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WHAT MAKES A FIRM INNOVATIVE? AN INTER-ORGANISATIONAL SOCIAL CAPITAL PERSPECTIVE ON EXTERNAL PARTNERS' INFLUENCE ON A FIRM'S INTELLECTUAL CAPITAL

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This research investigates how and to which extent the social capital inherent in a firm's external relationships to diverse business partners contributes to the firm's intellectual capital and in turn fosters its innovativeness. We apply the Social Capital Theory to an inter-organisational context and show how a firm's social relationships with its various external partners contribute to its intellectual capital, and how these contributions differ between different types of partners (e.g., customers vs. suppliers). In contrast to intra-organisational contexts, we show that the association between social capital and intellectual capital is positive, neutral, or even negative depending on the external partner's position *vis-a-vis* a firm's supply chain and the type of knowledge. Using data from 153 German manufacturing firms, the results of a PLS-based analysis provide important insights into how and through which mechanisms firms can become successful innovators.

Keywords: Uncertain relevance of knowledge; social capital; innovativeness.

Introduction

Research consistently shows that innovation is important for the growth potential and even survival of firms, and that it drives entire economies (Schumpeter, 1934). But what makes a firm innovative? When considering the notion of innovation networks with organisations as nodes and the relationships between these nodes as ties, extant literature addresses this issue from two perspectives. There are some studies considering characteristics of the nodes (Zaheer and Bell, 2005), their effect on knowledge (Pérez-Nordtvedt *et al.*, 2008), or the influence of other nodes' innovativeness on a focal firm's innovativeness (Moos *et al.*, 2015). Other studies focus on the relationships between nodes rather than characteristics of the nodes themselves, in particular, using a social capital perspective. In that regard, a key insight achieved over the years is that an organisation's social capital of relations to other entities enables knowledge flows from one entity to another (Schulz, 2003), which fosters the organisation's intellectual capital and organisational advantage (Nahapiet and Ghoshal, 1998), in turn affecting innovative capabilities (Subramaniam and Youndt, 2005).

Although extant literature applying the social capital lens provides a variety of valuable insights, some challenges have remained mostly unaddressed and opportunities left unused. Research has so far focused on social capital inside a firm (Tsai, 2000; Tsai and Ghoshal, 1998) but has neglected the firm's external network (as well as the study on knowledge transfer between network members by Inkpen and Tsang (2005); notable exceptions are the study on social capital's effect on the formation of inter-organisational networks by Walker *et al.* (1997). Yet, inter-organisational social capital may play an important role for a firm's intellectual capital as decisive antecedent of bringing about innovation because "few firms appear able to innovate alone" (de Jong and Freel, 2010). Inter-organisational social capital might also be "an interesting domain for further theoretical investigation" (Easterby-Smith *et al.*, 2008) because '(t)ransferring knowledge between organisations brings more complexity because of the multi-faceted nature of the boundaries, cultures, and processes involved' which in turn might lead to different effects and might need alternative explanations compared to firm-internal social capital. However, only a few studies investigate social capital inherent in a firm's external relationships (inter-organisational social capital). Such studies provide additional insights but should be furthered to go beyond specific coordination forms like strategic alliances to consider various types of external partners such as customers and trade associations. Different types of external partners might produce different results with respect to a focal firm because knowledge provided by external partners might be more similar and familiar (Coombs and Hull,

1998), or enable new trajectories when collaborating, e.g., with universities and government labs (de Faria *et al.*, 2010). In addition, knowledge from these external sources does not form a homogenous knowledge stock and it is useful to investigate the role of different types of knowledge (e.g., market knowledge vs. technological knowledge) in knowledge transfer (Sammarra and Biggiero, 2008).

Considering the arguments above, we focus on the relations between a focal firm and its different external partners, which we model as inter-organisational social capital, and their effect on a focal firm's intellectual capital. By focusing on inter-organisational social capital we address a topic almost neglected by extant research but suggested by Nahapiet and Ghoshal (1998) to investigate. They argue that internal organising is more conducive to develop high levels of social capital than market-based coordination, and they acknowledge that inter-organisational networks might also achieve high levels of social capital and that it would be useful to extend their analysis to inter-organisational settings. Further, we differentiate a focal firm's intellectual capital into a market and technological component because extant literature shows that these components are both essential and complementary to one another in achieving knowledge recombination for innovation success (Song *et al.*, 2005; Van den Bosch *et al.*, 1999). We model these ties as inter-organisational social capital and investigate how and why inter-organisational social capital between a focal firm and diverse external partners differentially contribute to a firm's intellectual capital split into a market and technological component. The aim is to better understand the transmission from the pure opportunity to access new external knowledge through inter-organisational social capital to intellectual capital, which is eventually transformed into innovation success (e.g., Lane *et al.*, 2006). The research question is as follows:

What is the differential effect of inter-organisational social capital with different types of business partners on a focal firm's intra-organisational intellectual capital?

To answer the research question, we draw on social capital theory (Nahapiet and Ghoshal, 1998) and on the concept of uncertain relevance of knowledge (Schulz, 2001), to develop a model connecting inter-organisational SC with intellectual capital, which is evaluated using data from 153 firms. We develop two research models at different levels of abstraction: At the high-abstraction level, our results show that inter-organisational social capital significantly contributes to the formation of a firm's market and technological knowledge (intellectual capital). At the low-abstraction level, we decompose social capital according to a focal firm's diverse partner types as well as intellectual capital according to different knowledge types to reveal the differential effects of social capital between a focal firm

and different specific types of partners on intellectual capital. Our study demonstrates to which extent inter-organisational social capital between a focal firm and its external network partners contributes to the focal firm's knowledge stock. In particular, we show that this effect depends on both the type of external partner and the type of knowledge.

In the following sections, we first introduce the underlying theoretical concepts and develop our research model. Then, we test the model based on quantitative data and finally discuss the results, implications, and limitations of our research.

Theoretical Background

Our model development is rooted in Social Capital Theory (Nahapiet and Ghoshal, 1998), which we complement by the concept of uncertain knowledge (Schulz, 2001). We thereby continue the stream of research regarding the interplay between a focal firm and its external partners (Moos *et al.*, 2015) and extend it by providing new theoretical considerations to add to our understanding of the mechanisms underlying the external partner's influence on a focal firm.

In this section, we will introduce three basic conceptualisations that will serve as a foundation for the development of our research model in the subsequent section. We first discuss social and intellectual capital in an inter-organisational context. Second, we introduce our conceptualisation of intellectual capital and knowledge sources. Third, we discuss the concept of uncertain relevance of knowledge.

Social and intellectual capital in an inter-organisational context

Social capital is "the sum of the actual and potential resources embedded within, available through, and derived from the network of relationships possessed by an individual or social unit" and intellectual capital represents "the knowledge and knowing capability of a social collectivity" (Nahapiet and Ghoshal, 1998).

Social Capital Theory (SCT) deals with relationships between actors (e.g., individuals, groups, firms) and highlights their importance for knowledge exchange and combination (McFadyen and Cannella, 2004; Nahapiet and Ghoshal, 1998). Social capital "inheres in the structure of relations between actors and among actors" (Coleman, 1988) and thus resides in relationships.

SCT predicts that social capital positively influences intellectual capital (Nahapiet and Ghoshal, 1998). As conceptualised in SCT, intellectual capital deals

particularly with social explicit and social tacit knowledge,[a] which we interpret as the knowledge stock of a firm that is shared among a firm's employees.

In our model, we conceptualise the relationships a firm has with its external partners using the social capital perspective. Thus, inter-organisational social capital is the social capital inherent in a focal firm's relationships with its external partners. Social capital positively influences the creation of intellectual capital "because social capital directly affects the combine-and-exchange process and provides relatively easy access to network resources" (McFadyen and Cannella, 2004). Social capital increases access to knowledge (Zahra and George, 2002) by providing the conduits for transferring knowledge (Hansen, 1999); by facilitating knowledge sharing (Alavi and Leidner, 2001) and by providing trusted relationships (Levin and Cross, 2004). Furthermore, social capital increases knowledge reach and richness (Sambamurthy *et al.*, 2003) by providing a shared language and a common frame of reference, and by lowering potential barriers to cooperation (Nelson and Cooprider, 1996). Social capital therefore facilitates the integration of new knowledge (Grant, 1996). Therefore, higher levels of inter-organisational social capital led to higher levels of intellectual capital.

Conceptualisation of intellectual capital and knowledge sources

Nahapiet and Ghoshal (1998) argue that "intellectual capital generally is created through a process of combining the knowledge and experience of different parties". Accordingly, the creation of intellectual capital needs both combination and exchange of knowledge. The authors further argue that the know-what, or specific knowledge contents, is an important factor to consider when investigating intellectual capital.

In the following paragraphs, we first turn to the types of knowledge and then discuss the contributions of different types of external partners.

We focus on two broad types of knowledge that have been suggested by extant literature to be the most relevant for a firm's innovation success: Market knowledge and technological knowledge (Lichtenthaler, 2009). Market knowledge represents knowledge about the external environment, and mainly about customers and competitors. It concerns not only the markets in which a firm is actually engaged, but also those that might be relevant to the firm in the future. Moos *et al.* (2015) lists several studies having investigated market knowledge, which are studies on knowledge about competitors and customers (De Luca and Atuahene-Gima, 2007), knowledge about suppliers (Gold *et al.*, 2001), knowledge about business partners (Nakayama, 2003), about industry information (Tippins and

[a]Please note that individual components are not part of Nahapiet and Ghoshal's concept of intellectual capital.

Sohi, 2003), and about market knowledge in general (Yli-Renko *et al.*, 2001). By contrast, technological knowledge refers to competence in and recognition of new technologies and practices to optimise or innovate production, business processes, products, or services. Prominent examples are IT knowledge (Bassellier *et al.*, 2001), technological competence (Ko *et al.*, 2005), and domain-specific and basic scientific knowledge (Matusik and Heeley, 2005).

We now will disentangle the aggregate term of 'external partners' (or short, partners, in the following) to refer to different types of external knowledge sources and argue that, in essence, by building on its inter-organisational social capital with different types of partners, the focal firm can raise intellectual capital composed of market and technological knowledge. The rationale behind is the assumption, also supported by SCT, that heterogeneity across partners is linked to knowing different things (heterogeneity of knowledge domains) and also to knowing things differently (heterogeneity of perspectives on similar knowledge domains), and fosters new combinations of knowledge and organisational learning. As discussed above, a firm's external social capital resides in relationships with its different types of partners. Specifically we draw on the partner type classifications from extant literature (Chen *et al.*, 2009; Laursen and Salter, 2006; Lesser *et al.*, 2000) and distinguish between customers, suppliers, commercial R&D service providers and public research institutions, which we call R&D partners (see also Moos *et al.*, 2015), and trade associations (e.g., industry associations and industry-wide working groups). Accordingly, knowledge sources (we use the term 'partner types' interchangeably) can be categorized in three groups: Vertical partners (customers and suppliers) are connected to the focal firm along the supply chain, horizontal partners (trade associations) are peers to the focal firm, and lateral partners are comprised of planned R&D partners (Moos *et al.*, 2015).[b]

Uncertain relevance of knowledge

For our argumentation of differential effects of inter-organisational social capital between a focal firm's different partner types and the focal firm itself on the market and technological knowledge of this focal firm, we draw on the concept of uncertain relevance of knowledge (Schulz, 2001) and link it to basic assumptions of SCT.

In their framework, Nahapiet and Ghoshal (1998) identify four conditions for exchange and combination of knowledge and thus for the creation of intellectual

[b]Moos *et al.* (2015) do additionally talk about "accidental relationships (friendship communities)" which individual managers of the focal firm might have with others (her personal network of professionals), but we neglect including these since they operate on a different level of analysis (individual level vs. firm level).

capital. These conditions are as follows: The accessibility of knowledge, the anticipation of value from exchange and combination of knowledge, the motivation to participate in the creation of intellectual capital, and the expectation that some of the value created can be appropriated. The authors further argue that social capital affects these conditions, which in turn facilitates the creation of intellectual capital.

Among these conditions, the anticipation of value from exchange and combination of knowledge is particularly important because "parties involved to avail themselves of the opportunities that may exist to combine or exchange resources [. . .] must anticipate that interaction, exchange, and combination will prove worthwhile, even if they remain uncertain of what will be produced or how" (Nahapiet and Ghoshal, 1998). In turn, anticipation of value may influence the motivation to engage with other parties in the creation of intellectual capital, renders the expectation of value appropriation more or less important, and influences the perceived importance of accessibility of knowledge. Further, anticipation of value relates to recognising the value of knowledge as highlighted by Cohen and Levinthal (1990), who argue that recognising the value of external knowledge, assimilating, and exploiting it form a firm's absorptive capacity, which is critical to its innovative capabilities. In that respect, recognising the value of external knowledge is a prerequisite to absorbing and finally exploiting this knowledge for commercial ends. Nahapiet and Ghoshal (1998) point out that the anticipation of value is important even if one is uncertain about what the outcome of exchange and combination will be and how this outcome will be created. The topic of uncertainty about whether certain exchange and combination produces value and to which degree, has been taken up by Schulz (2001), who introduced the concept of uncertain relevance of knowledge. The concept of uncertain relevance of knowledge posits that new knowledge bears an "unknown potential to affect everyone and everything. [. . .] The uncertain relevance of new knowledge contributes significantly to its allure, and it is probably one of the main reasons why it generates demand for 'news' which makes it attractive to consider" (Schulz, 2001). For example, if a focal firm's supplier has developed a new technology, this new technology is of uncertain relevance for the focal firm, because the potential benefits of the technology with regard to the focal firm's products and processes are unclear. Moreover, the firm is also uncertain about which changes in business practices it has to carry out in order to exploit this technology's potential. The firm has to anticipate the unknown potential of exchanging and combining knowledge with other parties. Although or even because the potential is uncertain, it may incline the focal firm to invest in exploration to assess whether this new technology can beneficially be combined with other pieces to make something new (Nahapiet and Ghoshal, 1998). Thus, the concept of uncertain relevance of knowledge relates to knowledge elements previously unknown to the firm but now

available through exchange that may broaden the combinatorial space among all accessible knowledge elements. However, before exploring new knowledge elements, there is a certain degree of uncertainty regarding the new knowledge elements and possible combinations' relevance to the firm's business practice. This consideration encompasses two aspects: First, the 'newness' of external knowledge is relevant: Incremental knowledge, which by definition builds on what is already known, has more certain relevance because it can be easily assessed based on already available knowledge. By contrast, unsettled and more radical knowledge departs substantially from existing knowledge making it hard to assess (Schulz, 2001). Second, the knowledge source's position or role in the focal firm's network is relevant. With this aspect we add a new perspective to the concept of uncertain relevance of knowledge. It not only depends on the degree of knowledge overlaps but also on the knowledge source's position or role in the focal firm's network as explained below. Taking both arguments together, the (perceived) certainty of knowledge relevance increases with

- Consistency of a knowledge source's knowledge, which is higher if the knowledge source is operating within the same domain as the focal firm because the knowledge is bound to a known domain and thus knowledge overlaps are probably high (Schulz, 2001).
- Credibility of a knowledge source, which is higher if the knowledge source is bound to the focal firm through recurrent activities and trusted relationships (Malhotra *et al.*, 2005) because the relation between the focal firm and the knowledge source exhibits high social capital (Nahapiet and Ghoshal, 1998), making knowledge offered to the focal firm of more certain relevance because of the knowledge source's credibility, or
- Competitive relevance of a knowledge source, which is higher if the focal firm depends on resources of the knowledge source because it affects the focal firm's profitability and thus its perceived knowledge exploitation opportunities (as it is the case with customers as knowledge sources where the focal firm depends on the probability of future demands) (Belderbos *et al.*, 2004).

Building on these arguments, we can now develop our hypotheses as per the type of the knowledge source and type of knowledge.

Model Development

Based on the conceptualisations derived in the previous section, we will now derive our hypotheses. In the resulting model, we investigate the inter-organisational social capital residing in the relationships between a focal firm and their partner

types such as customers or R&D partners. Drawing on existing research (Chen *et al.*, 2009; Laursen and Salter, 2006; Lesser *et al.*, 2000), we will differ between vertical, lateral, and horizontal partners to shed more light on differential effects driven by the difference across partner types. In addition, we will disentangle intellectual capital into different types of knowledge (i.e., market and technological knowledge), and examine the relationships between those in detail.

Relationship between the social capital with vertical partners and intellectual capital

Vertical partners are those partners that are connected with the focal firm through the focal firm's supply chain, which are customers and suppliers. Vertical partners provide knowledge of more certain relevance because of three reasons: The consistency of the knowledge source's knowledge, the knowledge source's credibility, and the competitive relevance of the knowledge source (differences between customers and suppliers will be indicated explicitly).

First, following our argument regarding consistency of a knowledge source's knowledge, knowledge sources operating within the same domain as the focal firm are more likely to exhibit knowledge overlaps making knowledge obtained from those sources of more certain relevance. Knowledge elements transferred along the supply chain are usually more comprehensible due to the same market and technological environment the companies along the supply chain are working in and allow companies "to incrementally build on the firm's existing internal knowledge" (de Faria *et al.*, 2010). Accordingly, similarity and familiarity characterize the knowledge bases of vertical partners and the focal firm (Coombs and Hull, 1998). This similarity eases knowledge transfer (Argote *et al.*, 2003) and makes knowledge elements easier to assess, i.e., the certainty about their relevance is higher. While the arguments above hold for vertical partners, in general, the following arguments differentiate between customers and suppliers.

For customers, we assume that market knowledge (customers' markets and positioning as well as moves in these markets) is provided along with knowledge about possible technological developments (Sammarra and Biggiero, 2008). Customers provide knowledge to their supplier (in our case: The focal firm) about the competitive landscape in the customer's market and also about competitors competing with the focal firm (Beckman *et al.*, 2004). Furthermore, customers provide knowledge to their supplier (in our case: the focal firm) about their market they compete in, including the customer's customers' needs, and which product features the customer may require from the focal firm in the future (Chatfield and Yetton, 2000; Rothwell and Dodgson, 1991). With respect to market knowledge, the consistency of suppliers' knowledge regarding a focal firm's market

knowledge is less clear. The supplier might nevertheless transfer knowledge about the focal firm's market which can be about the supplier's perspective on market developments based on its efforts to interpret market trends in the market relevant to the supplier where the focal firm is one of the many customers in that respective market. Suppliers may help by generating ideas and coming up with new concepts for products (Droge *et al.*, 2004) that affect the efficiency of the focal firm's manufacturing process and its cost structure (Ittner and Larcker, 1997). Furthermore, suppliers often provide knowledge in such a way that innovations are fostered at the supplier's customer (the focal firm, in our case), which in turn is beneficial for the supplier due to an increase in demand for the supplier's products (Atallah, 2002) that typically are used as components for the customer's products, e.g., as in the automotive industry.

Hence, we expect that the relation between customers and market knowledge is more pronounced as compared to the suppliers.

Regarding technological knowledge, suppliers might provide knowledge about future technologies that are relevant to the suppliers' products and in turn may open up opportunities for the focal firm's products if such technologies can be embraced. This knowledge provided by suppliers to the focal firm is of certain relevance as the focal firm may depend on the quality of the suppliers' products that they use to deliver quality products to its market and thus knowledge about technologies that may enhance suppliers' products will affect the focal firm's quality parameters, or help increase it, respectively. Similarly, early supplier involvement supports new product development of the focal firm by injecting new technologies suppliers may be specialized in and by suppliers' technology investments that complement those of the focal firm (Ettlie and Pavlou, 2006). Suppliers may also help reduce input cost uncertainty (Beckman *et al.*, 2004) by providing knowledge about input quality improvements (Belderbos *et al.*, 2004) and cost reduction or containment related to their factor market position and technological advances. Furthermore, collaborating with suppliers exhibits effects on labour productivity growth (Belderbos *et al.*, 2004) and on a focal firm's innovativeness by using the knowledge of intermediate goods suppliers in a focal firms development activities (Freel and Harrison, 2006). As discussed above, a focal firm's technological knowledge might further be influenced because customers provide knowledge about their markets along with knowledge about possible technological developments (Sammarra and Biggiero, 2008). Customers may also help reduce competitive uncertainty by providing knowledge about the focal firm's competitors in the technological domain (Beckman *et al.*, 2004). For example, customers may use products from different suppliers where the focal firm is one of these suppliers. Accordingly, customers may transfer knowledge about the technologies they use for their own products, technologies they come across with the

focal firm's competitors, and they may foster quality processes including the use of state-of-the art technology (Chatfield and Yetton, 2000; Rothwell and Dodgson, 1991). Hence, we expect that the relation between customers and technological knowledge is similar to suppliers.

Second, as discussed above, the knowledge source's credibility due to recurrent activities and trusted relationships increases the certain relevance of knowledge obtained from those sources. Customers may be ascribed an expert status in the relevant market and suppliers may be ascribed an expert status in specific technology domains, which affects knowledge creation (Argote *et al.*, 2003) and may lead to the propensity to accept and explore knowledge from those partners even if it is of uncertain relevance. This reasoning is also based on the assumption that companies bound to each other in a supply chain can be assumed to have more knowledge about the needs of their partners based on contractual agreements but also based on their experiences in daily operational procedures and interlinked processes that provide a basis for recurrent information sharing (Malhotra *et al.*, 2005). Firms also tend to exhibit a local search behaviour when looking for new knowledge. This is in part due to the effort needed to build external knowledge circuits by learning norms and habits, and how to absorb knowledge provided over these circuits (Laursen and Salter, 2006). Consequently, companies often rest on partners that they already know. Here, they are able to assess their capabilities and have less uncertainty, compared to partners with hitherto unknown characteristics — which leads to a set of companies close to the focal firm (Li and Rowley, 2002). This effect of 'closeness' can be even enhanced because "the greater the uncertainty that a firm's market or industry faces, the more likely that firm will strengthen the ties it presently has" (Beckman *et al.*, 2004). Companies linked via a supply chain can be regarded as an instance of those 'close' firms, which leads to searching new knowledge more intensely along the supply chain and ascribing this acquired knowledge to higher relevance because of higher closeness. Taken together, the arguments above regarding the knowledge source's credibility, we do not expect differences between the effects of focal firm's relation to customers and suppliers and a focal firm's market or technological knowledge.

Third, as introduced above, the competitive relevance of a knowledge source may play a role. Knowledge is of more certain relevance if the focal firm depends on resources of the knowledge source that affect the focal firm's profitability and thus its perceived knowledge exploitation opportunities (Moos *et al.*, 2013). A focal firm's partners may differ in their role as knowledge source, in that some deliver more incremental knowledge and some deliver more radical knowledge and help define new trajectories (Van Den Bulte and Wuyts, 2007). Other firms, such as customers, may also provide more radically new knowledge, e.g., based on

their experiences in market segments other than served by the focal firm. This knowledge might be of higher relevance in the case of customers because customers deliver it together with an application domain and thus reveal an exploitation opportunity. In addition, customers place orders, or they signal that they may place orders for new products and services in the future, which directly affects a firm's future economic benefit and leads to considering customer input seriously when developing new products (Maurer *et al.*, 2011). Overall, "collaboration with customers is important to reduce the risk associated with the market introduction of innovations" (Belderbos *et al.*, 2004). Accordingly, demand uncertainty — which is related to changing customer preferences — is reduced (Beckman *et al.*, 2004) and demand forecasts are more accurate. Moreover, the possible future increase in demand for a new product further induces accepting knowledge from customers which is additionally facilitated because there is no fear of information leakage as would be the case compared to collaborating with competitors (Atallah, 2002). Further, customers help reduce competitive uncertainty by providing knowledge about the focal firm's competitors and respective strategic moves (Beckman *et al.*, 2004). Taking all considerations together, knowledge from customers is directly connected with the customer's value perception of the firm's products and what customers deem relevant to the future development of the products. Thus, knowledge from customers affects the identification of exploitation opportunities (Shane, 2000) by extending a focal firm's existing knowledge base based on interaction with existing partners (Beckman *et al.*, 2004) and thus affects the economic benefit of firms. Consequently, this knowledge is linked with future economic benefits that the focal firm can reap and thus is of certain relevance.

Similarly, for customers, knowledge provided by suppliers to the focal firm (where the focal firm is in the role of the customer) will be of more certain relevance because suppliers have specialized competence in what they do and this competence is already used in the supply chain to build products. Nevertheless, the arguments provided above with regard to the competitive relevance of a knowledge source indicate that customers provide knowledge of higher competitive relevance compared to suppliers.

To sum up, partners connected along the supply chain provide knowledge with more certain relevance to the focal firm because they are operating in familiar markets where the opportunities, e.g., for finding new applications and combinations of existing technologies and new market knowledge are greatest (Kogut and Zander, 1992; Tsai and Ghoshal, 1998). This is in line with the results of the study by Laursen and Salter (2006), who show that the most important knowledge sources are suppliers and customers, and with the study by Atallah (2002) demonstrating that vertical spillovers (spillovers between buyers and sellers) are almost

always positively related to R&D efforts. In a similar vein, Schulz (2003) argues that knowledge relevance affects how much knowledge is transferred and where knowledge flows to. Consequently, supply chain partners provide more certain knowledge leading to an increased knowledge flow to the focal firm. Thus, the anticipation of value from exchange and combination of knowledge is easier to assess in case of vertical partners because of the consistency of knowledge, the credibility of partners, and the competitive relevance of these partners. Social capital affects anticipation of value through providing network ties between the focal firm and supply chain partners for exchange, shared language as a frame of reference to assess likely benefits, and identification with other parties that are seen as reference group again fostering the recognition of opportunities (Nahapiet and Ghoshal, 1998). Consequently, knowledge is easier exchanged and combined with vertical partners than with other types of partners, which leads to the creation of intellectual capital. Nevertheless, as we argued above, there are differences among vertical partners. We expect customers to provide knowledge with more certain relevance to the focal firm compared to suppliers because of the competitive relevance of customers and the consistency of customers' market knowledge related to the focal firm's market knowledge. Therefore, we hypothesize:

Hypothesis 1 (H1a/b): Higher levels of inter-organisational social capital regarding vertical partners lead to higher levels of intellectual capital in terms of (a) market knowledge and (b) technological knowledge.
Hypothesis H1c: The effect of inter-organisational social capital with customers on intellectual capital in terms of both market and technological knowledge will be higher compared to suppliers.

Relationship between the social capital with lateral partners and intellectual capital

Our next partner type is lateral partners who are substantiated as R&D partners in our context. In the course of innovation, firms search for partners that allow for incremental development of a firm's knowledge, and partners help define new trajectories where examples for the latter might be universities and government labs (de Faria *et al.*, 2010) that are subsumed under our term R&D Partners we now discuss first. Like in the previous section, our discussion considers three reasons why R&D partners might provide knowledge of more certain relevance: The consistency of the knowledge source's knowledge, the knowledge source's credibility, and the competitive relevance of the knowledge source.

First, in contrast to connections with vertical partners, consistency of R&D partners' knowledge is less pronounced. Firms often collaborate with R&D partners in the early stages of technology development. Consequently, in that stage uncertainty is rather high (Karlson and Callagher, 2012), approaches are unstructured and complex, and it is hard to predict success, which in part is "due to the unexpected and unknown interactions between and among knowledge sets" (Macher, 2006). This relates to R&D partnerships that are forms of exploration and directed towards expanding knowledge (Beckman *et al.*, 2004). Connected with the notion of exploration "is that the future value of new technologies, products, and processes is inherently uncertain" (Frankort *et al.*, 2012).

Considering that R&D partners (e.g., universities) often provide solutions to different industries, such as automotive and aerospace, and are not integrated into the focal firm's supply chain like suppliers, R&D partners are likely to exhibit more diverse knowledge compared to the knowledge provided by vertical partners. More diversity of knowledge is needed to provide sufficient learning opportunities (Argote *et al.*, 2003) but at the same time, more diversity hampers understanding because connections with existing knowledge are not easy to find (Baum *et al.*, 2010). Thus, while diverse external knowledge complements a firm's knowledge, which may lead to more radical new knowledge combinations, this external knowledge exhibits higher ambiguity at the same time and is therefore of more uncertain relevance.

Credibility of the knowledge source is the second consideration. R&D Partners are typically chosen due to complementarity of their knowledge but also due to their credibility. Firms enter technology alliances, in particular, in the early stages of technological development to get access to complementary knowledge but also to tap into "the social capital that is engendered by a partner's central position in its industry network" (Vasudeva *et al.*, 2013) and through it get access to further complementary knowledge. Vasudeva *et al.* (2013) find that a partner firm's social value which is based on this partner's connectedness and social capital with third parties in the industry increases the probability of alliance formation. Particularly in corporatist countries such as Germany (which is the empirical context of the study at hand), the development of partnerships is encouraged through norms that foster consensus and cohesion. Corporatist countries are characterized by "an emphasis on coordination and inclusiveness among the society's stakeholders, with organized interest groups holding stable positions in society and formally participating in the formulation and implementation of economic policy" (Vasudeva *et al.*, 2013). Thus, partner-related criteria of partner selection are in the foreground which are not necessarily connected with immediate benefits of gaining access to new knowledge but foster long-term gains (Vasudeva *et al.*, 2013). These partner-related criteria

encompass aspects such as compatible goals and culture, reciprocity, or prior ties and trust between top managers (Cummings and Holmberg, 2012), and they are thus based on prior experience or recurrent activities in the R&D domain. Further, social value depends on a partner's centrality in an industry network which makes this partner more prominent (Vasudeva *et al.*, 2013). At the same time, this prominence and centrality can only be achieved if a partner is known for well-behaving in partnerships (Frankort *et al.*, 2012), which makes the partner credible and fosters diffusion of knowledge due to the "confidence in source integrity and solid faith that the knowledge transferred will be returned in kind" (Rycroft, 2007). Thus, if there are trusted relationships to R&D partners and hence social capital is strong, transfer of knowledge that is of more certain relevance for the focal firm because of the knowledge source's credibility can be expected.

The third consideration refers to the competitive relevance of R&D partners. As discussed above, knowledge is of more certain relevance if the focal firm depends on resources of the knowledge source affecting the focal firm's profitability. In contrast to vertical partners, R&D partners are known to deliver more radical knowledge, which helps define new trajectories (Van Den Bulte and Wuyts, 2007). R&D partners provide access to knowledge needed to gain or sustain a technological leadership position (Karlson and Callagher, 2012) to aim at innovations with the potential to create new markets (Belderbos *et al.*, 2004) and to locate new technological knowledge and get an overview of trajectories in an industry (Eisenhardt and Santos, 2002). Thus, R&D partners are an important source for new knowledge (Cassiman and Veugelers, 2006), which affects the focal firm's future profitability and its perceived knowledge exploitation opportunities. In turn, the (perceived) certainty of relevance of knowledge provided by R&D partners increases. However, in contrast to customers, R&D partners' competitive relevance is lower because they do not place orders directly affecting a firm's profitability and may influence future market demands only indirectly while customers' value perception of the firm's future products drives down demand uncertainty.

The anticipation of value from exchange and combination of knowledge is not as easy to assess in the case of R&D partners as compared to vertical partners because the consistency of knowledge is lower, the credibility of partners might be comparable, and the competitive relevance of these partners is less. As discussed above, social capital affects anticipation of value, e.g., through providing network ties between the focal firm and its partners (Nahapiet and Ghoshal, 1998). Consequently, knowledge is exchanged and combined, and intellectual capital is created but more on the side of technological knowledge, which is more readily provided by R&D partners as compared to market knowledge. Furthermore, the

effect of social capital with R&D partners on intellectual capital should be lower compared to vertical partners because anticipation of value is more difficult as discussed above. Therefore, we hypothesize:

Hypothesis H2a/b: Higher levels of inter-organisational social capital regarding R&D partners lead to higher levels of intellectual capital in terms of (a) market knowledge and (b) technological knowledge.
Hypothesis H2c: The impact of inter-organisational social capital regarding R&D partners on intellectual capital is stronger for technological knowledge than for market knowledge.
Hypothesis H2d: The effect of inter-organisational social capital regarding R&D partners on intellectual capital in terms of both market and technological knowledge will be lower compared to vertical partners.

Relationship between the social capital with horizontal partners and intellectual capital

As horizontal partners, we recognize other member firms of trade associations the focal firm is a member of (in the following we briefly use the term "trade association"). Trade associations are industry bodies that are established and funded by organisations operating in a specific industry like the Mechanical Engineering Industry Association in Germany. Those trade associations provide networking opportunities and form working groups among member firms to collaborate in specific areas such as the Research Association for Power Transmission Engineering within the above-mentioned trade association, in particular, in the pre-competitive area where it is about laying foundations for future applications. Like in the sections above, we discuss three reasons for the provision of knowledge of more certain relevance.

First, the consistency of horizontal partners' knowledge is based on the fact that member firms of trade associations belong to the same domain regarding served markets and also technologies used like the focal firm, so that knowledge overlaps exist, or what Li *et al.* (2008) call low levels of information asymmetry. However, trade associations exhibit various working groups on different topics such as technological trends, but also joint manufacturing or marketing activities, which leads to a much broader scope of activities compared to a focal firm's supply chain partners. Trade associations often exhibit related resource bases as firms represented in such associations often serve comparable market needs or even are competitors. For example, knowledge from trade associations can be useful for benchmark comparisons when looking for ways of how to improve

innovation governance (Moos *et al.*, 2015). Nevertheless, particularly in turbulent environments, market knowledge is heterogeneously distributed among competitors which, in our case, are member firms of trade associations (Semadeni and Anderson, 2010), so that knowledge is not as consistent compared to vertical partners and thus increases the uncertain relevance of knowledge. However, specific member firms of trade associations who perform certain activities might be ascribed superior market knowledge (Semadeni and Anderson, 2010), which may lead to the perception of more certain relevance of knowledge.

Second, for assessing the credibility of trade associations, we refer to the arguments of Li *et al.* (2008). In that regard, trade associations resemble the notion of acquaintances. Acquaintances are characterized by "relatively low levels of information asymmetry and semi-strong or weak trust" creating "a serious situation for firms [i.e., members of trade associations] concerned about opportunism because it is likely that acquaintances can succeed in stealing their partners' core technologies" (Li *et al.*, 2008). That is, a trade association's knowledge is sufficiently consistent with the focal firm's knowledge to make use of it. But, at the same time — particularly when considering that member firms of trade associations are often competitors — this opens the door for opportunistic behaviour, which decreases credibility and thus makes knowledge offered to the focal firm of more uncertain relevance.

Third and as previously discussed, the competitive relevance of trade associations relates to the focal firm's dependency on resources of trade associations that affect the focal firm's profitability and its perceived knowledge exploitation opportunities. As trade associations and the focal firm deal with related markets and technologies, the knowledge provided through trade associations facilitates "the innovative process by enabling the [. . . focal firm] to make novel associations and linkages" (Cohen and Levinthal, 1990). In addition, cooperation, also with competitors, fosters innovation activities, leading to novel products (Belderbos *et al.*, 2004). However, compared to vertical partners, the competitive relevance is lower because they do not directly influence actual and future demand for the focal firm's offerings.

To sum up, and similar to R&D partners, the anticipation of value from exchange and combination of knowledge is not as easy to assess as compared to vertical partners because the consistency of knowledge, the credibility of partners, and the competitive relevance of trade associations are lower. As discussed above, social capital affects anticipation of value, e.g., through providing network ties between the focal firm and vertical partners for exchange and shared language and codes (Nahapiet and Ghoshal, 1998). Accordingly, the effect of social capital with horizontal partners on intellectual capital should be lower compared to vertical

partners because anticipation of value is more difficult as discussed above. Taking the above arguments together, we propose:

Hypothesis 3 (H3a/b): Higher levels of inter-organisational social capital regarding trade associations lead to higher levels of intellectual capital in terms of (a) market knowledge and (b) technological knowledge.
Hypothesis H3c: The impact of inter-organisational social capital regarding trade associations on intellectual capital (market knowledge and technological knowledge) is weaker compared to vertical partners.

Methodology

We collected data through a survey carried out in the German manufacturing industry. To detect the effects of different external partner types' influence on innovation success, a firm must exhibit a minimum level of diversification of external partners and be able to focus on linkages where benefits are potentially high. Thus, similar to the argumentation of Cantwell (2002), our sampling focused on larger firms that typically have the resources and routines to involve various external partners. Further, we did not select the overall firm as the level of analysis but their most important (i.e., largest, most significant) product division. Firms often encompass various product divisions serving different markets with different technologies, different partners, and different degrees of success. Focusing on a single product division allows avoiding aggregation effects at the firm level and allows selecting survey participants that are closer to the study variables examined.

Empirical context and data collection

We identified the 2,500 largest German manufacturing firms (SIC codes 3011-3999) by revenue[c] and contacted each firm by phone to identify the senior manager responsible for the most important product division. For 2,160 firms, we were able to identify the person in charge of the selected product division or the manager responsible for the innovation activities in this division. We sent our survey to these managers and, after two rounds of reminders, received 229 completed questionnaires. These senior managers answered all questions and provided their assessment of relationships to all external partners. In the following

[c]All firms' revenues are above the European Union's definition for Small and Medium Sized Enterprises (50 Mio €).

analyses, we have used those data which showed no missing values regarding the items used ($n = 159$).[d]

Measurement

The questionnaire is based on a review of the literature on social capital, partner types, and organisational knowledge. In that respect, four experienced researchers extracted measurement instruments from 97 journal articles,[e] assessed them regarding content validity and suitability regarding our research domain, and developed the questionnaire. The subset of measures which was identified by the project team to most adequately fit to our theoretical constructs was included in a pretest conducted in eight firms (think-aloud approach with innovation managers). This led to several refinements in order to eliminate ambiguities, improve understandability, and to better adapt them to our research domain and to the target group's terminology. The pretests showed that the concept of intellectual capital and its respective constructs (market knowledge and technological knowledge) were the most sophisticated components. Therefore, we additionally carried out a card-sorting procedure with industry experts: They were asked to assign cards (encompassing one measurement item per card) to the respective knowledge constructs. After conducting these tests, three items had not been assigned to constructs as expected. We deleted one of these three items and re-formulated the two other items to ensure consistent grouping. Finally, the measurement instrument was again pretested by six representatives of companies responsible for innovation management. These pretests showed consistent answering behaviour so that no additional adaptation deemed necessary. The final instrument encompasses reflective measures (3–4 per construct) for each construct and is shown in detail in Table A.1 in Appendix A.

We operationalised inter-organisational social capital for each partner type as a second-order construct by separately capturing the three different dimensions of social capital (Nahapiet and Ghoshal, 1998): The structural dimension deals with the existence and strength of links between actors and their structure. These links refer to the interaction between actors and facilitate the flow of information (Granovetter, 1973). Second, the relational dimension of social capital involves mutual respect and trust that develop over time (Granovetter, 1985). Trust, in turn, improves the exchange and integration of knowledge among actors and also guides further actions through the creation of mental maps or models that act as

[d]Later on, we will explain how we compared the data from the 159 responses with the remaining 70 answers to make sure that our results can be at least generalized to our overall data set.

[e]The list of articles and instrument items can be provided upon request. We screened all major management journals. Most of the 97 articles found were published in the Journal of Marketing (19 articles), the Journal of Product Innovation Management (16), and in the Strategic Management Journal (15).

filters for information and lead to an increase of congruency regarding the perception of information (Galunic and Rodan, 1998; Hansen, 1999). Third, the cognitive dimension of social capital deals with shared vocabulary, narratives, and interpretations (Nahapiet and Ghoshal, 1998). As with trust, the development of relationships over time also leads to a greater understanding by creating a common language and symbols (Galunic and Rodan, 1998), which in turn improves the exchange of knowledge.

Each social capital dimension was measured for each partner type by three reflective items.

Intellectual capital existing in the firm's product division was operationalized by market knowledge and technological knowledge being separate constructs (compare Lichtenthaler, 2009).

To partial out rival explanations for intellectual capital, we used several control variables (Moos *et al.*, 2015): firm size (revenue),[f] size of the R&D activities of the product division (number of R&D employees (absolute and relative to division)),[g] importance of the product division for the firm (single item), strategy type (based on Droge *et al.* (2008), with a scale ranging from 'focusing on optimization of processes' to 'focusing on innovation leadership'), environmental turbulence (three reflective items based on De Luca and Atuahene-Gima (2007) and Jaworski and Kohli (1993)), and job experience of the respondent (two items: Level of current position and number of years holding the current position).

Data analysis

For evaluating the model, we used partial least squares (PLS) and applied SmartPLS 3 (Ringle *et al.*, 2015). PLS was favoured over covariance-based structural equation modelling approaches since its focus is not on fitting a coherent research model to the data but to maximise explanatory power for the dependent variables (i.e., intellectual capital of the product division) (Hair *et al.*, 2017; Rigdon, 2016).

Given the complex three-layered operationalisation of the Social Capital construct, we had to consolidate the scores of the items to scores of the first-order constructs (via confirmatory factor analysis) before running the PLS model. The model was then tested using the recommended standard parameterization in SmartPLS (c.f. Hair *et al.*, 2019). For testing the significance of the estimation results, we used the bootstrapping procedure with 5,000 samples.

[f]The effect of industry type was not tested because we surveyed only the manufacturing industry.

[g]We were not able to use the product division's R&D budget as further control variable because we achieved too many missing values (this would have reduced the data set from 153 to 123). However, testing the model with this smaller data set, showed structurally the same results.

Results

Data quality

Before evaluating the PLS model, the data needs to be evaluated regarding distributional assumptions. We checked for outliers (none available) and tested the item-level data for being normally distributed. Some of the items showed some deviation from the normal distribution, which was another reason for using PLS, since this approach has proven to be more robust than other Structured Equation Modeling (SEM) methods (Hair *et al.*, 2019).

We also tested the data on non-response bias, by comparing the answers given by early respondents and those that had only answered after a reminder call or mail. The test did not show significant differences in the items used. Further, we compared the demographics of revenue and number of employees of those firms that answered with those that did not answer. The results of this test showed again no significant differences.

Measurement evaluation

We then moved on and evaluated the measurement model in PLS. The quality criteria ensuring reliability and validity of the measurements, according to the state-of-the-art sources such as (Hair *et al.*, 2019), are mostly fulfilled[h]: 57 of the 62 loadings are larger than 0.7 and all are highly significant (cf. Table A.1 in Appendix A which also shows the questionnaire items); five items are below 0.7, but three of them are at least larger than 0.6 (as suggested in Bagozzi and Yi (1988)). The remaining two belong to the 36 items of the SC construct; they are larger than 0.5 and we decided to leave them in the model to ensure that social capital was measured identically for all partner types.

Further, composite reliability of the constructs is larger than 0.83 in all cases, Cronbach's alpha is larger than 0.7, and the AVEs of all (first-order) constructs are larger than 0.63 (i.e., sufficient convergent validity) (cf. Table A.2 in Appendix A) and also larger than the squared correlations of the construct scores with any other construct scores (cf. Table A.3 in Appendix A); correspondingly, the loadings of the indicators are higher than their correlations with any other construct (i.e., sufficient discriminant validity).[i] Additionally, the HTMT ratios also confirm discriminant validity (Gold *et al.*, 2001; Henseler *et al.*, 2015), as almost all values are clearly below 0.85; just one ratio is 0.88 (cf. Table A.4).

[h]In the next section, we test different variants of our research model. The test statistics, given in the Appendix, result from testing the full, aggregate model ("Model I"). Nevertheless, the other variants fulfill the quality requirements as well.

[i]Due to length restrictions, we did not include the extensive table of cross-correlations in this paper but will of course provide it upon request. Similarly, the table of inter-item correlations could not be inserted here because of its size, but can be delivered, as well.

Testing the hypotheses

After the data and measurement model have been shown to provide the necessary quality, we looked at the structural model. Table 1 shows the results by providing the path coefficients, their level of significance, and the R^2s.

Table 1. Model test results.

Model (standardized path coefficients)	Controls only		Complete model	
Dependent variable:	IC-MK	IC-TK	IC-MK	IC-TK
SC with customers			**0.368*** **	**0.447*** **
SC with suppliers			0.059	0.035
SC with R&D partners			0.055	**0.216***
SC with trade associations			−126	0.096
Firm size	0.066	0.145*	0.053	0.105
Size of R&D	0.048	0.013	0.003	0.075
Relative size of R&D	0.056	0.064	0.021	0.000
Importance of division	0.195**	0.141*	0.101	0.005
Strategy	0.062	0.030	0.076	0.038
Turbulence	0.138	0.100	0.080	0.024
Position of respondent	0.040	0.020	0.051	0.002
Experience of respondent	0.083	0.158*	0.041	**0.162****
R^2	0.068	0.084	0.278	0.401
R^2 adjusted	0.027	0.044	0.219	0.352

Notes: Legend: SC = Social Capital; IC-MK = Intellectual Capital/Market Knowledge; IC-TK: Intellectual Capital/Technological Knowledge. Significance levels: * : 0.05; ** : 0.01; *** : 0.001.

We see that social capital with customers has a strong and significant impact on both dimensions of intellectual capital, followed by social capital with R&D partners which contributes to technological knowledge only. Relationships for all other hypotheses remained insignificant.

Next, because the social capital scores for the different partner types are not perfectly unrelated, i.e., not linearly independent, we used a hierarchical deconstruction approach, retesting the model after having removed the strongest social capital factor (i.e., with customers) (Model I in Table 2) and subsequently removing another SC factor, respectively (resulting in three different models II to IV).

In Table 2 we can see that, after removing the customers, social capital with another partner type becomes significant; most consistently, it is the R&D partners. If those are removed as well (Model III), trade associations become significant and outperform the suppliers.

Table 2. Relative effects of each type of partner.

Model	Complete model		Model I		Model II		Model III		Model IV	
Dependent var.	IC-MK	IC-TK	IC-MK	IC-TK	IC-MK	IC-TK	IC-MK	IC-TK	IC-MK	IC-TK
SC with customers	**0.368*** **	**0.447*** **								
SC with suppliers	0.059	0.035	0.098	0.041	0.129	0.051	0.131	0.123		
SC with R&D partners	0.055	**0.216***	**0.176***	**0.351*** **	**0.232****	**0.406*** **			**0.185***	**0.349*** **
SC with trade associations	126	0.096	0.085	**0.196***			**0.210***	**0.241****	**0.166***	0.127+
Firm size	0.053	0.105	0.081	0.138*	0.075	**0.151***	0.091	**0.141***	0.073	**0.132***
Size of R&D	0.003	0.075	0.033	0.039	0.046	0.028	0.022	0.050	0.037	0.037
Relative size of R&D	0.021	0.000	0.027	0.012	0.015	0.015	0.012	0.015	0.001	0.003
Importance of division	0.101	0.005	0.142	0.049	**0.164***	0.063	0.126	0.048	0.150	0.059
Strategy	0.076	0.038	0.072	0.053	0.034	0.062	0.075	0.008	0.102	0.034
Turbulence	0.080	0.024	0.162	0.151	0.156	0.136	0.139	0.110	171	0.146
Position of respondent	0.051	0.002	0.037	0.031	0.084	0.014	0.003	0.075	0.027	0.028
Experience of respondent	0.041	**0.162****	0.063	**0.175****	0.070	0.120	0.036	**0.166***	0.066	**0.180****
R^2	0.278	0.401	0.180	0.263	0.159	0.243	0.140	0.172	0.166	0.256
R^2 adjusted	0.219	0.352	0.119	0.209	0.107	0.196	0.084	0.118	0.112	0.208

Notes: Legend: SC = Social Capital; IC-MK = Intellectual Capital/Market Knowledge; IC-TK: Intellectual Capital/Technological Knowledge. Significance levels: * : 0.05, ** : 0.01, and *** : 0.001.

Finally, we also tested individual models for each partner type where the social capital with a single partner type remained the only independent variable (next to the controls). In this analysis, all partner types were shown to positively contribute to the firm's knowledge stock (see Table 3).

Table 3. Results of testing individual models for each type of partner.

Model	Direct model with SC = Customers		Direct model with SC = Suppliers		Direct model with SC = R&D partners		Direct model with SC = Trade associations	
Dependent var.	IC-MK	IC-TK	IC-MK	IC-TK	IC-MK	IC-TK	IC-MK	IC-TK
SC	**0.446*** **	**0.525*** **	**0.177***	**0.161***	**0.264*** **	**0.420*** **	**0.230****	**0.270*** **
Firm size	0.031	0.098	0.078	**0.143***	0.067	**0.143***	0.084	**0.148***
Size of R&D	0.002	**0.065***	0.045	0.017	0.048	0.024	0.025	0.050
Rel size of R&D	0.025	0.045	0.007	0.046	0.020	0.005	0.027	0.039
Importance of division	0.114	0.052	**0.181***	0.122	**0.163***	0.072	0.134	0.059
Strategy	0.036	0.003	0.048	0.024	0.072	0.067	0.092	0.023
Turbulence	0.054	0.029	0.128	0.090	0.157	0.132	0.160	0.111
Position of respondent	0.069	0.069	0.067	0.016	0.062	0.027	0.008	0.092
Experience of respondent	0.026	0.125	0.052	0.140	0.084	0.125	0.040	**0.180***
R^2	0.238	0.326	0.094	0.107	0.143	0.240	0.121	0.163
R^2 adjusted	0.199	0.292	0.047	0.061	0.098	0.200	0.073	0.117

Table 4. Results of testing hypotheses.

Hypotheses	Description	Result	Details/Comments
H1a	SC with vertical partners → market knowledge	Partly confirmed	Not confirmed for suppliers in multivariate model
H1b	SC with vertical partners → technological knowledge	Partly confirmed	Not confirmed for suppliers in multivariate model
H1c	Effects (H2a/b) are stronger for customers than for suppliers	Confirmed	
H2a	SC with R&D partners → market knowledge	Partly confirmed	Not confirmed in multivariate model
H2b	SC with R&D partners → technological knowledge	Confirmed	
H2c	Effect of SC with R&D partners on technological knowledge is larger than on market knowledge.	Confirmed	
H2d	Effect of SC with R&D partners is weaker than effect of SC with vertical partners.	Partly confirmed	Confirmed for customers.Rejected for suppliers. Instead, effect of R&D partners on technological and market knowledge is larger than the one of suppliers.
H3a	SC with trade associations → market knowledge	Partly confirmed	Not confirmed in multivariate model
H3b	SC with trade associations → technological knowledge	Partly confirmed	Not confirmed in multivariate model
H3c	Effect of SC with trade associations is weaker than effect of SC with vertical partners.	Partly confirmed	Confirmed for customers. Rejected for suppliers.

Table 4 summarizes the test of our hypotheses.

Before we discuss our findings, we will report the results of some additional analyses to underline the reliability and validity of our results.

Additional tests to ensure reliability and validity of the results

Our data showed a substantive proportion of missing values, reducing the dataset from 229 to 159 for testing our model. Most missing values appear in the social capital variables because some firms stated to have, e.g., no R&D partners, and skipped this part of the questionnaire. We compared the 159 firms with the 70 remaining to determine whether this reduced 'amount' of social capital in the latter group is related to the model's constructs as proposed. We calculated the scores of all constructs by confirmatory factor analyses and compared the average scores between the two groups. The only significant difference appeared regarding the level of technological knowledge ($p < 0.039$). This means that a firm/product division with missing values in the social capital section of the questionnaire stated that it has less technological knowledge.

A possible issue threatening the validity of the results when using surveys is common method bias (CMB). We applied several procedures to uncover the indications of CMB. First, we conducted the Harman single-factor test, which showed no single component to explain the majority of overall variance (the largest component explained 20.2%). Second, we used two theoretically unrelated marker variables (Lindell and Whitney, 2001) and tested for correlation with the latent variable scores. Some of them showed significant correlations (up to 0.277 for 22% of all construct-to-marker correlations, but with an insignificant average correlation of 0.123, $T = 0.18$). To check the effect of common method variance on our results, we included a common method factor (reflected by the marker variables) that was linked to each endogenous construct of the full model. In that regard, we did not follow the best-of suggestion made in Podsakoff *et al.* (2003) because Richardson *et al.* (2009) showed that the previous recommendations were misleading and can lead to wrong indications with a quite high probability.

By comparing the model with the common method factor vs. without the common method factor, we did not find any structural differences in path strengths or R^2.[j]

Additionally, to avoid single-response bias and for further analysis of CMB, we collected data from a second source which was the manager of the marketing division for our endogenous innovation success variable. We contacted the 229

[j]A comparison of the test results from evaluating the model with vs. without the common method factor be handed out if the reviewers wish.

firms that we had received the first questionnaire from and received 67 completed questionnaires (29.7% response rate). Unfortunately, this is a too small number for directly using this additional data source, but it is sufficient to evaluate to evaluate the inter-rater agreements regarding the innovation success between the first and second respondents (see Tiwana (2008) for a similar procedure). The result shows that the correlations of the scores of the dependent variables (calculated by separate confirmatory factory analyses) between the first and second respondents are positive and highly significant (for IC-MK: $r = 0.221$, $p = 0.036$; for IC-TK: $r = 0.301$, $p = 0.007$). This further supports the quality of our data in terms of common method variance and it alleviates the subjectivity of our outcome measurement.

Finally, we acknowledge the ongoing debate about the suitability of the PLS approach and whether it is inferior to covariance-based SEM approaches or not. As explained in the methodology section, we have deliberately chosen PLS for good reasons. In order to refute any possible criticism on that method, we have also retested our model and hypotheses with CV-SEM using the SPSS AMOS package. We specified the same model (though without control variables since CV-SEM is not a regression approach) and tested it with the same data. Table A.5 in Appendix A shows the results which are most statistically match with the results of the PLS-based tests and in some lead to the same conclusions regarding the validation of our hypotheses. Furthermore, since CV-SEM also supports a statistical comparison of individual model parameters, we used it for an explicit test of the 'path comparison' hypotheses H1c, H2c, H2d, and H3c; the approach and the results are explained and documented in Appendix A.

Discussion

Drawing on the Social Capital Theory and the concept of uncertain relevance of new knowledge, we have investigated the effect of inter-organisational social capital on a firm's intellectual capital.

Findings and implications

Our research question was: What is the differential effect of inter-organisational social capital with different types of business partners on a focal firm's intra-organisational intellectual capital?

We find that the effects under study depend on both the partner type and the type of knowledge, and more precisely on the consistency of partner types' knowledge with that of the focal firm, the credibility of partner types, and their competitive

relevance. Consequently, the inter-organisational social capital with different types of business partners influences market and technological knowledge (the components of a focal firm's intra-organisational intellectual capital) differently.

More detailed, our research exhibits the following contributions:

First, by providing one of the rare empirical studies dealing with inter-organisational social capital, we show a new way how social capital generates intellectual capital (Maurer *et al.*, 2011).

Second, extending previous research, we show that the social capital between a focal firm and different external knowledge sources such as customers and suppliers differentially impacts a focal firm's intellectual capital. Empirical analyses show that the effect depends on the type of external partner as well as the type of knowledge that eventually might transfer into innovation success. External partners can be regarded as knowledge sources delivering knowledge valuable for innovations. Social capital across the boundary of a firm is the mechanism that allows a firm to tap into these knowledge sources and thus is conducive to building market and technology knowledge. In that regard, another interesting result of our study stems from the differentiation of intellectual capital into technological knowledge and market knowledge. Technological knowledge usually focuses on this research which often deals with R&D and neglects other environments (Lane *et al.*, 2006), while other types of knowledge are rarely addressed (for an exception see e.g., Lichtenthaler (2009)).

Third, we put forth that the strength of the inter-organisation social capital's effect of intra-organisational intellectual capital further depends on certain characteristics of the partner types: the consistency of partner types' knowledge with that of the focal firm, the credibility of partner types, and their competitive relevance. We thereby provide new theoretical arguments why the observed effects occur.

The results (see Table 5 for a summary) provide important insights regarding how and through which mechanisms firms develop their intellectual capital, which, in turn, is an important contributor to subsequent innovations.

In the following, we will discuss these findings in more detail. As hypothesized, inter-organisational social capital with customers is positively associated with both market and technological knowledge. However, in contrast to our hypothesis, we could not find a significant effect of inter-organisational social capital with another vertical partner type — suppliers — and market and technological knowledge. We argue that the potential difference between customers and suppliers regarding the competitive relevance may explain the insignificant result regarding suppliers. In our interpretation, knowledge is of more certain relevance if the focal firm depends on resources of the knowledge source that affect the focal firm's profitability and thus its perceived knowledge exploitation opportunities. Accordingly, the

competitive relevance of this knowledge is higher. Customers, via placing orders, expressing requirements regarding future offerings (Maurer *et al.*, 2011), delivering input that reduces the risk of introducing new offerings (Belderbos *et al.*, 2004) and thus reduces demand uncertainty (Beckman *et al.*, 2004) might exhibit considerably more competitive relevance for a focal firm compared to customers which increases the willingness to accept knowledge from customers more than from suppliers.

We also found that R&D partners contribute more to market and technological knowledge than suppliers but not more than customers. However, our hypothesis 2d formulates that social capital with vertical partners, customers and suppliers, contributes more to market and technological knowledge of the focal firm than R&D partners. While this is supported for customers, it does not apply for suppliers.

We argue that there are several reasons for this finding. Knowledge provided by R&D partners is less consistent with a focal firm's knowledge and does not create as much overlap compared to knowledge from vertical partners. R&D partners are also not bound with recurrent activities in such extent to a focal firm than vertical partners. Both arguments decrease the certain relevance of new knowledge. However, the competitive relevance of getting access to knowledge that bears the potential of gaining leadership position and creating new markets might be larger than that of suppliers but lower than that of customers. The reason might be that R&D partners, due to their expertise in certain technology fields, provide access to knowledge needed to gain or sustain a technological leadership position (Karlson and Callagher, 2012). R&D partners may also aim at innovations with potential to create new markets (Belderbos *et al.*, 2004), and to locate new technological knowledge and get an overview of trajectories in an industry (Eisenhardt and Santos, 2002). On the one hand, these reasons point to future benefits in other areas than those achievable in the current activities where suppliers and customers are bound to. On the other hand, such future benefits obtained from knowledge of R&D partners are more uncertain than knowledge obtained from customers that is suited to reduce risks of market introduction. Thus, knowledge obtained from R&D partners with its uncertain relevance "contributes significantly to its allure, and it is probably one of the main reasons why it generates demand for 'news' which makes it attractive to consider" (Schulz, 2001), which makes it more relevant than knowledge obtained from suppliers but at the same time, due to the increased risks of market introduction, less relevant than knowledge obtained from customers.

Table 5 summarizes the theoretical and practical implications of our study.

Table 5. Summary of theoretical and managerial contributions.

Research question	Theoretical implications	Practical implications
How do effects of inter-organisational social capital differ between different types of partners (such as customers, suppliers etc.) and types of knowledge?	• **Multi-theoretical innovation perspective:** Theoretical explanation of how firm-external knowledge sources influence intellectual capital of a firm shows: • **Innovation success through external social capital and the** uncertain relevance of new knowledge: This study offers new theoretical arguments regarding the "why" firm-external knowledge influences intellectual capital. Namely, the study shows that inter-organisational social capital is important for innovativeness. The effect strength depends on the uncertain relevance of new knowledge, which in turn is influenced by the type of knowledge and knowledge source (i.e., partner). • **Relational knowledge impact:** The study puts forth link characteristics, conceptualised as social capital, to the hitherto investigated knowledge characteristics and shows the profound strength of this relational effect. • **Source-dependent impact of knowledge:** We add three characteristics of knowledge sources that influence the impact of the gained knowledge. These are as follows: Consistency of a source's knowledge with that of the focal firm, credibility of the source, and competitive relevance of the source.	• **Role of network partners:** External partners provide valuable knowledge and increase innovation success. However, there should be a preference order when investing in external knowledge sources, beginning with the strongest knowledge contributors: customers, followed by R&D partners, suppliers, and, finally, trade associations. Accordingly, resource allocation to external relationships should consider knowledge contribution as additional manageable object. • **Characteristics of the external partners:** Resource allocation to external relationships should further consider characteristics of the external partner regarding the uncertain relevance of knowledge, namely, its competitive relevance, credibility, and the consistency of the knowledge bases.

Limitations

As any empirical research, our approach has some limitations. First, we have captured an organisational perspective by using data retrieved from a single key informant. This limitation was mitigated by addressing the expert in charge of the innovation process to gather the relevant variables (Tallon *et al.*, 2000). Furthermore, to ensure that method bias is not a serious problem, we collected supportive data from the marketing manager as the second source and applied several analytical procedures to detect common method variance and to partial out a potential method factor. Second, the generalisability of results is limited by the single-industry perspective. On the other side, this helps to sort out rather complex industry contingencies which otherwise could have affected our results (e.g., the different partner types will have completely different connotations and contributions towards a firm's knowledge in different industries). Third, there are further factors that contribute to innovation success but were not considered by our study. For example, organisational culture is a determinant that should be incorporated into further research. Fourth, as we used a cross-sectional study design, we can neither validate the direction of causalities defined by the model nor can we account for long-term effects such as survival rates of firms. However, since our model was developed based on a well-established theory, which has substantiated widely acknowledged causalities among the constructs considered, we are confident that the main effects are in the direction as hypothesised rather than the other way around. Overall, we can assume that applying rigorous data collection procedures, evaluating data quality, and using comprehensive tests for empirical validity and reliability have contributed to achieving valid empirical results.

Future research

A promising avenue for further relevant research is illuminating the role of particular external partners in an in-depth investigation of the different dimensions of external partners' social capital and their impact on the diverse representations of intellectual capital. Furthermore, the literature provides evidence that interactions with external partners are influenced by information technology, such as knowledge management systems or inter-organisational collaboration tools (Boland *et al.*, 2007). Thus, social capital might be affected by consciously investing in IT systems and 'provides an understanding of the role IT can and will play in the larger business environment' (Lyytinen and Rose, 2003).

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Appendix A.

In contrast to PLS, CV-SEM does allow for testing the (un)equality of different paths, as hypothesized in H1c, H2c, H2d, and H3c. For each of these four hypotheses, we specified an alternative model (constraining the related paths to be equal (i.e., 0-hypothesis) which was statistically compared against the unconstrained model. The results in Table A.6 show that each of those models fits significantly poorer than the original, unconstrained, model, which means that the paths addressed by the respective hypotheses are different, leading to the (partial or complete) confirmation of the hypotheses.

Table A.1. Construct specifications, items, and item loadings.

Construct	Item label	Item	Loading	Sources
Market knowledge	IC-MK1	Our product division's knowledge about our competitors' strategies is very thorough.	0.790	a, b
	IC-MK2	Our product division's knowledge about our customers is broad and complete.	0.825	
	IC- MK3	Our product division has thorough knowledge about emerging customers and their needs.	0.788	
	IC-MK4	Our knowledge of potential competitors' strengths and weaknesses is very thorough.	0.874	
Technological knowledge	IC-TK1	Our product division has very high knowledge about state-of-the-art technologies and practices relevant for us.	0.813	c, d, e
	IC-TK2	Our product division has very high knowledge about implementing new technologies.	0.908	
	IC-TK3	Our product division has the necessary skills to implement newly acquired technological knowledge.	0.893	
	IC-TK4	Our product division has considerable competences in utilizing new technologies.	0.876	
Social capital #partner type# (structural)	SC#NT#s1	The exchange with our most important #partner type# is very intensive.	0.857–0.921	f, g, h
	SC#NT#s2	We exchange a lot of information with our most important #partner type#.	0.844–0.907	

Table A.1. (*Continued*)

Construct	Item label	Item	Loading	Sources
	SC#NT#s3	Compared to the industry average we interact ... frequently with our most important #partner type #. (Scale: 'considerably less', 'less', 'rather less', 'just as', 'rather more', 'more', 'considerably more') [I and my most important private contacts have interacted ... regarding business-related topics within the last three years. (Scale: 'weekly', 'monthly', 'quarterly', 'biannually', 'annually', 'less frequently, 'never')]	0.584–0.717	
Social capital #partner type# (relational)	SC#NT#r1	The chemistry between us and our most important #partner type# is right.	0.844–0.894	i, j
	SC#NT#r2	Our most important #partner type# are absolutely trustworthy.	0.877–0.906	
	SC#NT#r3	The relationship to our most important #partner type# is characterized by mutual respect.	0.880–0.920	
Social capital #partner type# (cognitive)	SC#NT#c1	We and our most important #partner type# always agree about innovative topics.	0.770–0.837	d
	SC#NT#c2	The communication with our most important #partner type# about content wise topics is outstandingly.	0.827–0.883	
	SC#NT#c3	Our most important #partner type# and we always have a common language to deal with technical issues. (I and my most important private contacts tell similar anecdotes from daily business.)	0.641–0.797	

Notes: #partner type#: 'customers', 'suppliers', 'R&D partners', trade associations'. #NT#: 'C' for 'customer', 'S' for 'supplier', 'R' for 'R&D partners', 'T' for 'trade associations'. All items were originally in German and have been measured by a 7-Point-Likert-Scale, ranging from 1 (totally agree) to 7 (totally disagree) except item SC#NT#s3.

*In case of suppliers, the loading was only 0.629. In case of trade associations, the loading was only 0.519 and did not meet the usual thresholds. Nevertheless, we decided to capture it in order to ensure measurement consistency across the different partner types.

**In case of trade associations, the loading was only 0.594.

Items are adopted and adapted to our research domain from (a) De Luca and Atuahene-Gima (2007); (b) Atuahene-Gima (2005); (c) Matusik and Heeley (2005); (d) Ko *et al.* (2005); (e) García-Morales *et al.* (2007); (f) Goles and Chin (2005); (g) Chung *et al.* (2003); (h) Fang (2008); (i) Sarkar *et al.* (2001); (j) Tiwana and McLean (2005).

Table A.2. Quality measures on construct level (first-order constructs only).

	Construct	AVE	Composite reliability	Cronbach's alpha
IC-MK	IC – Market knowledge	0.672	0.891	0.837
IC-TK	IC – Technological knowledge	0.763	0.928	0.896
SC#C#c	Social capital customers (cognitive)	0.635	0.839	0.712
SC#C#r	Social capital customers (relational)	0.759	0.904	0.841
SC#C#s	Social capital customers (structural)	0.641	0.841	0.714
SC#S#c	Social capital suppliers (cognitive)	0.700	0.875	0.785
SC#S#r	Social capital suppliers (relational)	0.782	0.915	0.861
SC#S#s	Social capital suppliers (structural)	0.684	0.864	0.765
SC#R#c	Social capital R&D partners (cognitive)	0.634	0.838	0.711
SC#R#r	Social capital R&D partners (relational)	0.822	0.933	0.892
SC#R#s	Social capital R&D partners (structural)	0.727	0.887	0.807
SC#T#c	Social capital trade associations (cognitive)	0.630	0.834	0.705
SC#T#r	Social capital trade associations (relational)	0.802	0.924	0.876
SC#T#s	Social capital trade associations (structural)	0.638	0.836	0.707

Table A.3. Discriminant validity (Fornell–Larcker criterion, first-order constructs only).

	#1	#2	#3a	#3b	#3c	#4a	#4b	#4c	#5a	#5b	#5c	#6a	#6b	#6c
#1 IC-MK	0.820													
#2 IC-TK	0.514	0.873												
#3a SC#R#c	0.258	0.338	0.796											
#3b SC#R#r	0.145	0.374	0.615	0.907										
#3c SC#R#s	0.282	0.290	0.551	0.608	0.852									
#4a SC#C#c	0.409	0.507	0.465	0.308	0.254	0.797								
#4b SC#C#r	0.344	0.433	0.298	0.277	0.194	0.662	0.871							
#4c SC#C#s	0.398	0.397	0.170	0.079	0.251	0.436	0.377	0.801						
#5a SC#S#c	0.238	0.216	0.318	0.316	0.221	0.410	0.351	0.129	0.837					
#5b SC#S#r	0.220	0.257	0.332	0.395	0.306	0.266	0.316	0.104	0.728	0.884				
#5c SC#S#s	0.187	0.117	0.080	0.242	0.248	0.109	0.194	0.233	0.472	0.498	0.827			
#6a SC#T#c	0.208	0.119	0.357	0.158	0.164	0.275	0.092	0.006	0.254	0.217	0.035	0.793		
#6b SC#T#r	0.130	0.217	0.271	0.235	0.123	0.227	0.264	0.029	0.149	0.282	0.087	0.605	0.895	
#6c SC#T#s	0.331	0.270	0.211	0.199	0.248	0.107	0.131	0.164	0.142	0.221	0.124	0.475	0.490	0.799

Note: (Grey values indicate where no discriminant validity is required since those values represent combinations among constructs which share the same items (first/second-order constructs).

Table A.4. Discriminant validity (HTMT values (should be below 0.9)).

	#1	#2	#3	#4a	#4b	#4c	#4	#5a	#5b	#5c	#5	#6a	#6b	#6c	#6	#7a	#7b	#7c
#1 IC-MK																		
#2 IC-TK	0.591																	
#3SC	0.518	0.566																
#4a SC#R#c	0.327	0.420	0.826															
#4b SC#R#r	0.166	0.419	0.717	0.763														
#4c SC#R#s	0.356	0.342	0.700	0.705	0.715													
#4 SC#r	0.310	0.441	0.833	0.045	0.987	0.994												
#5a SC#C#c	0.525	0.630	0.809	0.656	0.383	0.327	0.498											
#5b SC#C#r	0.406	0.497	0.682	0.387	0.320	0.236	0.350	0.848										
#5c SC#C#s	0.521	0.498	0.546	0.232	0.134	0.343	0.260	0.610	0.484									
#5 SC#C	0.558	0.628	0.791	0.492	0.327	0.347	0.429	1.104	1.003	0.945								
#6a SC#S#c	0.288	0.260	0.762	0.424	0.378	0.268	0.398	0.551	0.428	0.188	0.456							
#6b SC#S#r	0.257	0.294	0.759	0.418	0.450	0.355	0.459	0.338	0.370	0.133	0.333	0.880						
#6c SC#S#s	0.253	0.157	0.588	0.120	0.289	0.302	0.274	0.172	0.242	0.339	0.292	0.583	0.599					
#6 SC#S	0.303	0.273	0.805	0.372	0.429	0.354	0.434	0.404	0.397	0.246	0.410	1.042	1.017	0.932				
#7a SC#T#c	0.289	0.163	0.659	0.504	0.202	0.241	0.340	0.424	0.126	0.079	0.239	0.351	0.286	0.095	0.281			
#7b SC#T#r	0.148	0.243	0.615	0.343	0.263	0.161	0.283	0.288	0.309	0.083	0.269	0.178	0.325	0.158	0.256	0.724		
#7c SC#T#s	0.449	0.350	0.611	0.285	0.238	0.338	0.320	0.181	0.154	0.228	0.216	0.185	0.267	0.179	0.242	0.632	0.603	
#7 SC#T	0.330	0.292	0.729	0.435	0.275	0.279	0.363	0.345	0.238	0.147	0.283	0.271	0.343	0.168	0.301	1.056	0.985	1.001

Note: Grey values indicate where no discriminant validity is required since those values represent combinations among constructs which share the same items (first/second-order constructs).

Table A.5. Results from retesting the model in AMOS (CV-SEM).

Model	Complete model		Model I		Model II		Model III		Model IV	
Dependent var.	IC-MK	IC-TK	IC-MK	IC-TK	IC-MK	IC-TK	IC-MK	IC-TK	IC-MK	IC-TK
SC with customers	**0.496*** **	**0.502*** **								
SC with suppliers	0.052	0.037	0.165	0.080	0.196	0.094	**0.203***	**0.212***		
SC with R&D partners	0.080	**0.201***	0.098	**0.388*** **	0.160	**0.421*** **			0.166+	**0.417*** **
SC with trade associations	0.122	0.034	0.179+	0.090			**0.206***	**0.219***	**0.203***	0.100
Model Fit Indices:										
^{2}/df	319.9/155 = 2.064		200.5/109 = 1.840		113.4/71 = 1.597		122.5/71 = 1.726		129.6/71 = 1.825	
CFI	0.906		0.938		0.966		0.957		0.953	
GFI/AGFI	0.847/0.793		0.893/0.849		0.925/0.889		0.921/0.884		0.918/0.878	
SRMR	0.056		0.0496		0.408		0.480		0.494	
RMSEA	0.075		0.066		0.056		0.062		0.066	
ECVI	2.460		1.689		0.950		0.998		1.035	

Table A.6. CV-SEM model comparison for path comparison hypotheses.

Model	Constraints (i.e., less degrees of freedom)[k]	X^2	*p*
H1c	2	15.108	0.001
H2c	1	5.419	0.020
H2d	4	19.837	0.001
H3c	4	17.449	0.002

Notes: [k]For example, for H2c the parameters of paths "SC-customers → IC_MK" and "SC-suppliers → IC_MK" as well as the parameters of paths "SC-customers → IC_TK" and "SC-suppliers → IC_TK" have been pairwise set equal.