give higher priority to formal as compared to relational governance mechanisms, given their legal nature and binding character:

Hypothesis 2: In coopetition for radical innovation, managers prefer formal governance over relational governance.

2.2.3 Perceived market uncertainty versus certainty

Cognition research and decision theory underlines that uncertainty depends largely on the ambiguity of information available, an issue that becomes particularly acute in a radical innovation context where managers face difficulties both in identifying paths of cause-and-effect, and are unable to collect the information required to construct realistic scenarios (Gavetti & Rivkin, 2007). The presence of market uncertainty is a major market condition that influences firms' strategic behavior (Ritala & Hurmelinna-Laukkanen, 2009), and is theorized to be a relevant coopetition driver (Bengtsson & Raza-Ullah, 2016), especially for radical innovation (Chiambaretto et al., 2020). When facing a high level of market uncertainty, firms perceive the future development of their respective industry as uncertain since change is occurring rapidly (Ritala, 2012). Coopetition literature indicate that firm-based and market-based uncertainty are key reasons why firms decide to enter cooperative networks in an attempt to reduce uncertainty (Beckman et al., 2004) and spread their risks and costs involved in their business operations (Ritala, 2012).

Competitors represent "suitable partners when market uncertainty is high", as an empirical study of 209 Finnish firms (Ritala, 2012, p. 310) indicates, since they possess not only similar resources, knowledge, and costs (Gnyawali & Park, 2011; Le Roy et al., 2016), but also similar interests in emerging service and product markets, general market conditions, and technologies (Luo et al., 2007; Kim & Parkhe, 2009) which continuously change and cannot be successfully covered solely by one firm (Hurmelinna-Laukkanen et al., 2008; Rice & Galvin, 2006). Further, this common understanding facilitates complementary resources and knowledge bundling (Bouncken et al., 2020), costs (Ritala, 2012), risks and knowledge sharing (Bouncken & Kraus, 2013) to deal with the perceived market uncertainty and to boost coopetitors' innovativeness (Baumard, 2009). Amazon is one example which has been found to implement coopetition-based buisness models in high market uncertainty conditions (Ritala et al., 2014).

Prior research highlighted a positive moderating effect of market uncertainty on the relationship between coopetition and innovation (Ritala, 2012) as well as a positive moderating effect of the closely related concept of technological uncertainty on the relationship between coopetition and revolutionary innovation (Bouncken & Kraus, 2013). However, high uncertainty in radical innovation may discourage firms from coopeting (Bouncken et al., 2016). On the other hand, in the case of stable, non-dynamic and non-complex markets with a low degree of market uncertainty, coopetition may not be a priority for competitors, as they do not face the need for risk, cost and resource sharing given that they possess sufficient resources by themselves to deal with the limited risks (Ritala, 2012). Consequently, we postulate:

Hypothesis 3: In coopetition for radical innovation, perceived market uncertainty is preferred over perceived market certainty.

2.2.4 Knowledge management: Knowledge sharing versus knowledge protection

Sharing relevant information is important for coopetition success, but creates tensions related to information spillovers, underresearched in the literature with few notable case studies (Fernandez et al., 2018). The relationship between coopetition and innovation is based on factors such as coopeting firms' absorptive capacity (Pereira & Leitão, 2016; Yan et al., 2020), their appropriability regimes (Ritala & Hurmelinna-Laukkanen, 2013), and their knowledge integration (Enberg, 2012). Despite the importance of knowledge management for coopetition (Kogut, 2000), and the risks associated with the ability of other firms to extract and appropriate their coopetitors' knowledge in innovation processes (Ritala & Hurmelinna-Laukkanen, 2009), research on the trade-offs and preferences related to isolation of knowledge sharing and knowledge protection is still nascent.

Scholars argue that knowledge sharing under coopetition enhances the dissemination of knowledge between competitors, facilitates positive network externalities by shaping the institutional environment (Ritala & Hurmelinna-Laukkanen, 2009), and promotes the development of innovations (Estrada et al., 2016). Thus in knowledge-intensive industries, coopetition is particularly important, as coopetition facilitates the access to external knowledge and helps develop R&D and technological innovation (Bouncken & Kraus, 2013; Carayannis et al., 2014). However, coopetitors need to protect their core knowledge from their competitors (Ritala et al., 2015), given the possibilities of knowledge leakage, opportunism and informational spillovers (Fernandez & Chiambaretto, 2016). Ritala and Hurmelinna-Laukkanen (2013) stress that coopetition poses a high risk for knowledge exchange when market opportunities appear. Especially in terms of radical innovation, the key benefits of knowledge exchange and its safe transfer in a competitive environment can only be achieved with formal knowledge protection mechanisms ((Bouncken et al., 2020).

Despite the need for knowledge sharing and knowledge protection under coopetition, coopetitors may be apt to give priority on knowledge sharing than on knowledge protection when they cooperate with competitors for radical innovation. The development of a broad knowledge base is an essential ingredient for radical innovation as it facilitates the understanding of new information such as technologies (Chesbrough, 2003) and helps to deal with the resource-demanding character of radical innovation. However, competitors have a relatively high degree of absorptive capacity, which in radical innovation settings may increase risks (Ritala & Hurmelinna-Laukkanen, 2009). This poses major managerial challenges that need to be carefully addressed (Fernandez & Chiambaretto, 2016). Thus, we hypothesize:

Hypothesis 4: In coopetition for radical innovation, managers prefer knowledge sharing over knowledge protection.

3. Methodology

Scholars identify ambiguities in terms of distinct environmental contingencies that have an effect (Ritala, 2012) on the likelihood of coopetition adoption (Gnyawali & Park, 2009), on the coopetition process (Fernandez et al., 2014), and its subsequent outcomes (Le Roy & Czakon, 2016). We follow the cognitive stream of strategy research (Helfat & Peteraf, 2015) in addressing the varied firm responses to environmental contingencies. By adopting the individual manager's level of analysis, we aim at capturing the cognitive underpinnings of coopetition design (Gavetti et al., 2012). Differently from extant literature, we do not focus on past events by associating constructs to coopetition that had already taken place, but instead put managers into a scenario where their individual preferences can be experimentally identified.

Experiments differ from conventional surveys because relationships can be manipulated, controlled and even randomized (Kraus et al., 2016). With respect to closeness to reality, conjoint studies have a higher relation to reality due to the evaluation of whole product and service concepts (DeSarbo et al., 1995). Conjoint experiments have become a prominent technique to measure consumer choices in the last three decades (Eggers & Sattler, 2009). While established in marketing research, conjoint experiments as well as other forms of experimentation have found its way to entrepreneurship and strategy research (Gavetti et al., 2012; Kraus et al., 2016), accounting now for approximately half of the experimental methods used (Chiambaretto et al., 2020).

Choice-based conjoint analysis provides various advantages. Compared to traditional measuring tools, it embeds realistic simulated decisions into an experimental setting with high internal validity. Accordingly, the effect on decision-making is explicable by derived preference selection instead of modifications in rankings. Participants have the possibility to decide intuitively rather than rating alternatives, which holistically reflects a natural environment. We therefore account for the fact that coopetition design can be seen as a multidimensional decision process that requires a joint assessment of multiple criteria (Chiambaretto et al., 2020). Choice-based conjoint analysis offers novel insights into the importance of different attributes simultaneously. Participants are forced to evaluate and make trade-offs between repeated choice-sets (e.g., Eggers et al., 2016; Lohrke et al., 2010). Such partition of participants' decisions helps unveiling their underlying preference structures and decision rules (Chiambaretto et al., 2020). We deem these advantages as beneficial for our experimental design as respondents are forced into a realistic scenario of deciding what factors are most important in a coopetition setting.

The independent variables are chosen based on prior literature and clustered into four main factors. The relationship between these coopetition-influencing factors and preference for a coopetition strategy is carried out through an experimental research, namely a choice-based conjoint analysis experiment. Therefore, the attributes can constitute two options (Table 1).

Table 1. Attributes and levels of the conjoint choice measurement

Attribute	**Level 1**	**Level 2**
Number of partners	*Dyadic* coopetition partners	*Multiple* coopetition partners
Governance type	*Formal* governance	*Relational* governance
Market conditions	Market *uncertainty*	Market *certainty*
Knowledge management	Knowledge-*sharing*	Knowledge *protection*

Our hypotheses are integrated into preference measurements representing a mix of characteristics, which are translated into perceived preferences (Wilkie & Pessemier, 1973). In choice-based conjoint analysis theory, participants choose between several choice options from which they estimate the highest utility (Louviere, 1988). There is also the possibility to select none of the presented alternatives, which is defined as a no-choice option (DeSarbo et al., 1995). In this research context, participants were questioned to select the coopetition design for radical innovation they deemed as most attractive (preference). Multiple alternatives are presented to the respondents repeatedly, which can vary in terms of different levels.

The preferences can then be anticipated with the multinomial logit regression (MNL) where in form of choice probabilities *prob* an alternative *a* is chosen from a selection set of *J* alternatives (Louviere et al., 2000).

$$1)\quad prob_{i}(a|J) = \frac{exp\,(V_{ia})}{\sum_{j}^{J} exp\,(V_{ij})}$$

3.1. Experiment design

The scenario development started with searching for industries where coopetition strategies are predominantly applied, and an experimental setting is easy to understand for potential respondents. Since activities in high-tech industries may be perceived as too complex within an experiment, the conceptual framework is embedded in the *automotive industry* where coopetitive relationships are commonly applied (Akpinar & Vincze, 2016). In addition to the widely-known industry, established firms were selected where coopetition strategies can lead to an increase in technological innovation (Gnyawali & Park, 2011).

The scenario needed to be both novel and plausible at the time of the experiment (in 2016), we deliberately chose self-driving electric cars as a radical innovation example. To increase realism and comprehensibility we used established firms in our experiment, as they were likely to be well-known by the respondents. We have chosen Tesla, the German automotive firm Volkswagen (VW), and Daimler. Tesla is a pioneer and confirmed disruptor in the development of both self-driving and electric cars. VW, being one of the worlds' largest car manufacturers, was trying to catch up in the electric car sector while, Daimler, being one of the upper-level brands in the German-speaking countries, was one of the first established manufacturers that dealt with self-driving (e.g., Mercedes' F015 project as of 2015).

A set of four attributes (Louviere, 1988) was used. Each varying coopetition influencing factor represents an experimental attribute including two differing levels (Table 1). To foster realism and understanding of the attributes and levels, an explanation of the scenario put respondents in the role of an executive board member of the German automotive firm Volkswagen (VW). It was assumed that VW is increasingly confronted with internal and external pressures, such as the downward trend of sales figures of diesel cars. Consequently, VW decides to cooperate with equally prominent firms in the automotive sector to enter a *joint radical innovation strategy*, namely to develop a self-driving electric car with reduced battery charging. A pretest was conducted to determine the perceived level of radicalness regarding the innovation depicted in the scenario. Thus, 43 Business Administration students from a larger Austrian university indicated the degree of radical innovation of the following options: hybrid car, electric car, self-driving car, self-driving electric car and a self-driving electric car with reduced battery charging. The Gatignon et al. (2002) four item-measure was applied on a 5-point Likert scale. Respondents indicated that the self-driving electric car with reduced battery charging was perceived most radical (M = 1.60, SD = .69) and thus chosen as the radical innovation in the scenario. To make sure the joint innovation strategy succeeds between the competitive partners, several decision elements had to be taken into consideration. The attributes, that is: the number of partners, governance type, market conditions, and knowledge management (Table 1), including their relevant characteristics or levels were shown to the respondents.

Overall, 2^4 (2x2x2x2 = 16) possible combinations of radical innovation strategies were optimized by a Fedorov algorithm (Fedorov, 1972) to obtain a D-efficient full factorial design with twelve choice-sets (D-efficiency = 1). These were double-checked to avoid illusory combinations and were equally arranged to ensure balanced and orthogonal choice designs as well as minor overlaps (Kuhfeld et al., 1994). Furthermore, the chronological order of the choice-sets was systematically randomized including three randomly chosen hold-outs to estimate internal consistency. Thus, a total of 15 choice-sets was shown to participants to ensure validity among all observed decisions. All choice-sets consisted of three decision options, two diverse strategic options (the second option was a fold-over of the first one) and a *no-choice* option. An online questionnaire system was applied to carry out the choice-based conjoint analysis. Respondents also had the possibility to review a comprehensive table explaining the four attributes at any time during the experiment (Figure 2) via clicking a link. After the first decision, an additional page was integrated to remind the respondents to view the subsequent decisions regardless of the previous page. Furthermore, they were asked to read all questions and choice-sets carefully, which appears to be essential due to the complex nature of the scenario. It should be noted that we understand our design as experimental in line with the understanding of applying a manipulated, controlled, statistical design (Carson et al., 1994).

Figure 2. Explanation of attributes as seen by the respondents

Attribute	Level 1	Level 2
Number of partners	Cooperation with **one** competitor (VW with Tesla)	Cooperation with **more than one** competitor (VW with Tesla and Daimler)
Degree of formalization	Cooperation is based on **formalized** agreements (formalized governance)	Cooperation is based on **trust** and **handshake quality** (relational governance)
Market conditions	After 2020, all diesel cars will be legally prohibited by the ministry of environment (**market uncertainty**)	No differences in the current market conditions (**market certainty**)
Knowledge management	**Shared** development of batteries and technology (shared development)	**Isolated** development of batteries and technology (isolated development)

3.2. Measures

To control possible background effects that could explain the outcome of the experiment, control variables were included on the last pages of the online experiment (Table 2).

Table 2. Measures

Construct/Variable	**Role**	**Conceptual definition**	**Operational definition / Measurement**
Number of partners	Manipulated factor	The number of collaborating partners: dyadic versus multiple/network coopetition (Yami and Nemeh, 2014)	Attribute in experimental design with corresponding levels (2)
Governance type	Manipulated factor	Formal governance based on formal contracts and agreements or relational governance mechanisms based on, for instance, trust (Bouncken et al., 2016)	Attribute in experimental design with corresponding levels (2)
Market conditions	Manipulated factor	The particular industry will face a disrupting change in market conditions (defined as market uncertainty) or no changes in market conditions are expected (defined as market certainty)	Attribute in experimental design with corresponding levels (2)
Knowledge management	Manipulated factor	Cooperation is based on knowledge management that encourages the sharing of knowledge between competitors (defined as knowledge sharing) or on knowledge management that focuses on the protection of knowledge (defined as knowledge protection).	Attribute in experimental design with corresponding levels (2)
Strategic choice	Dependent variable	Coopetition shaping decision in a radical innovation project based on manager's preferences	Choice-based conjoint with three options depicted and a no-choice option
Attitude toward brand	Control variable	Predisposition regarding the depicted brands VW, Daimler, and Tesla.	Three items (good-bad, like-dislike and nice-not nice) scale from Chattopadhyay and Basu (1990) (applied on a 5-point semantic differential scale)
Age	Control variable	Age of the respondents	Age classes (under 20, 20-29, 30-39, 40-49, 50-64, above 65)
Gender	Control variable	Gender of the respondents	Binary question (female, male)
Professional status	Control variable	Professional status of the respondents	Status classes (Employee, executive, managing director, other)

To assess the potential effect of the named brands (VW, Daimler, Tesla) on the final results, the three-items scale (good-bad, like-dislike and nice-not nice) of Chattopadhyay and Basu (1990) was applied on a 5-point semantic differential scale for measuring attitudes towards brands. Back-translation from English to German and back was applied (Brislin, 1970).

For this study, control variables such as gender, age, place of residence, working status, hierarchy level, industry, number of employees as well as the firms' headquarters were added. The profession status level describes the participants' position in the respective firm and was divided into four sections: 1) employee, 2) manager, 3) managing director or member of top management and 4) other. The number of employees indicated the size of the firm resulting in: 1) 1 to 9 employees indicating micro enterprises, 2) 10 to 49 employees indicating small enterprises, 3) 50-249 employees indicating medium-sized enterprises, and 4) more than 250 employees indicating large enterprises.

3.3. Data collection

We draw a purposive online sample from top management team members from companies in the four German-speaking countries (Austria, Germany, Switzerland, Liechtenstein). Since these markets provide strongly export-oriented firms, the competitive pressure increases from neighboring countries, which supports clarity and understanding of the scenario.

We addressed the top management of the 25 largest companies in each of the countries, including a request to forward our invitation to other appropriate participants on the same level. Overall, of the 388 respondents that commenced the online experiment, 160 respondents provided all information and completed the questionnaire yielding a completion rate of 41%. Subsequent consistency checks of business background, response patterns (e.g., a participant always chose the no-choice option) and implausible responses (e.g., executives under 20 years of age) found no issues. Thus, no respondents had to be excluded.

Finally, non-response bias (Armstrong & Overton, 1977), using t-tests and chi-square association tests for early respondents (first quartile) and late respondents (forth quartile), common method bias (Podsakoff et al., 2003, comparing a common factor model with a noncommon factor model for the three attitude measures (in SEM) have been tested. Results indicated no biases.

4. Results

4.1. Descriptive statistics

Descriptive sample frequencies are provided in Table 3. Overall, 72% of the respondents were male while indicating a rather equal distribution of age. Place of residence showed that most respondents came from Austria (79%), followed by Switzerland (12%), Germany (7%) and Liechtenstein (2%). Further information about respondents' firm characteristics and hierarchy levels reveals that 93 executive managers (58%) and 67 managing directors or members of the executive board (42%) were among respondents. For the extent of this study, all participating employees were constantly controlled, if they could be entitled as decision-makers within a specific working scope. Nine respondents (pooled in field 'Others') evaluated themselves as self-employed, consultant, project manager, or head of office – all based on a business-related background (6%). Regarding the number of employees and firm size, slightly more respondents were part of large (46%) than of small (31%) or medium-sized firms (28%). This implies an equal distribution of industries and firm sizes, consistent with the finding that coopetition can evolve in all respective areas (Gast et al., 2015). Since the focus of the choice-based conjoint analysis as an experimental design is on internal validity, we deem this sample as sufficient for our research question.

Table 3. Respondents' characteristics

Control Variable		N	Share (%)
Gender		*160*	*100*
	Male	116	72
	Female	44	28
Age		*160*	*100*
	20-29	38	24
	30-39	28	18
	40-49	39	24
	50-64	50	31
	Over 64	5	3
Place of Residence		*160*	*100*
	Austria	127	79
	Germany	11	7
	Liechtenstein	3	2
	Switzerland	19	12
Professional status		*160*	*100*
	Executive (manager)	93	58
	Managing director (or executive board)	67	42
Firm size		*160*	*100*
	Micro enterprises (<10)	27	17
	Small enterprises (10-49)	31	19
	Medium-sized enterprises (50-249)	28	18
	Large enterprises (>250)	74	46
Branch		*160*	*100*
	Finance and insurance	15	9
	Manufacturing	41	26
	Construction	17	11
	Trade	13	8
	Services	11	7
	Tourism	11	7
	Education	18	11
	Other	34	21
Headquarters		*160*	*100*
	Austria	102	64
	Germany	12	7
	Liechtenstein	30	19
	Switzerland	16	10

Notes. Totals provided in *italics*.

4.2. Decision consistency and reliability

To investigate consistency among respondent's decisions, three repeated hold-outs were used by repeating choice-sets 1. 4 and 9 after the twelve experimental ones. Intraclass correlation coefficients (ICC) for fixed raters were applied to compare the relative consistency of each original decision (1. 4, 9) with its respective hold-out (Shrout & Fleiss, 1979). Values of .78 (10), .86 (4) and .74 (9) indicate a good relative consistency (McGraw & Wong, 1996). Regarding the scales of attitude towards the brands VW, Tesla and Daimler, principal component analysis (PCA) with minimum residual estimator as well as Cronbach's Alpha were conducted to assess dimensionality and reliability regarding internal consistency. All items loaded on their respective factor in single factor-PCAs as well as in a three-factor PCA, indicating the expected dimensionality and convergent as well as discriminant validity (lowest loading for VW: .80, for Daimler: .85, for Tesla: .90, no cross-loadings). Reliability was likewise no issue with Cronbach's Alphas of .87 (VW), .89 (Daimler), and .90 (Tesla). All other variables are manipulated or manifest, and thus cannot be assessed regarding consistency or reliability.

4.3. Model estimation

Based on the experimental design, we assume that each attribute as a latent construct contains a utility that can be portioned into a systematic and an error component (random utility theory). This systematic utility can be derived from the present choices by the MNL model (Louviere et al., 2000). Since we aim to obtain individual-level estimates of all factor utilities (partworth utilities), we apply a Hierarchical Bayes (HB) MNL from Markov-Chain-Monte-Carlo (MCMC) simulation with 20,000 Metropolis iterations and 10,000 burn-in iterations, that is the Markov chain had time to converge before the remaining 10,000 iterations were used to obtain partworth utilities as mean estimates assuming a normal distribution of partworth utilities. To check the convergence of the Markov chain, we applied the Geweke diagnostic, a test that compares the means of the first drawn estimates (near 10.000th iteration) and the last drawn estimates (near 20,000th iteration). Comparing the early 10% and last 50%, we found no significant differences in any model. Hence, convergence seems to be achieved.

Modeling consisted of three models. First, a control-only model is estimated, involving individual respondents' characteristics as control variables, namely the three attitudes towards VW, Daimler, and Tesla as well as age, gender, and status. Dummy variables were used for age, gender and status. Second, model 2 only estimates the four coopetition influencing factors (number of partners, governance type, market conditions, and knowledge management). Third, model 3 estimates both types, control variables, and influencing factors. Models are compared on the basis of BIC (Bayesian Information Criterion) and Pseudo R^2 (Cragg & Uhler, 1970). That is, a model is comparably better (to another one) if BIC is smaller and Pseudo R^2 larger. To ease interpretation, we also derived credible intervals for different widths as a function of a given p-value. For example, a p-value of .01 (1%) indicates a credible interval of [.005 & .995] since it contains 99% of the partworth distribution (typically indicated by ** in traditional frequentist statistics). That is, if the credible interval does not contain zero, its point estimate implies a Type I error of $\leq .01$ (1%) for the hypothesis of being "significantly" different from zero. Please note, that the number of observations is different for both types of variables, 160 observations for control variables and 5,760 (160x12x3) nested decisions for coopetition design.

4.4. Hypotheses tests

Table 4 provides results for the three models estimated. Model 1 indicates the highest BIC (7,445.26) of all models and thus inferior fit with a Pseudo R^2 of .00. That is, control variables do not account for preference in the choices, further illustrated by the result that no control variable shows a sufficient effect on choices, nor significance in terms of credible interval width. Comparing model 2 and 3, this insignificance of control variables remained stable after including coopetition influencing factors, yielding a higher BIC for model 3 (6,682.57) compared to model 2 (6,578.66) and equal Pseudo R^2 (.18). We thus conclude that model 2 is fitting the data best, and continue with hypothesis testing based on model 2.

Table 4. Model comparison

			Model 1			*Model 2*			*Model 3*		
Role	**Variable**	**Level**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**	**Estimate**	**SE**	**p**
Intercept			-.692	.004	n.s.	-1.031	.001	***	-1.090	.004	*
Influencing factors	Number of partners	Coop. with multiple competitors				.326	.001	***	.319	.001	***
	Governance type	Relational governance				-1.509	.001	***	-1.506	.001	***
	Market conditions	Market uncertainty				.853	.001	***	.850	.001	***
	Knowledge management	Shared development				1.281	.001	***	1.289	.001	***
	Attitude towards VW		-.006	.000	n.s.				-.002	.000	n.s.
	Attitude towards Tesla		.005	.000	n.s.				.000	.000	n.s.
	Attitude towards Daimler		.000	.000	n.s.				.001	.000	n.s.
	Age	30-39	-.003	.004	n.s.				.064	.004	n.s.
		40-49	.019	.004	n.s.				.052	.004	n.s.
		50-64	.015	.004	n.s.				.070	.004	n.s.
		Over 64	.021	.005	n.s.				.064	.005	n.s.
	Gender	Male	-.002	.001	n.s.				-.015	.001	n.s.
	Professional status	Executive	-.013	.001	n.s.				-.003	.001	n.s.
		Managing director	-.002	.001	n.s.				.000	.001	n.s.
Control variables		Other	-.007	.001	n.s.				-.002	.001	n.s.
Model	BIC		7,445.21			6,578.66			6,682.57		
	Pseudo R^2		.00			.18			.18		

Hierarchical Bayes (HB) MNL from Markov-Chain-Monte-Carlo (MCMC) (20,000 Metropolis iterations 10,000 burn-in iterations). Factor coefficients based on 5,760 decisions; control variables based on 160 respondents. SE: Naive standard error for estimate. p-values derived from credible interval (CI) comparison: ***: CI [.0005 & .9995] contain no zero, **: CI [.005 & .995] contain no zero, *: CI [.025 & .975] contain no zero, n.s.: all CI contain zero. Estimate: unstandardized fixed effect. Contrast categories for base: Cooperation with more than one competitor (Number of partners), Relational governance (Governance type), Market uncertainty (Market conditions), Isolated development (Knowledge management), 20-29 (Age), Female (Gender), Employee (Professional status). BIC: Baysian Information Criterion. Pseudo R2 is Nagelkerke / Cragg-Uhler R-squared calculated from Multi-nomial logic model with ML estimator.

The results show that multiple coopetition (VW with Tesla and Daimler) reveals a positive partworth estimate (Model 2: estimate = .326, 99.9 percent credible interval contains no zero). That is, multiple partnerships are significantly preferred over dyadic coopetition, supporting hypothesis 1.

Concerning hypothesis 2, relational governance mechanisms show a negative estimate (Model 2: estimate = -1.509, 99.9 percent credible interval contains no zero). Thus, respondents prefer the option indicating a higher degree of formalization and thus supports confirms hypothesis 2 that in coopetition for radical innovation, formal governance mechanisms are clearly preferred over relational governance mechanisms.

Regarding the coopetition influencing factor market conditions (market uncertainty vs. market certainty), a positive partworth estimate is found (Model 2: estimate = .853, 99.9 percent credible interval contains no zero). Hence, respondents perceive more utility for radical innovations if coopetition was to be carried out in an uncertain, rather than a certain market environment, supporting hypothesis 3.

Finally, for hypothesis 4, the effect of knowledge sharing shows a significant positive partworth estimate for shared development (Model 2: estimate = 1.281, 99.9 percent credible interval contains no zero). Therefore, hypothesis 4 can also be supported: In a coopetition setting aiming at radical innovation, knowledge sharing is preferred over knowledge protection.

Deriving the relative importance from these partworth estimates by dividing the range of each factor partworth utility (two times the absolute value of the estimate) through the sum of all partworth ranges yields 8% for number of partners, 38% for governance type, 22% for market conditions and 32% for knowledge management. This means that governance type is perceived most important for the respondents' decision, knowledge management second most important, market conditions second least, and number of partners least important. Please note that estimates in model 3 remain stable and no level of the control variables (age, gender, status) reaches significance (all 99.9 percent credible intervals contain zero). Thus, there are no differences in preference (partworth) for older or younger participants, women, and employment statuses.

5. Discussion

The way coopetition is designed determines how the benefits and risks are structured (Ritala, 2009), and contributes to our understanding of how managers shape their business context (Gavetti et al., 2017). The theory of planned behavior explains at the individual level of analysis that actual behaviors are strongly related to intentions to perform behaviors, which in turn can be predicted from attitudes towards behaviors (Ajzen, 1991). Hence, it is essential to understand the manager's preferences when it comes to designing a coopetition strategy for radical innovation.

Our experimental research study provides novel insights into the preferences of managers regarding the number of partners, governance type, market conditions and knowledge management, and identifies a clearly preferred design of coopetition for radical innovation. When striving for radical innovation, managers seem to recognize that engaging with many partners helps to overcome both individual and dyadic constraints, allows to reach for critical mass, and spread risks over many actors. In case of failure, a network has a higher capacity to cover respective monetary losses and prevent financial ruin as compared to dyads (Gnyawali & Park, 2009; Schiavone & Simoni, 2011). Interestingly, our experiment shows a preference towards network coopetition regardless of the dyad that managers may have considered. Indeed, a dyadic coopetition with either an incumbent player in the industry, or a technologically advanced player (Tesla) could have been chosen. The preference towards network coopetition supports the view that even two technologically strong firms are unlikely to develop and commercialize radical innovation alone, which is consistent with recent theoretical (Teece,

2018) as well as case-based claims (Fernandez et al. 2018). By involving many firms, the capacity of networked coopetitors to work out and impose technical standards increases (Teece, 2018). Interestingly, the fewer actors are left outside the coopetition network, the lower is the likelihood that radical innovation will appear outside the network. In our experiment, managers have reduced this risk to zero by involving all possible actors in a clear preference to unlock the true potential of coopetition (Czakon, 2018).

Our results show that governance is the single most important variable in shaping coopetition design. When competitors engage in coopetition for radical innovation, our findings reveal that managers prefer a coopetition design based on formalized contracts stipulating each party's privileges, obligations, rules, and punishments (Bouncken et al., 2016; Fernandez & Chiambaretto, 2016; Jiang et al., 2013; Salvetat et al., 2013). This is in line with previous literature suggesting that formal protection mechanisms are required to fully benefit from knowledge sharing mechanisms under coopetition (Ritala & Hurmelinna-Laukkanen, 2013; Fernandez et al., 2018). Since the development of radical innovations is of particular importance for the performance of many firms (Bouncken et al., 2017), opportunistic behavior may be likely to occur. The implementation of formal governance mechanisms allows coopetitors to minimize opportunism and to align their incentives, instead of solely relying on relational governance in the form of, for instance, social capital (Yami & Nemeh, 2014), or trust (Czernek et al., 2017). The preference towards formal governance mechanisms also supports prior literature views that relational governance may not offer sufficient enforceability in radical innovation settings and is therefore not regarded as effective for dealing with uncertainty (Grandori, 2006).

Regarding the relationship between coopetition design and perceived market uncertainty when engaging in radical innovation, our findings show a preference for market uncertainty conditions. Radical innovation typically involves situations of full structural ignorance, wherein information ambiguity is coupled with the inability to construct realistic scenarios (Gavetti & Rivkin, 2007). Scholars highlight the beneficial aspect of market uncertainty on coopetition adoption when looking for innovation in general and for radical innovation in particular (Ritala, 2012; Bouncken & Kraus, 2013). Coopetition leads to a uncertainty reduction by involving relevant actors, which contributes to control technology development trajectories (Gnyawali & Park, 2009; Yami & Nemeh, 2014). By involving all competitors, firms are able to collectively face high uncertainty, and thus reduce competitive uncertainty (Beckman et al. 2004). Therefore, the choice of multiple partners contributes to transform high market uncertainty into low market uncertainty. Additionally, we note that formal governance is the most relevant single factor in shaping the business context, which again contributes to reduce uncertainty (Grandori, 2006). In short, managers prefer to respond to market uncertainty through collective action, making this variable controllable.

Our findings indicate the importance of knowledge sharing mechanisms, whereas knowledge protection has no significant effect on coopetition for radical innovation. This result is interesting since previous research highlights that the protection of core knowledge and emerging novel innovations through an appropriability regime is a common strategy of large firms when they engage in coopetition for radical innovations (Ritala & Hurmelinna-Laukkanen, 2013; Bouncken & Kraus, 2013). Remarkably, the participants in our experiment prefer the shared development of radical innovations in cooperation with their competitors over knowledge protection. This effect could be explained by the fact that knowledge sharing and knowledge-integration as well as the flow of information between competitors represent an essential objective in coopetitive relationships (Enberg, 2012; Fernandez et al., 2018), especially when competitors cooperate for radical innovation. Since knowledge can constitute a competitive advantage but individual firms oftentimes possess only insufficient knowledge on their own (Enberg, 2012), participants in our experiment realized the importance knowledge sharing mechanisms with competing market players. In order to succeed, several conditions are ubiquitous – such as inter-personal trust or the existence of similar knowledge levels (Soekijad & Andriessen, 2003) as well as reciprocal learning effects, the creation of collective knowledge and the development of knowledge relevant routines (e.g. Ho & Ganesan, 2013). The main objective might even be the involvement of both mechanisms, knowledge sharing *and* knowledge protection, to ensure expedient outcomes of the relationship (Estrada et al., 2016).

6. Conclusion

This experimental study aimed at identifying choices preferred by managers when designing coopetition for radical innovation design. Our findings offer several noteworthy contributions to the literature. Our choice-based conjoint analysis invigorates coopetition research methodological diversity by looking at managers preferences, instead of exploring past actions. We contribute to a better understanding of actual coopetitive behaviors by laying down preferred options for radical innovation. We extend prior research which has rarely taken the pre-formation phase (Czernek & Czakon, 2016) in focus, and even less the preferences that precede decisions and actions.

6.1. Theoretical contributions

Understanding preferences is a major step in explaining behavioral variability across situations, even if several other factors come into play (Ajzen, 1991). Our findings advance extant literature by considering the four coopetition design attributes at the same time. We offer a clear picture of individual preferences important for exploring both actual decisions on coopetition for radical innovation, and their subsequent implementation. We thus contribute to examine the behavioral antecedents to coopetition. Prior research has tended to identify single factors relevant in shaping coopetition for radical innovation, which offered both fragmented and ambiguous results. Our study addresses this important gap by providing evidence on managers' preferences regarding the design of the environment in which coopetition for radical innovation may take place. Coopetition design affects both the type of relationships with competitors and shapes the context for radical innovation by including all relevant competitors.

Our results show clear preferences regarding the design of coopetition for radical innovation. Coopetition managers seem to prefer altering the business game from individual competition towards a positive sum coopetitive game (Brandenburger & Stuart, 2007). Their subsequent coopetition for radical innovation design choices demonstrate a preference for increasing the likelihood of success by involving all relevant actors, and by intensively sharing knowledge despite the risks typically associated with coopetition. By doing so managers are able to effectively address uncertainty typical to radical innovation. This rigorous finding offers a landmark for further studies of radical innovation coopetition, which may focus on why and how actually implemented coopetition designs deviate from this individual preference.

Secondly, by showing that network coopetition is preferred for radical innovation, we extend prior literature, focused mostly on dyads (Gnyawali & Park, 2009; Fernandez & Chiambaretto, 2016). The finding that network coopetition is preferred for radical innovation reveals that prior focus on dyadic coopetition is not covering the full scope of options, and misses the preferred option. Our study shows that radical innovation encourages managers to look for collective solutions to individual firm's challenges. While network-level studies of coopetition recently appear in tourism (Czakon & Czernek, 2016), innovation has been left relatively unattended in this respect. One reason why network coopetition for radical innovation is relatively less visible in the literature might be connected with the additional difficulties managers face when engaging with multiple coopetitors, which in turn would call for a dedicated managerial skillset and organizational capability (Park et al., 2014a). It is worth exploring this hypothesis in order to better understand why the preferred option is often not implemented. While for dyadic coopetition, the literature offers structural solutions for managing challenges inherent to radical innovation such as coopetitive project teams (Fernandez & Chiambaretto, 2016), much less is known for network settings.

Thirdly, we identify a preference for formal governance. Despite the ongoing debate about how formal and informal mechanisms relate (Czernek et al. 2017), or how governance matters in innovation oriented collaboration (Bouncken et al. 2019) our results indicate that managers prefer formal mechanisms over informal ones when pursuing radical innovation.

6.2. Managerial implications

It is increasingly important for managers to consider various factors in order to successfully innovate. By grouping a large number of partners and developing networks, firms can concentrate on own core competencies and derive benefit from the strengths of involved partners. Hence, managers ought to focus on developing individual skills and subsequent organizational capabilities necessary to properly frame strategic options (Gavetti, 2005) when aiming at radical innovation.

Radical innovation seems to be seen dependent on the environment. The more uncertain it is, the rather also the entrepreneurial opportunities arising from this context (Covin et al., 2016). This raises an emphasis on opportunity-seeking behaviors of managers depending on the extent of uncertainty in the market (which was, in our experimental setting, extraordinarily high for the case companies at the time the study was carried out).

Last, but not least, in a coopetition context aiming at radical innovation, transparency in investments and intellectual property rights need to be contractually regulated. If knowledge sharing is the preferred option, then both organizational settings and *formal* inter-organizational governance design needs to create favorable conditions for collective coopetitive radical innovation. This serves as the basis for the simplification of knowledge sharing and exchange between coopetition partners.

6.3. Limitations and further research agenda

Our study limitations are mainly attributable to the research design deployed. Experiments are very useful in understanding individual choices in a controlled environment. However, design choices limit the external validity of results. We have provided a simplified cognitive representation of the radical innovation problem managers face. One limitation arising from these choices refers to the possible effect of cultural and national variables. Since we only included participants from German-speaking, central European countries, our study's results may be limited in terms of applicability and generalizability to other national and cultural regions. We believe that, following Mullinix et al.'s (2015) estimation, purposeful samples such as ours "can play a fruitful role" and "are useful testing grounds for experimental social science" (p. 24). Hence, checking external validity in other cases or industries of radical innovation envisioned in the present or future can be valuable.

Furthermore, managers may have different cognitive representations than our experiment design, and the way they manage them is important for strategy framing (Gavetti et al., 2012). By focusing on the under-researched individual manager's preferences, we leave beyond the scope of attention the collective cognitive processes that shape the firm's dominant logic and directs actual actions. Therefore, it is important to investigate how the individual preferences transform into a collective understanding of the opportunities embedded in coopetition for radical innovation. By laying down evidence on individual preferences, we open ways for a more detailed look into the differences that may appear at various hierarchy level regarding preferences and actual actions may contribute to better understand the cognitive underpinnings of the firm's radical innovation output. More specifically, it is important to understand why many cases of coopetition for radical innovation are carried out in dyads, despite a clear preference for networks identified in our experiment. By uncovering the barriers for effective network coopetition, further research may foster collective radical innovation projects, and contribute to unlocking the true potential of coopetition.

We recognize that our experimental scenario involved large firms, which usually refer to formal governance in strategic actions (Poppo & Zenger, 2002), and prefer the acquisition of explicit knowledge and mutual understanding through contractually specified rights and obligations (Li et al., 2008). This extends recent experimental studies of SMEs preferences when coopeting with large firms (Chiambaretto et al. 2020). Similarly to that study our results may be connected with the ‘either-or’ decision, solely investigating preferences regarding one level of the respective variable was taken into account. Contractually specified agreements and relational governance might have a complementary role, which might be more applicable in practice (Czernek et al., 2017). More nuanced choices, instead of the “or-either” that our participants were asked to make, offer avenues for a fine-grained understanding of individual preferences when designing coopetition for radical innovation. Individual characteristics such as risk aversion may also contribute to the preference context and should be investigated in subsequent studies.

Further research may fruitfully focus on the interaction between coopetition design factors such as formal governance and knowledge sharing. Additionally, future research could look closer at individual factors with extended levels or characteristics, which influence coopetition and innovation. To mention only one, relational governance mechanisms combine various approaches highlighting interpersonal aspects in collaborative agreements. Apart from trust, social exchanges could be divided into mutual influence, cultural contingencies Rezaei et al., 2020) and commitment (Akdoğan & Cingšz, 2012; Murray & Kotabe, 2005; Muthusamy & White, 2005). Since the results indicate the importance of the factors governance type and knowledge management, further research in coopetition might focus on subsequent developments and investigations of formal governance mechanisms and knowledge exchange in an innovative strategy context.

A general preference of managers for multiple coopetition or network coopetition suggest that prior scholarly inclination towards studying dyadic relationships calls for urgent shift. While understanding that dyads are important to grasp paradoxes, and offer a simplified setting to carry on investigations, network coopetition appears as a predominant and preferred setting to managers. Our study encourages further network coopetition scrutiny.

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