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In the vanguard of openness: which dynamic capabilities are essential for innovative KIBS firms to develop?

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ABSTRACT

In this paper, we examine whether the innovativeness of knowledge intensive business services (KIBS) firms is affected by their inherently high rate of interactions with clients and partners. Even if such firms do not deliberately follow an open innovation strategy, they are exposed to knowledge flows from other organisations. A particularly interesting issue is the connection between openness and the need to develop dynamic capabilities for distinct phases of knowledge processing. Building on resource-based views, we have developed hypotheses on the respective importance of KIBS firms' dynamic capabilities and their inclination to engage in open innovation. Since clients and partners can contribute to activities especially at the beginning and end of the innovation value chain, KIBS should consider focusing on developing a 'conceptualizing' capability for translating raw ideas into marketable service propositions. The importance of this capability is confirmed by our regression analyses on survey data from 125 KIBS in the Netherlands. By contributing to the literature on KIBS and open innovation, we shed light on strategically balancing capability development and external capability sourcing.

KEYWORDS

KIBS; open innovation; dynamic capabilities; innovation value chain; service innovation

JEL CLASSIFICATIONS

O31; O32

1. Introduction

Almost three decades ago, Richard Barras described the alignment of business services in retail banking as an 'interactive innovation process' forming the forefront of novel modes of innovation (Barras 1990). A large body of subsequent research has studied how novelty arises from the interactions that are so characteristic for service provision (e.g. Edvardsson et al. 2001; Hsieh and Tidd 2012). Of particular importance is the role of firms providing knowledge intensive business services (KIBS), like strategic, technical, financial or legal consultancies.¹ Because these firms interact intensively with a great variety of parties—including

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¹Following common practice, we use the acronym 'KIBS' to refer to firms providing knowledge intensive business services (Muller and Zenker 2001). Our focus on knowledge sourcing leads us to prefer this label to the similar notion of 'professional service firms' (PSFs).

clients, knowledge institutes and other strategic partners—KIBS are considered as the bees that cross-pollinate knowledge throughout the innovation system (Miles et al. 1995; Den Hertog 2000; Muller and Zenker 2001).

Traditionally scholars have focused mostly on how KIBS can contribute to innovation within their client firms, and much less on explaining the variation in KIBS' own innovativeness (Den Hertog 2000; Amara et al. 2010). This gap is mainly because innovation efforts in service firms are regarded as difficult to measure, due to the object of these efforts being intangible (Leiponen 2005). Service providers, knowledge intensive or not, are known for formalising their innovation efforts only occasionally (Miles 2007). The observation that they do develop new services has led to increasing interest in service providers' innovation activities (Gallouj and Savona 2009). Consequently, an alternative is being developed to gauge how able and likely a service firm is to innovate. Rather than sticking to formalised R&D, scholars are urged to study innovation in services by adopting the broader notion of dynamic capabilities (Amara et al. 2010; den Hertog, van der Aa, and de Jong 2010; Teirlinck and Spithoven 2013). Dynamic capabilities reflect the activities underlying a firm's ability to adapt (Teece, Pisano, and Shuen 1997). Depending on how they are operationalised, dynamic capabilities can be related to the phases of the innovation value chain (Janssen and Den Hertog 2016). In developing a measurement scale for dynamic service innovation capabilities (DSICs), Janssen, Castaldi, and Alexiev (2016) propose five capabilities: two for knowledge sourcing, one for knowledge transformation (conceptualising), and two for knowledge application. As Love, Roper, and Bryson (2011) have shown, using the innovation value chain for studying the importance of knowledge exchanging activities offers promising research opportunities.

A measurement scale for DSICs allows us to investigate which dynamic capabilities foster innovation in KIBS. Additionally, the fact that KIBS firms' daily activities involve extensive knowledge brokerage also begs the question how their inherent openness (i.e. exposure to knowledge in other organisations, notably clients) affects their ability to innovate. The past decade has seen a rising interest in open innovation strategies, allowing firms to develop new solutions by relying on knowledge beyond the boundaries of their own organisation (Chesbrough 2006). Unlike firms where open innovation strategies are a real alternative to closed innovation modes, KIBS nearly always interact intensively with their customers, as well as with consulting partners, knowledge institutes or government associations (Leiponen 2005; Tether and Tajar 2008). Recent contributions suggest that KIBS engaging deliberately in external knowledge sourcing and internal R&D activity are more innovative (Mansury and Love 2008; Leiponen 2012), but until now, the interaction of these two key factors has hardly been investigated. We therefore have little understanding of how innovation-oriented partnerships in naturally highly open firms like KIBS affect their innovation activities and performance. At the same time, given the trend that firms in virtually every industry are increasingly adopting service-based business models and becoming part of multi-actor producing systems, this research gap pertains to a topic that could enrich the broader (open) innovation literature (Chesbrough 2011).

This paper focuses on KIBS firms facing the decision of which dynamic service innovation capabilities to develop. So far, the influence of DSICs on innovativeness has not been

empirically explored, and the combination of dynamic capabilities and openness has hardly been touched upon (Lichtenthaler and Lichtenthaler 2009; Van de Vrande et al. 2009).² We therefore investigate how the relative importance of a certain capability is affected by the extent to which a KIBS firm relies on the skills and competences of others, whether through on-the-job interaction or deliberate collaboration. Our main research question is: *Which dynamic capabilities are essential for innovative KIBS to develop?*

The two baseline hypotheses we propose are that all DSICs are significantly related to KIBS innovativeness (Hypothesis 1), just like their tendency to engage in deliberate openness (Hypothesis 2). Our core hypothesis concerns the role of DSICs and openness during the different stages of knowledge processing (Love, Roper, and Bryson 2011). According to the resource-based view, firms can achieve a sustained competitive advantage by devoting their scarce resources to developing capabilities that enable them to transform their business practices (Wernerfelt 1984). Access to the knowledge and competences of others reduces the need to develop in-house strengths (Teece 1986; Barney 1991). Our literature review suggests that interactions with other parties can contribute most to the explorative and exploitative aspects of service innovation, but are of less use for the intermediate translation of raw ideas into marketable service propositions (Roper, Du, and Love 2008; Lehrer et al. 2012). On this basis, we expect that if KIBS engage in high levels of openness, the most important capability for being innovative is conceptualising (Hypothesis 3). This conceptualising capability concerns activities aimed at processing suggestions for new service solutions into actual offerings aligned with a firm's organizational structure, resources, markets and other business propositions (Love, Roper, and Bryson 2011). Supporting practices include prototyping, concept visualizing and (service) blueprinting (den Hertog, van der Aa, and de Jong 2010).

The quantitative investigation we present is based on survey data. An initial explorative analysis, in which five key DSICs are regressed on innovativeness, first reveals that the capability to sense user needs is not discriminative for KIBS where their innovation output is concerned. All the other capabilities – in particular for sensing (technological) options – are positively and significantly related to innovative output, as is the variable for deliberate partnerships. Only in conceptualising, however, do we encounter a significant interaction effect. This finding confirms that highly open firms, like KIBS engaging in innovation-oriented partnerships, could consider focusing their resources on developing a conceptualisation capability. By contributing to literature on KIBS and open innovation (Hsieh and Tidd 2012; Mina, Bascavusoglu-Moreau, and Hughes 2014; Battisti et al. 2015), we shed light on strategic considerations with respect to balancing capability development and external knowledge sourcing (Caloghirou, Kastelli, and Tsakanikas 2004).

2. Theory and hypotheses

The investigation into our research question draws on the combination of various theoretical perspectives, namely the resource-based view (RBV), the dynamic capability view (DCV) and the innovation value chain (IVC). Section 2.1 introduces the notion of dynamic capabilities and the presumed relationship with innovativeness in KIBS. Here, we identify the

²Note that openness in this paper refers to the discourse of open innovation (Chesbrough 2006) rather than the currently unfolding literature on open strategies (Hautz, Seidl, and Whittington 2016).

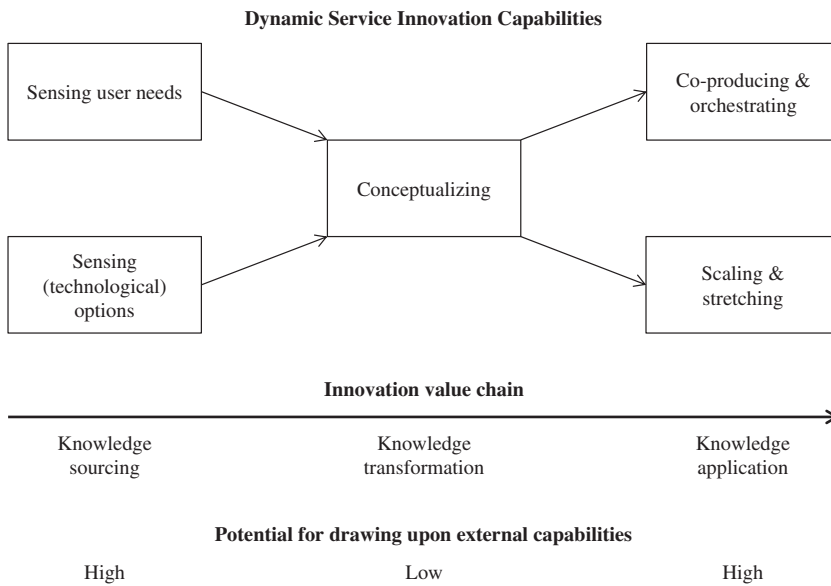


Figure 1. The links between dynamic service innovation capabilities (den Hertog, van der Aa, and de Jong 2010), the innovation value chain (Hansen and Birkinshaw 2007; Roper, Du, and Love 2008), and the potential for innovative firms to draw on external capabilities. Adapted from Janssen, Castaldi, and Alexiev (2016).

most relevant capabilities for each innovation phase of the IVC. Section 2.2 is our hypothesis of how a KIBS firm's level of openness relates to innovativeness. In Section 2.3, we analyse the potential for KIBS to rely on openness for capability development instead of developing capabilities in-house. Figure 1 summarises the theoretical elements of our framework.

2.1. Dynamic capabilities in KIBS: roles in the innovation value chain

According to the resource-based view on economic and technological change, firms need to develop certain capabilities in order to translate resources, including knowledge, into business value (Barney 1991). Teece, Pisano, and Shuen (1997) and Zollo and Winter (2002) proposed that some firms may even develop second-order capabilities, which they refer to as 'dynamic capabilities'. These allow firms to sense developments and acquire promising suggestions, transform them into new propositions, and reconfigure their organisation so that the new offering can be commercialised (Zahra, Sapienza, and Davidsson 2006; Teece 2007). Dynamic capabilities are thus commonly regarded as important antecedents for innovativeness (Crossan and Apaydin 2010).

Due to their traditional focus on technological innovation, studies on innovativeness tend to be biased towards R&D capabilities. Especially in the understudied field of services, performing the processes that generate novel combinations of knowledge entails more than the availability of capabilities bound to R&D (Miles 2007). Service innovation is said to depend primarily on individuals' skills and professional knowledge, rather than on the narrow (and relatively rarely encountered) set of activities that fall under formalised R&D (Leiponen 2012). Because of service particularities like an intangible and interactive nature (Parasuraman, Zeithaml, and Berry 1985; Gallouj and Weinstein 1997), the continuous and

organic innovation process in services occurs relatively close to the client (Edvardsson et al. 2001; Tether 2005). This is all the more true for KIBS firms, who often develop new concepts by combining the knowledge and experience they acquire in their role as knowledge brokers (Den Hertog 2000; Tether and Tajar 2008).

Acknowledging the limitations of the R&D concept, scholars are increasingly adopting the broader notion of dynamic capabilities when giving a comprehensive account of a KIBS firm's ability to innovate (Hogan et al. 2011; O'Cass and Sok 2013; Teirlinck and Spithoven 2013). Crucial in this respect is the availability of a comprehensive capability framework that allows for comparative analyses across different KIBS firms (Amara et al. 2010). In line with the emerging synthesis approach to service innovation (Gallouj 1994; Coombs and Miles 2000), such a comprehensive framework and corresponding operationalisation were developed (den Hertog, van der Aa, and de Jong 2010; Janssen, Castaldi, and Alexiev 2016). The resulting framework of dynamic service innovation capabilities (DSICs) combines elements of frameworks developed for specific service industries. The five operationalized capabilities are: sensing user needs, sensing (technological) options, conceptualising, co-producing & orchestrating, and scaling & stretching (den Hertog, van der Aa, and de Jong 2010; more details in Janssen, Castaldi, and Alexiev 2016; Janssen and Den Hertog 2016).

These DSICs, in line with leading work by Teece (2007), are associated with the knowledge processing steps as captured by the innovation value chain (Roper, Du, and Love 2008). The capability 'sensing user needs' refers to a firm's intelligence function to obtain insight in demands from existing or potential clients. Similarly, the capability 'sensing (technological) options' pertains to activities for keeping up to date with possibilities to create new solutions. As the upper and middle parts of Figure 1 show, the capabilities for sourcing knowledge on demand and supply side developments both precede the (use of the) capability for 'conceptualising'. This latter capability concerns the knowledge transformation step in the innovation value chain, when obtained signals are converted into propositions for viable solutions. The underlying activities include practices like prototyping and service blueprinting. With respect to the knowledge application step, the capabilities required for exploiting a new proposition ('co-producing and orchestrating' and 'scaling and stretching') depend on the presence of the conceptualisation capability. Together the five capabilities thus cover the various stages that characterise the iterative processes of knowledge production and application. As each capability has distinct merits, and every value chain stage is essential for achieving new concepts, our first baseline hypothesis reads:

Hypothesis 1: All dynamic service innovation capabilities are positively related to KIBS' innovativeness.

2.2. Openness and innovation in KIBS

Apart from investing in dynamic capabilities, firms can also try to access and exploit the knowledge and competences that exist beyond their boundaries. Innovation and management scholars have a long history of studying topics like external knowledge search, partnerships, networking, inter-organizational learning and open innovation (Van de Vrande et al. 2009; Gassmann, Enkel, and Chesbrough 2010; Laursen 2012). As it is costly to rely entirely on firm-internal abilities to generate, transform and diffuse knowledge, there is a strong incentive for firms to seek knowledge and skills already 'out there'. Whether this

knowledge resides in clients, professional experts, or elsewhere, other parties are sometimes in a position to provide highly valuable insights about market opportunities. There is a wide consensus that being open to knowledge flows can enhance a firm's innovativeness substantially (Chesbrough 2006; Laursen and Salter 2006).

Whereas open strategies can be clearly distinguished from closed R&D in the manufacturing of new goods, this difference is far less obvious in the domain of services (Chesbrough 2011). Increasingly, service innovation is regarded as emerging from innovation networks that extend wider than customers (Bryson, Rubalcaba, and Ström 2012). Discussions on multi-agent frameworks (Gallouj and Weinstein 1997; Windrum and García-Goñi 2008) have been revitalised with the rising interest in openness (Rubalcaba et al. 2012; Battisti et al. 2015). Today, both service production and service innovation are regarded as inherently distributed phenomena, carried out by a wide range of actors (Tether and Tajar 2008).

Arguably, the most open form of service provision is found in knowledge-intensive business services. By their very nature, KIBS are deeply involved in extensive knowledge exchange (Den Hertog 2000; Consoli and Elche-Hortelano 2010). Their core activity is to transfer information, design, experience or professional knowledge to client firms and assist in applying them (Leiponen 2005; Pina and Tether 2016). Besides drawing on interactions that form part of the routines on which KIBS' core activities rely, KIBS also develop partnerships explicitly aimed at innovation (Leiponen 2012). The key reason to engage purposively in inward and outward knowledge flows is that the costs of accessing valuable external knowledge might be relatively low (Chesbrough 2006). Although KIBS are already well connected to other parties via their routine-like operations, several studies have confirmed that they still engage in (and benefit from) deliberately initiated partnerships (Mansury and Love 2008; Leiponen 2012; Mina, Bascavusoglu-Moreau, and Hughes 2014). Based on this observation, our second baseline hypothesis is as follows:

Hypothesis 2: Engaging in deliberate openness contributes to KIBS' innovativeness.

2.3. Dynamic capabilities in the innovation value chain and openness of KIBS

Despite the alluring advantages for firms to open up their innovation processes, there are also reasons to retain a certain amount of in-house innovation activity. Currently, a major question in the field of open innovation concerns the very connection between openness and in-house R&D (Cassiman and Veugelers 2006; Dahlander and Gann 2010). On the one hand, scholars argue and occasionally show that having R&D (or dynamic) capabilities can leverage the value of external knowledge sourcing (Caloghirou, Kastelli, and Tsakanikas 2004; Chesbrough 2006; Van de Vrande et al. 2009). This complementarity is in line with the common conviction that a high level of knowledge flows requires sufficient ability to process (Cohen and Levinthal 1990; Cassiman and Veugelers 2006; Dahlander and Gann 2010). On the other hand, several authors highlight the downside of engaging in both internal and external R&D activities (e.g. Love, Roper, and Vahter 2014). Here, the main argument for substitutability is that engaging in both activities is costly (Laursen and Salter 2006; Leiponen and Helfat 2010): having internal dynamic capabilities reduces the need to rely on external knowledge and competences (Love and Roper 2001; Roper, Du, and Love 2008). One way to resolve this contradiction is to avoid debates about optimal levels

of openness, and instead ask which particular activities open firms should concentrate on (Von Zedtwitz and Gassmann 2002).

Understanding how openness affects innovation processes along the value chain still requires considerably more insight in the relative role of clients and partners with respect to the acquisition, transformation and application of knowledge. Especially for KIBS, this is a matter of great strategic importance. Because KIBS are by definition heavily involved in openness, their default situation already poses the dilemma of which capabilities to invest in internally, and which activities to perform together with externals (Mina, Bascavusoglu-Moreau, and Hughes 2014). Compared to investing in activities that other parties can also perform, scarce resources can better be devoted to activities that allow a firm to make sense of the knowledge it has to process (Love and Roper 2001; Leiponen and Helfat 2010; Love, Roper, and Vahter 2014). From this perspective, balancing the development of dynamic capabilities and relying on partners essentially mean avoiding a costly overlap, while maintaining sufficient capabilities to actually use external knowledge (Laursen and Salter 2006). Looking again at the innovation value chain, the challenge for innovation managers is to concentrate their efforts on activities that can only be supported by other parties to a limited extent (Roper, Du, and Love 2008). Deciding which capability to spend scarce resources on thus demands insight in the extent to which openness can contribute to knowledge sourcing, transformation and application activities. As for the specific case of KIBS, existing studies offer valuable insights on the potential to rely on external partners for capability development along the three stages of the innovation value chain. We draw on such studies to arrive at our final hypothesis.

2.3.1. Knowledge sourcing

The recent surge of studies on open innovation has examined the benefits of (pre-dominantly) inbound flows of knowledge (Gassmann, Enkel, and Chesbrough 2010). Chesbrough (2006) stresses that openness can increase the quality and quantity of ideas entering the innovation funnel which forms the basis for the innovation value chain. More specialist literature on service innovation and service management has focused extensively on the role of customers and co-creation (Bryson, Rubalcaba, and Ström 2012). Almost unanimously, scholars find that involving customers contributes to service innovativeness (e.g. Leiponen 2005; Tether 2005). Close interaction with customers offers valuable opportunities to learn about both their explicitly expressed and latent needs (den Hertog, van der Aa, and de Jong 2010). Edvardsson et al. (2001) stress that inviting customers to take part in service innovation processes leads to a better understanding of their preferences. When studying external links in U.K. business services, Love, Roper, and Bryson (2011) confirm that customers are significantly important primarily in the exploratory stage of innovation processes.

The involvement of suppliers has also proven to be beneficial for gathering ideas for new service propositions. A study on KIBS by Leiponen (2005), also showed that knowledge sourcing from competitors is positively related to innovation. Although universities do not seem to be an important source for service innovation, this is contradicted by studies on the knowledge-bridging role of KIBS as the core of innovation systems (Muller and Zenker 2001; Amara, Landry, and Doloreux 2009). Access to scientific and technical knowledge is an important complement for keeping up to date with actual or potential customers' needs (den Hertog, van der Aa, and de Jong 2010; Mina, Bascavusoglu-Moreau, and Hughes 2014).

Assuming that a larger variety of knowledge sources corresponds to more diversity in the signals a firm can interpret, the breadth of knowledge search is often related to innovativeness (Laursen and Salter 2006). Indeed, applying CIS data to information flows used by KIBS, Leiponen (2005, 2012) shows that the breadth of knowledge sourcing is also an important determinant of service innovation.

In sum, it is commonly believed that KIBS firms can strengthen their knowledge sourcing by listening to their working partners' expressed demands and suggestions. Although this certainly makes the case for interacting intensively with partners, it does not imply that firms should also invest in capabilities like sensing user needs and (technological) options (den Hertog, van der Aa, and de Jong 2010). Conversely, Roper, Du, and Love (2008) interpret the resource-based view by suggesting that firms ask themselves whether additional investments are the most effective way of enhancing business performance. Precisely because interaction with partners comes with (relatively) easy access to their ideas, KIBS could focus on innovation activities that require relatively little help from outsiders.

2.3.2. Knowledge application

At the other end of the innovation value chain, or funnel, we find activities aimed at the actual implementation and commercialisation of a new proposition. Manufacturing-based studies on openness in the innovation process tend to associate implementation practices with outbound knowledge flows, such as licensing and selling IP (Dahlander and Gann 2010). Since the disembodied nature of service innovation hardly allows for such practices, they are less likely to be encountered in KIBS. Consistently, Love, Roper, and Bryson (2011) find that KIBS use fewer external linkages in the later stages of the innovation value chain.

Despite modest possibilities to commercialise outward flows of knowledge, recent studies suggest that openness can contribute to the actual creation of business value in service firms. Whereas the relevance of seeking unexploited demand and untapped options decreases further along the innovation value chain, the importance of detailing a new proposition increases. In the knowledge application phase, external linkages notably with customers and suppliers are useful for KIBS. This is emphasised by den Hertog, van der Aa, and de Jong (2010), who build on several earlier studies when introducing the capability of 'coproducing and orchestrating'. Kindström, Kowalkowski, and Sandberg (2013) argue that the value network of services is based on service systems in which providers, service partners and customers jointly fulfil the tasks required for delivering a service experience or solution. The fact that services – also new ones – are co-produced, implies that customers play an important role in making service provision successful. Indeed, Lehrer et al. (2012) show that designers can increase the quality of their services by relying on client collaboration (e.g. for testing solutions), just like many studies on co-creation have done (Carlborg, Kindström, and Kowalkowski 2014; Rubalcaba et al. 2012). Scholars also highlight the value of involving diverse parties (e.g. other service providers) for optimising and continuously redesigning new concepts (den Hertog, van der Aa, and de Jong 2010).

KIBS firms' natural interaction with clients is also vital for their ability to 'scale and stretch' newly developed service formulas. Service delivery practically always results in the provider obtaining some kind of feedback on consumption and usage (Edvardsson et al. 2012; Cusumano, Kahl, and Suarez 2015). The availability of these signals allows KIBS to better understand how their new service is valued, and which explicit or latent needs are being fulfilled (Gustafsson, Kristensson, and Witell 2012). Observations on customer

behaviour, expectations and perceptions are not just useful for fine-tuning the innovation, but also contain information on how to market the service and who to target. Co-creation and customer relationships associated with service delivery are therefore seen as advantageous for developing successful marketing strategies (Vargo and Lusch 2004). Moreover, KIBS' tendency to interact with parties like professional associations relieves the necessity to possess their own skills for rolling out and marketing a new service model (Love, Roper, and Bryson 2011).

From the above findings, we can conclude that the deployment of (new) services often occurs in collaboration with parties who possess the skills and knowledge required for both service production and improvement. From the perspective of a resource-optimising strategy (Roper, Du, and Love 2008), this implies a reduced indispensability of KIBS' own dynamic capabilities for implementing new propositions. In the operationalised version of the framework by den Hertog, van der Aa, and de Jong (2010), this relates to the importance of capabilities for 'coproducing & orchestrating' and 'scaling & stretching'.

2.3.3. Knowledge transformation

In between sourcing knowledge and applying it to market-ready solutions, we find the intermediate stage of converting market signals into actual propositions (Hansen and Birkinshaw 2007; Love, Roper, and Bryson 2011). Research on openness has only touched on how firms can integrate acquired external sources into their own operations and innovations (West and Bogers 2013). Nevertheless, the capacity to synthesise and transform knowledge is expected to be of great strategic importance for successful innovation (Lichtenthaler and Lichtenthaler 2009; Roper, Love, and Zhou 2017).

Den Hertog et al. note that the conceptual nature of services implies that this translation stage is peculiar: a service innovation cannot be researched, developed, prototyped and tested in the same way as physical goods (2010, 500). Due to the intangibility of the service product, the possibilities to communicate codified knowledge are limited. A high amount of tacit knowledge is required to assemble raw market signals into an innovative knowledge combination. Only if firms manage to generate full-fledged service concepts, is there a basis to conduct experiments and assess how to optimally organise the delivery of the new proposition. Apart from integrating new information (on needs and options) and past experiences, KIBS thus also face the challenge of aligning a novel service proposition with their current business activities. This element of service conceptualisation requires a comprehensive understanding of what the new offering entails.

The description of the dynamic service innovation capability of conceptualising provides relatively few suggestions for how to involve other parties (den Hertog, van der Aa, and de Jong 2010). In fact, the benefits of openness are mainly discussed as an intra-organizational issue: knowledge transformation 'is mostly in the hands of a multidisciplinary project team' (den Hertog, van der Aa, and de Jong 2010, 501). Indeed, Love, Roper, and Bryson (2011) show that internal openness in the form of team working is important when encoding ideas into viable service offerings. Moreover, in three case studies on customer-interaction by design services, Lehrer et al. (2012) find that the stage of knowledge transformation is best performed in isolation. They claim that separation between service firms and clients at this stage of service innovation can be beneficial for KIBS, especially if the innovation involves a high degree of creativity. These findings correspond with earlier research on

KIBS' knowledge conversion activities. Muller and Zenker (2001) showed how KIBS spread knowledge through an innovation system by interacting with clients in both knowledge production and knowledge diffusion stages. The knowledge recombination or 'codification' stage, however, is not associated with any innovation-related interactions.

2.3.4. *Synthesis of relative capability importance*

Up until now, no one has assessed whether the possibilities encountered for relying on partners influence the need for different dynamic capabilities; certainly not for inherently open firms like KIBS. Since the seminal work by Laursen and Salter (2006), we know there are lower returns from external searches, but a qualitative appreciation of this drawback is lacking. Roper, Du, and Love (2008) advise that firms adopting an open innovation strategy should develop capabilities for activities requiring little help from outsiders. Following the notion of complementary innovation assets (Teece 1986), investments can best be focused on innovation assets not available through interaction. Laursen and Salter (2014) echo this view, and warn against the risk of overly relying on partners, thereby failing to perform essential tasks internally. When applied to KIBS, this argument leads to an expectation of the most essential capabilities for being innovative.

Synthesising our observations, we highlight the possibilities for relying on partners for each distinct phase of the innovation value chain (see also the lower part of Figure 1). As said, a low potential for openness implies a higher importance of a firm's own capabilities.

First of all, research on knowledge sourcing by KIBS shows that external linkages (whether routine-based interaction or deliberate collaboration) are important for acquiring signals on market demands and ways to meet these demands. KIBS, by virtue of their very openness, are therefore expected to have sensing capabilities. Secondly, although partners' roles diminish when activities in the innovation value chain become less explorative, studies on commercialisation and management of new services have demonstrated that partner importance reappears when the innovation funnel reaches the stage of actually deploying new formulas. KIBS engaging intensively in deliberate partnerships do not need to invest as much in internally developed 'co-producing and orchestrating' and 'scaling and stretching' capabilities, since they can rely on their partners' capabilities. For activities related to transforming raw ideas into strong propositions, however, the potential role of parties in a firm's client and partner network is not self-evident. Our review of studies on openness in KIBS suggests that knowledge transformation occurs best in isolation, or at least is less likely to be substituted with the input of collaborating parties. Scholars not specifically looking at KIBS have stated that firms need their own encoding capacity to actually use the knowledge they have gathered: 'Once acquired, the innovation effect of external knowledge will depend on firms' ability to encode that knowledge into their innovation outputs' (Roper, Love, and Zhou 2017, 21).

Our theoretical and empirical findings thus imply that it is better for KIBS to complement an open strategy with a strong conceptualising capability. While the capabilities for the initial and final stage of the innovation value chain can certainly be strategically important, their potential to allow highly open firms to be even more innovative is probably inferior to the value of being able to conceptualise. In other words: looking at the *relative relevance* of the various dynamic capabilities, we expect the importance of conceptualising

to increase compared to other capabilities when KIBS become more open. Our third (and core) hypothesis is thus:

Hypothesis 3: When KIBS engage in high levels of openness, the most important capability for being innovative is conceptualising.

3. Method for statistical analysis

The examination of our hypotheses is based on survey data analysis. Section 3.1 presents the data-set, Section 3.2 the statistical method, and Section 3.3 the description of variables used in our models.

3.1. Data-set

The statistical analysis we present is based on a data-set constructed by sending a questionnaire to a wide variety of Dutch firms in the greater Amsterdam and Utrecht areas. The topics covered included: the firm's service delivery, innovation strategy, innovation types, capabilities, openness and formalisation, financial performance, management team and market environment. The survey sample was composed by randomly drawing addresses from Bureau van Dijk's REACH database, ensuring industry and firm size representativeness. The letter containing the questionnaire was addressed to the CEOs or managers of 8054 firms with ten or more employees and yielded 458 responses (online and by mail). With respect to industry and firm size, the firms that participated are to a large extent similar to the non-respondents. We analysed a subsample of the firms registered as KIBS that responded to all the items used in our models.

Previous studies have classified firms as KIBS if they engage in computer and related activities, research and development, or other business activities (Castaldi 2009; Leiponen 2012). In the international classification of economic activities (NACE Rev. 2), they come under information and communication services (industry group J) or professional, scientific and technical activities (industry group M). The Table 1 shows how our sample of 125 cases is distributed within these KIBS categories.

Table 1. Sectoral composition of the data-set.

KIBS group/industry	Respondents
J: Information and communication	42
<i>Publishing activities</i>	1
<i>Motion picture, video and television programme production, sound recording and music publishing</i>	8
<i>Programming and broadcasting activities</i>	1
<i>Telecommunications</i>	1
<i>Computer programming, consultancy and related activities</i>	28
<i>Information service activities</i>	3
M: Professional, scientific and technical activities	83
<i>Legal and accounting activities</i>	10
<i>Head office activities; management consultancy activities</i>	28
<i>Architectural and engineering activities</i>	22
<i>Scientific research and development</i>	3
<i>Advertising and market research</i>	17
<i>Other professional, scientific and technical activities</i>	3
Total	125

3.2. Statistical method

We examined the impact of DSICs and openness on innovation using a series of hierarchical linear regression models. Firstly, we explored the relative influence of the five dynamic capabilities on renewal of the service portfolio (Model 1). Including all capabilities simultaneously in one model gave an empirical account of the respective importance of each capability for creating service innovation. Up till now, this essential step has not been reported in the literature (den Hertog, van der Aa, and de Jong 2010; Janssen, Castaldi, and Alexiev 2016). In Section 2.1, we hypothesise that all capabilities matter for a KIBS firm's innovativeness.

Secondly, we looked at the relationship between openness and innovation (Model 2). We used the model to test our second hypothesis, stating that deliberate partnerships are relevant for innovativeness even in firms that by their very nature are open.

In the third model, we included the capabilities and openness in one single regression. Model 3 sheds some light on the relative role of openness, but mainly serves as a step towards the final analysis.

In Model 4, we extended the previous model with the effects of interaction between dynamic capabilities and openness. This model provides a test for our third and final hypothesis. We examined to what extent openness moderates the relationships between distinct dynamic capabilities and innovativeness. Although analytically it might be more comprehensive to compare highly open KIBS with moderately open KIBS, we followed the advice given by Spiller et al. (2013) not to dichotomise a continuous variable or split our sample; doing so might lead to a loss of statistical power and increase the risk of encountering spurious effects. Instead, we adhered to common practice by running a model of the (simplified) type below, to eventually test whether and to what extent an increase in one amount of openness relates to an increase in the *effect* of a certain capability (Spiller et al. 2013).

$$Y = \beta_0 + \beta_1 * \text{DSIC} + \beta_2 * \text{openness} + \beta_3 * \text{DSIC} * \text{openness} + \epsilon$$

3.3. Description of variables in the models

The data-set we applied contains responses to a Community Innovation Survey (2010), as well as several items for new measurement scales. Particularly, relevant for the current study are the items relating to dynamic service innovation capabilities (DSICs) and service innovation. All the reported constructs were measured with the 7-point Likert scale. Table 2 shows the descriptive statistics and correlations of the subsequently discussed variables. In order to reduce the effect of multi-collinearity, the variables used for interaction terms were mean-centred (Aiken and West 1991). The last column of Table 3, which shows our results, confirms that all the variables in our final model have a variance inflation factor well below the critical threshold of 10 (Diamantopoulos and Winklhofer 2001). Measurements of construct reliability for the current sample are provided in Appendix A. As mentioned throughout, *Dynamic service innovation capabilities* form a key set of independent variables in our models.

Openness is the other focus of this study. To be consistent with the established body of research, we adapted a standard scale from the Oslo Manual for collecting innovation data (OECD 2005). Firms were asked to what extent they have formed deliberate innovation-oriented partnerships with different types of partners such as suppliers, customers, competitors, external advisors, commercial labs, higher education institutions, public research institutes

Table 2. Descriptive statistics and correlations.

	Mean	Std. Dev.	1	2	3	4	5	6	7	8	9	10	11
1 Firm size (log)	3.56	1.34											
2 Formalised innovation activity	3.38	1.32	0.01										
3 Market dynamism	5.07	1.27	0.01	0.05									
4 Competitive pressure	4.96	1.16	−0.06	−0.09	0.20*								
5 DSI1: Sensing user needs	4.74	1.20	0.04	0.39**	0.19*	0.09							
6 DSI2: Sensing (tech.) options	5.29	1.11	0.01	0.32**	0.34**	0.15	0.47**						
7 DSI3: Conceptualising	4.83	1.12	−0.13	0.22*	0.28**	−0.13	0.48**	0.54**					
8 DSI4: Co-producing & orchestrating	4.64	1.26	0.02	0.20*	0.11	0.10	0.25**	0.30**	0.25**				
9 DSI5: Scaling & stretching	4.38	1.24	0.10	0.26**	0.13	−0.09	0.29**	0.38**	0.26**	0.02			
10 Openness (partnerships)	2.82	0.93	0.09	0.19*	0.21*	0.16	0.14	0.32**	0.18*	0.37**	0.04		
11 Service innovation	4.46	0.89	0.01	0.13	0.31**	0.09	0.26**	0.52**	0.44**	0.30**	0.33**	0.31**	

* $p < 0.05$; ** $p < 0.01$.

Table 3. Results from the regression analyses of service innovation.

	Model 1			Model 2			Model 3			Model 4		
	β	Std. error		β	Std. error		β	Std. error		β	Std. error	VIF
Firm size (log)	0.022	0.051		-0.013	0.056		0.010	0.051		-0.014	0.052	1.155
Formalised innovation activity	-0.072	0.056		0.068	0.058		-0.086	0.056		-0.067	0.058	1.397
Market dynamism	0.112	0.057		0.255***	0.061		0.101	0.057		0.107	0.058	1.279
Competitive pressure	0.055	0.063		0.005	0.067		0.042	0.063		0.052	0.065	1.349
DSIC 1: Sensing user needs	-0.089	0.083					-0.077	0.083		-0.084	0.088	1.846
DSIC 2: Sensing (tech.) options	0.299***	0.090					0.276***	0.091		0.279**	0.099	2.333
DSIC 3: Conceptualising	0.228**	0.089					0.223**	0.088		0.222**	0.090	1.952
DSIC 4: Co-producing & orchestrating	0.174**	0.070					0.141*	0.073		0.137	0.075	1.348
DSIC 5: Scaling & stretching	0.187**	0.074					0.194**	0.073		0.211**	0.075	1.337
Openness (partnerships)				0.245***	0.079		0.119	0.074		0.142	0.079	1.502
DSIC 1 * Openness										-0.124	0.091	1.978
DSIC 2 * Openness										-0.035	0.101	2.257
DSIC 3 * Openness										0.183*	0.092	2.118
DSIC 4 * Openness										-0.020	0.073	1.506
DSIC 5 * Openness										-0.116	0.082	1.539
R^2	0.381			0.164				0.391			0.424	
Adjusted R^2	0.332			0.129				0.338			0.345	
F	7.852			4.661				7.334			5.358	

* $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$.

and professional organizations. One minor modification we made was including a question on the importance of freelancers, since they account for a significant part of the Dutch work force. The variable in our analysis is the average score for all partner types. Note that this indicator concerns partnerships deliberately formed to create innovation; they complement the interaction a firm engages in naturally when delivering its products or services. Items and descriptive statistics are included in Appendix B.

Service innovation is the dependent variable. It was constructed by posing survey questions regarding changes and renewal in a firm's services in the three preceding years. Asking respondents to look back is a common method for analysing the lagged effect of capabilities on innovativeness (e.g. Mansury and Love 2008). Since novelty in services is hard to grasp with traditional distinctions like process and product innovation, we adopted insights on the multidimensional nature of service innovation (Den Hertog 2000). We used the measurement items introduced by Janssen, Castaldi, and Alexiev (2015), who developed scales for six different service dimensions (den Hertog, van der Aa, and de Jong 2010). Using these scales, we then constructed an aggregated measurement by adding up the scores for each dimension (according to Mina, Bascavusoglu-Moreau, and Hughes 2014; see also Appendix C).

Control variables, as presented in our analyses, include the logarithm of firm size. In line with similar studies, we also used a proxy for the extent to which a firm is oriented towards innovation (e.g. Leiponen 2012). Since R&D budgets are an inappropriate measurement in the context of KIBS, we asked whether they had formalised procedures for innovation in place. Questions were adapted from the service innovation formality scale created by Avlonitis, Papastathopoulou, and Gounaris (2001), in particular their items on systematic behaviour and documentation. Our formalisation measurement is the average score for the five items that demonstrated most construct reliability (Appendix D). Our final two control variables are the environment in which a firm operates. This aspect, which might affect our findings, is captured by the environmental turbulence (Laursen and Salter 2006), and the degree of competitive intensity (Keupp and Gassmann 2009). Competitive pressure and market dynamism (Cronbach $\alpha = 0.706$ and $\alpha = 0.844$, respectively) were measured with scales developed by respectively Jaworski and Kohli (1993) and Jansen, Van Den Bosch, and Volberda (2006).

4. Results from regression models

Before exploring the role of openness, we examined to what extent the five DSICs can be related to novelty in a firm's service portfolio. Inspection of the descriptive statistics in Table 2 reveals that all the individual capabilities are significantly correlated with service innovation. This is a reassuring finding for managers who are investing in the activities that undergird these dynamic capabilities, but does not yet reveal the optimal allocation of scarce resources. To study the relative influence of the DSICs and test our first hypothesis, we simultaneously tested the statistical relationships of all the capabilities in one single regression model.

Model 1 in Table 3 largely confirms our first hypothesis that all the dynamic capabilities matter for a KIBS firm's ability to be innovative. The only capability with no significant predictive power (in a model containing other capabilities and control variables) is 'sensing user needs'. Compared to other DSICs, this capability does not appear to be correlated with

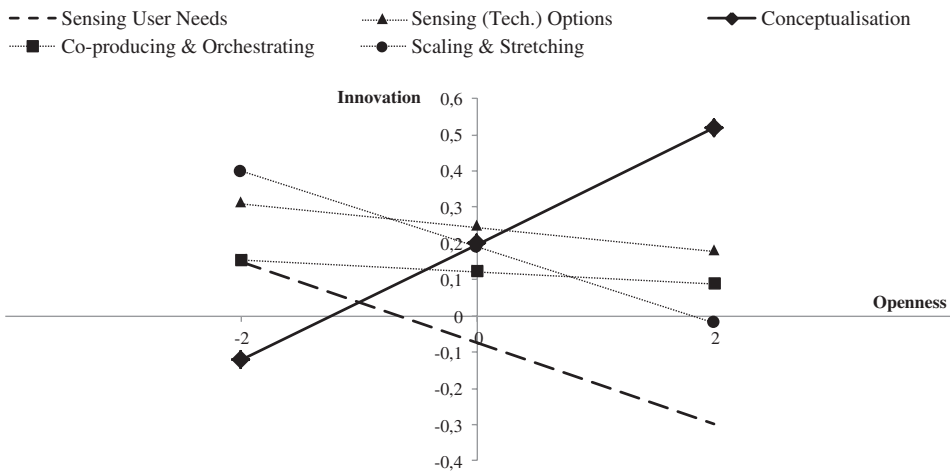


Figure 2. The total effect of each dynamic capability on innovation equals the direct effect plus the indirect effect ($\beta_{\text{DSIC}} + \beta_{\text{DSIC} \times \text{openness}} \times \text{openness}$), based on regression model 4 results (standardised coefficients). Notes: Dashed line corresponds with effect where intercept and slope do not significantly differ from zero. Dotted lines are effects where only slope is not significantly different from zero. Continuous lines refer to effects where both intercept and slope significantly differ from zero

innovativeness. The capability, that turns out to matter most, namely sensing (technological) options, is strongly related to creating service innovation.

Looking at Model 2, we observe that the variable for engaging in deliberate partnerships is positively related to service innovativeness, also for firms who already interact intensively with other parties. This finding confirms our second hypothesis. According to the third regression results, however, maintaining deliberate partnerships (in addition to routine forms of interaction) does not improve the model substantially if these firms also invest in capabilities. In Model 3, the influence of the respective capabilities is similar to the coefficients in Model 1, except for the capability of co-producing and orchestrating. The positive coefficient for this variable becomes slightly less significant if we control for the fact that firms have open innovation processes, and thus might be more experienced in jointly producing a service.

Finally, the key question concerns the interaction between the two factors of interest: which internal capabilities matter most when a KIBS firm's degree of openness increases? This is what the moderating variables in Model 4 reveal. Including the interaction terms of openness and the dynamic capabilities shows that almost none is statistically significantly related to service innovation (which is why the total goodness-of-fit does not improve when moving from Model 3 to Model 4; the significance of the change in F is only 0.293). The one exception here is conceptualising. Whereas capabilities for the initial and final phases of the innovation value chain do not show complementarities with a high level of openness, the interaction term for conceptualising is positively significant. Although the observed effect is only weak, it is clearly stronger than the negative and insignificant effects of the other interaction terms. These findings are in line with the hypothesis that the importance of conceptualising surpasses other capabilities when KIBS innovate more openly.

In order to confirm our third hypothesis, we calculated the entire effects of the dynamic capabilities in Model 4. For each capability, the total effect equals the direct effect plus the

interaction effect. In terms of the simplified model presented earlier, this can be written as: $\beta_1 + \beta_3 * \text{openness}$.

As shown in Figure 2, the total effects of four out of five capabilities on innovation are flat lines, given that the corresponding (negative) interaction term with openness is not significant. For sensing user needs, even the average effect, as captured by the coefficient of the direct effect, is not significant. Only for conceptualising, we observe that its relationship with innovativeness indeed increases significantly when a firm operates more openly. For levels of openness just above the sample average (zero because variables are standardised), the total effect of conceptualising becomes more important than the total effect of sensing technological needs (the most influential capability in regular business circumstances). In sum, while additional openness does not lead to a larger marginal innovation-effect for four of the capabilities, there is no clear ceiling for the interaction between openness and the conceptualising capability. Having a strong conceptualising capability seems to allow innovation-pursuing KIBS to make more use of the knowledge flows they engage with, unlike the capabilities associated with obtaining or applying (and thus disseminating) knowledge.

5. Discussion

Drawing on the regression results, this Section describes our findings (5.1), their implications (5.2) and discusses the limitations and possibilities for further research (5.3).

5.1. Findings

This study took up the challenge of diving deeper into the under-researched phenomenon of open service innovation in KIBS (Leiponen 2012; Mina, Bascavusoglu-Moreau, and Hughes 2014). Due to the absence of appropriate metrics, up till now, hardly any assessment has been made of the relationship between having dynamic capabilities (internally) and realising service innovation (den Hertog, van der Aa, and de Jong 2010). This is why our empirical models also assessed the broader relationship between dynamic capabilities and innovativeness in KIBS. According to our statistical findings, sensing user needs is the only capability not significantly related to KIBS innovation output. This result is at odds with earlier findings from a broader sample of service providers (Janssen, Castaldi, and Alexiev 2016). For those firms that interact less intensively with their clients than KIBS, sensing user needs was significantly related to turnover from innovative sales. The counter-intuitive finding from the current study emphasises the need to focus on complementarity when developing in-house capabilities.

Our regression results are in line with common findings that customers have a major impact on (service) innovation (e.g. Love, Roper, and Bryson 2011); they suggest that for KIBS, this is not a promising area to target when developing dynamic capabilities. Because professional service providers typically engage in 'on-the-job' learning by interacting closely with their clients (Leiponen 2005), there appears to be relatively limited value in developing such an intelligence function. As Leiponen noted (2012, 1258), an internal sensing function 'cannot replace direct contact between clients and employees active in new service development'.

On the other hand, sensing (technological) needs appears to be all the more important for achieving service innovation. The discriminatory aspect of this capability is in line with

the generally acknowledged view that many service innovations are driven by opportunities stemming from, for instance ICT technologies (Sirili and Evangelista 1998). Because such technologies can offer a great competitive advantage, KIBS are advised to invest in activities that enable them to stay up to date with the latest ICT developments. These efforts are typically found in business development or ICT departments within an organisation where employees are responsible for scanning promising opportunities (den Hertog, van der Aa, and de Jong 2010).

Our current analyses on service innovation in KIBS show that four out of five capabilities are not significant in combination with openness. In our interpretation, when KIBS raise their level of openness by maintaining innovation-oriented partnerships (rather than just engaging in operational interaction), conceptualising becomes more important for achieving innovative output. The regression results thereby provide strong evidence that KIBS which maintain extensive external relationships might benefit from the ability to translate acquired and generated market signals into marketable propositions. In such circumstances, the other capabilities are relatively less attractive to develop internally, because clients and partners can also provide (or contribute to) some activities at the beginning and end of the innovation value chain. Thus, the answer to our research question is that conceptualising appears to be a particularly important dynamic capability for innovation in highly open firms.

5.2. Implications

Our empirical evidence has significant implications. For researchers as well as managers, it supports the need to pay attention to knowledge transformation or assimilation (Roper, Love, and Zhou 2017). Instead of only considering the explorative and exploitative aspects of open innovation (Van de Vrande et al. 2009), our results indicate that especially the intermediate capability of conceptualising allows open firms to benefit from knowledge flows. According to den Hertog, van der Aa, and de Jong (2010), firms can develop their conceptualising capability by engaging in practices like prototyping, concept visualizing, service blueprinting, nurturing corporate entrepreneurship and out-of-the-box thinking. Similar tools stemming from a marketing or 'service design thinking' perspective (e.g. Furrer et al. 2016) include experience blueprinting and emotion/process mapping. All these examples can help firms to transform insights in customer needs and technological options into actual propositions. Besides understanding and crafting every step of a customer's service journey, they also ensure that the delivery of the novel service is carefully aligned with existing offerings, thereby creating a 'total solution' or consistent bundle of services (den Hertog, van der Aa, and de Jong 2010). Finally, holistic approaches like service-based business model mapping provide support in designing the strategic links between value creation, capture and delivery (Janssen and Den Hertog 2016).

Taking a broader perspective, our findings also invite us to reflect on the role of KIBS within innovation systems. Conceptualising appears to be the one critical capability that open KIBS maintain better internally. We suggest that there are relatively few opportunities for firms to draw on external knowledge during the encoding stage. This is consistent with the claim that transforming raw ideas into bespoke solutions is a highly complex task, demanding specialised skills (Muller and Zenker 2001; Lehrer et al. 2012). For knowledge economies, KIBS' ability to transform knowledge might be just as important as their contribution to disseminating it. After all, translating knowledge into problem-solving strategies

and spreading knowledge are both essential for industrial evolution and economic growth (Consoli and Elche-Hortelano 2010). The ability of KIBS to assemble knowledge into new solutions, in addition to merely transferring knowledge, legitimates special policy attention (Toivonen 2007). Evidence that conceptualising resides mostly within KIBS themselves, supports interventions aimed at improving KIBS' interaction with public and private organisations that are less able to convert knowledge themselves.

5.3. Further research and limitations

The analyses in this paper suggest that the act of conceptualising is something KIBS might want to invest in, especially if they have an above-average level of openness. In order to better support innovation managers, future studies could investigate how to build and exploit a conceptualising capability. To what extent these results are valid for non-KIBS is still to be examined. For instance, there might be more possibilities to rely on clients and partners in contexts where knowledge is often codified. According to Roper et al., the ability of a firm to engage in conceptualising (or 'encoding') is determined by factors related to organisational culture, structure and resources (2014, 21). By demonstrating the use of a capability framework, this paper opens the way to investigate these expectations empirically. Moreover, our results provide input for emerging debates on managing processes like knowledge generation, encoding and application (Love, Roper, and Bryson 2011; Roper, Love, and Zhou 2017), as well as knowledge systematisation and reconfiguration (Consoli and Elche-Hortelano 2010).

Future research could also clarify under which circumstances sensing user needs enables KIBS to become more innovative than the competition. In a service-oriented study, Salunke, Weerawardena, and McColl-Kennedy (2013, 1093) state that 'the use of dynamic capabilities in gaining and exploiting customer-based knowledge and its effect on sustaining innovation-based advantage remains a neglected area'. One key moderating factor is likely to be the extent to which KIBS deliver customised rather than standardised services. The paradox that sensing user needs hardly matters to firms that interact closely with their users can perhaps be explained by the downside of focusing too much on the needs of particular customers, rather than seeking concepts that are valuable to a wider client population.

As for the limitations of this study, the authors stress that they obtained all the empirical results from self-reported data. Despite our efforts to ensure methodological rigour, we acknowledge that replications and extensions of the presented analyses can benefit from secondary data sources. However, we also stress that the emphasis in all the analyses is on testing which factors (dynamic capabilities and openness) matter most. This focus on relative rather than absolute performance renders problems of common method bias largely irrelevant.

6. Conclusion

Innovation scholars typically study KIBS for their role as knowledge brokers and innovation generators (Den Hertog 2000; Muller and Zenker 2001), but research increasingly focuses on how openness affects innovation processes within KIBS themselves (Love, Roper, and Bryson 2011). While some authors have stressed the need to assess the role of open innovation in services, our study is one of the first to examine the importance of innovation-oriented partnerships in firms whose regular business activities already demand intensive forms of interaction.

Working towards an analysis of the moderating role of openness, our study firstly contributes to assessing the relative importance of specific dynamic capabilities. The framework of dynamic service innovation capabilities has hardly been used to determine which kind of innovation activity is most discriminative when it comes to achieving innovation. Acknowledging that resources are limited, we aim to inform managers having to decide which capabilities to concentrate on.

Importantly, this paper assesses whether the value of dynamic capabilities is related to a firm's routine-like and innovation-oriented openness. Whereas research on external knowledge sourcing has focused primarily on identifying optimal levels of openness (e.g. Laursen and Salter 2006), we present supporting evidence for the argument that there is a functional restriction to the extent to which firms can rely on the skills and knowledge of others. From a resource-based perspective, the most important capability to focus on, is the one related to a phase of the innovation value chain where other parties can contribute least (Roper, Du, and Love 2008; Love, Roper, and Bryson 2011). In line with an exploratory case study by Lehrer et al. (2012), we show that for KIBS, an internal conceptualising capability is most complementary to extensive external knowledge sourcing. Moderately open KIBS benefit most from their capability to sense technological options, but least from a sensing user needs capability. Based on our findings, we conclude that KIBS appear to differ in their reliance on clients and partners. While openness is a common characteristic, there seems to be room for strategically considering which activities to perform or not to perform jointly with others. The mere production of knowledge intensive business services requires extensive forms of interaction; but to create novel services, it is up to the firm itself how much (and especially for what purposes) it wishes to involve external inputs. Making the right choices here has a significant impact on a firm's innovativeness and consequently its competitive edge.

Looking beyond the domain of KIBS, our results are also relevant for the increasing number of firms adopting an open innovation strategy and switching to service-inclusive business models (Chesbrough 2011; Mina, Bascavusoglu-Moreau, and Hughes 2014). As noted by many authors, servitisation involves more than replacing (or complementing) the production of artefacts for delivering services. The provision of services and the accompanying client interaction might have a direct impact on how firms organise the development of new propositions. Returning to the observations by Barras (1990), we stress that insights in the innovative behaviour of firms at the forefront of openness are strategically relevant to any firm following the path to highly interactive modes of production.

Disclosure statement

No potential conflict of interest was reported by the authors.

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Appendices: Measurement items

Appendix A. Measurement items for dynamic service innovation capabilities

Dynamic service innovation capabilities are measured using scales proposed by den Hertog, van der Aa, and de Jong (2010) and operationalised by Janssen, Castaldi, and Alexiev (2016).

Table A1. Measurement items for dynamic service innovation capabilities (Janssen, Castaldi, and Alexiev 2016).

Sensing user needs. Cronbach $\alpha = 0.737$

- We systematically observe and evaluate our customers' needs.
- We analyse the actual use of our services.
- Our organisation is strong in differentiating user groups and market segments.

Sensing (technological) options. Cronbach $\alpha = 0.737$

- Staying up to date with promising new services and technologies is important for our organisation.
- In order to identify possibilities for new services, we use different information sources.
- We keep track of which technologies our competitors are using.

Conceptualising. Cronbach $\alpha = 0.734$

- We are innovative in creating ideas for new service concepts.
- Our organisation experiments with new service concepts.
- We align new service offerings with our current business and processes.

Coproducing & orchestrating. Cronbach $\alpha = 0.752$

- Collaboration with other organizations helps us to improve or introduce new services.
- Our organisation is strong in coordinating service innovation activities with several parties.

Scaling & stretching. Cronbach $\alpha = 0.650$

- For developing new services, we take into account our branding strategy.
 - Our organisation actively engages in promoting its new services.
 - We introduce new services by keeping to our marketing plan.
-

Appendix B. Measurement items for deliberate openness

Questions on the importance of different types of partners are based on the Oslo Manual (OECD 2005). In this case, the 7-point Likert scale ranges from 'very important' to 'very unimportant'. Since we are particularly interested in external openness, we slightly modified the usual list of co-operation partners. 'Other enterprises within the enterprise group' are not taken into account in this analysis, while 'Professional organizations, trade unions' and 'Freelancers' are added for completeness.

The following partners have been important for our service innovations in the past three years:

- Suppliers of equipment, materials, services or software
- Companies purchasing our services
- Customers
- Competitors or other businesses in our industry
- Consultants and external advisors
- Commercial labs or private R&D institutes
- Universities or other higher education institutions
- Government or public research institutes
- Professional organizations, trade unions
- Freelancers

Cronbach α = 7.52; mean (of mean score) = 2.82; variance = 0.86; standard deviation = 0.93

Appendix C. Composite indicator and measurement items for service innovation

The variable for 'Service innovation' is an aggregated measurement (index), calculated by adding up the scores for the six service dimensions defined by den Hertog, van der Aa, and de Jong (2010). The table below shows which survey items underlie the six individual constructs, based on the measurement scales developed by Janssen, Castaldi, and Alexiev (2015). For the 125 respondents in our tests, the construct reliability of the composite indicator for service innovation is equal to Cronbach α = 0.688.

Table C1. Measurement items for six service innovation dimensions (Janssen, Castaldi, and Alexiev 2015). The service innovation variable used in our analyses is a composite indicator based on the average score of the six dimensions.

New Service Concept (NSC)

- Our organisation has developed new (service) experiences or solutions for customers.
- We combined existing services in a new formula.
- We developed a new way of creating value for our customers and ourselves.

New Customer Interaction (NCI)

- Our organisation has developed new channels for communicating with customers.
- We have updated the way we contact our customers.

New Value System /Business Partners (NBP)

- We have revised the role of external parties for producing our services.
- We involve new partners in the delivery of our services.

New Revenue Model (NRM)

- By introducing new services, we have changed the way we generate revenue.
- The way we are paid (financial construction) has been adapted.

New Organizational Delivery System (NODS)

- We have changed our organisation to create new services.
- Producing new services requires new skills from our employees.

New Technological Delivery System (NTDS)

- Technology plays an important role in the renewed production of our services.
 - We have renewed our service offerings with new or different uses of ICT.
-

Appendix D. Measurement items for formalising service innovation

Items are adapted from the service innovation formality scale created by Avlonitis, Papastathopoulou and Gounaris (2001).

- We evaluate the progress of our new service development systematically
- The development of new services occurs via specific guidelines and procedures
- The final decision to introduce a new service is the result of a formalised process
- New services are developed according to a schematic plan
- Progress with developing new services is documented in writing

Cronbach α = 0.916; mean = 3.38; variance = 1.75; standard deviation = 1.32