



***Dynamic capabilities for service innovation:
Conceptualization and measurement***

Matthijs Janssen, Carolina Castaldi and Alexander Alexiev

Working paper 14.07

Eindhoven Centre for Innovation Studies (ECIS),
School of Innovation Sciences,
Eindhoven University of Technology, The Netherlands

Dynamic capabilities for service innovation: conceptualization and measurement

Matthijs Janssen ^{a,b,c}, Carolina Castaldi ^a, Alexander Alexiev ^c

^a *School of Innovation Sciences, Eindhoven University of Technology.
Den Dolech 2, IPO 2.04, 5600 MB Eindhoven, the Netherlands. M.J.Janssen@tue.nl; C.Castaldi@tue.nl.*

^b *Dialogic Innovatie en Interactie.
Hooghiemstraplein 33-36, 3514 AX, Utrecht, The Netherlands.*

^c *Amsterdam Centre for Service Innovation, VU University Amsterdam.
De Boelelaan 1105, 5A-35, 1081 HV Amsterdam, the Netherlands. A.S.Alexiev@vu.nl*

ABSTRACT

For both managers and policy makers involved in innovation, capability failures regarding development of new services are a major concern. Efforts to strengthen those capabilities, and evaluation thereof, demand more comprehensive insight in firms' actual abilities to source ideas and convert them into marketable service propositions. This paper aims to provide clarity by operationalizing a set of dynamic service innovation capabilities (DSICs).

We first review how existing conceptualizations adopt recent insights from the dynamic capability view, which emphasizes the need to identify microfoundations corresponding to a limited set of common constructs. One of the encountered conceptualizations, consolidating earlier works in specific service sectors, was found appropriate for gauging DSICs across a wide range of industries. It exemplifies how DSICs can be conceptualized according to the so-called synthesis approach to service innovation by capturing insights on the evolutionary properties of the creation of novel solutions.

Secondly, we operationalize a refined version of such DSICs and develop a measurement scale, using two subsamples from a dataset of 391 Dutch firms. The measured capabilities are found to correlate to different extents with performance measures. Our main contribution, a validated scale for five complementary DSICs, opens the way to comparative analyses which are of relevance for further research, management and policy development.

Key words

Dynamic capabilities, service innovation, measurement scale

JEL codes: 031, L2

1. Introduction

According to evolutionary theorizing, the continuous creation of novelty and variety in economic activity is a key driver for development and prosperity (Schumpeter, 1934). To a large extent, the mechanisms behind economic and technological change rely on firm-level entrepreneurial experimentation (Nelson & Winter, 1982; Dosi et al., 2010). By developing dynamic capabilities, firms are able to generate, adopt and apply new knowledge that can power innovative output (Teece & Pisano, 1994). The issue is also of concern to policy makers, as organizations having weak dynamic capabilities might hamper the processes of knowledge production and dissemination that characterize a well-functioning innovation system (Edquist, 2011).

Recent research has explored the nature and forms of these capabilities in different contexts, focusing on specific organizational processes and structures that represent capability microfoundations (Teece, 2007; Foss, 2011). While identifying dynamic capabilities has been addressed extensively within the context of technological innovation, the discussion is fairly nascent in the service innovation literature. This is regrettable, as innovation in the domain of services plays an essential role within economies (Leiponen, 2012): not only do professional and knowledge intensive business services spur innovation in other sectors (Muller & Zenker, 2001), but novel services are regarded as a source of competitive advantage for virtually all industries (Vargo & Lusch, 2004, Consoli, 2007).

Many firms experience severe problems when developing new services and their attempts often fail (Smith et al., 2007). Prescriptive instruments for service innovation are frequently urged for (Sundbo, 1997; Gallouj & Djellal, 2010). However, in order to enhance firms' ability to introduce new services successfully, it is crucial to empirically investigate which capabilities are important (e.g. Rubalcaba et al., 2010; Den Hertog et al., 2010). Such evidence can only be gained through inter-firm comparison, rather than by identifying firm-specific capabilities (Baretto, 2010). Similarly, the development of capability-supporting policy instruments and their evaluation demand metrics that can indicate the relative strength of firms' potential to create new services.

To this end, this paper aims to operationalize a set of dynamic capabilities for service innovation that is general enough to be relevant across different sectoral contexts, yet sufficiently specific to capture the salient evolutionary properties of individual firms' dynamic capabilities. These goals are in line with a so-called synthesis approach to service innovation (Coombs & Miles, 2000; Gallouj, 1994), which is advocated as the step required to advance innovation research as a whole. Once these criteria are met, scholars can investigate similarities and differences across firms in order to equip managers and policy makers with a basis for assessing where to direct investments in capability development.

To meet our objective, we first review existing conceptualizations of dynamic service innovation capabilities (DSICs). After reviewing recent contributions to the dynamic capability view in management theory, we discuss how these have been integrated into the domain of services by studies stemming from the domain of business strategy, marketing and service management. In absence of a central debate in which the various conceptualizations are related to each other, it remains unclear which approach is most suited to assess the relative strength of DSICs. In order to move forward with developing an actual measurement

scale, we create a systematic overview and select the conceptualization that fits best with a synthesis approach to service innovation.

Next, we use two subsamples of a multi-industry survey to separately purify and validate a measurement scale. Results from the corresponding exploratory and confirmatory factor analyses show that the selected capabilities can be measured accurately. The most important modification of the original framework concerns the finding that one of the capabilities appears to consist of two sub-capabilities. Apart from assessing convergent and discriminant validity, we use structural equation modeling (SEM) for analyzing the structural paths between the capabilities. Finally, we assess to what extent the distinct DSICs relate to turnover from innovation and comparative firm performance. We find positive correlations, but the exact value of a particular dynamic capability differs per performance measure.

The validated measurement scale, which is our main contribution, captures to what extent firms possess DSICs that are relevant for different processes concerning novelty creation and application. For researchers, this common measure opens the way for comparative analysis across firms and sectors, whereas for managers and policy makers, the scale offers a prescriptive tool to strengthen capabilities for service innovation.

2. Theoretical background

2.1 The dynamic capabilities view

New ways for creating and capturing value often require an enterprise to extend, modify, or completely revamp what it is doing (Katkalo et al., 2010). Dynamic capabilities play a crucial role in this respect: they refer to a firm's ability to adapt its structural organization and resulting output (Teece et al., 1997). Zollo and Winter (2002) describe a dynamic capability as "the learned and stable pattern of collective activity through which the organization systematically generates and modifies its operating routines in pursuit of improved effectiveness".

Despite its theoretical usefulness and broad adoption, the concept of dynamic capabilities proves hard to operationalize. In fact, most contributions in the dynamic capability view (DCV) concern debates on its foundations (Di Stefano et al., 2010). Critics point at the lack of empirical grounding (Zahra et al., 2006) and accurate measurement (Williamson, 1999). Focusing on solely the analytical value of dynamic capabilities, many empirical studies are characterized by the use of distant proxies. In an attempt to make the DCV more hands-on, Teece (2007) specified the *microfoundations* undergirding *a set of common dynamic capabilities*. His contribution departs from traditional DCV in two respects, which we consider as key properties of the current understanding of the nature of dynamic capabilities.

First, a focus on a few 'fundamental' classes of dynamic capabilities presumes that, despite being executed in firm-specific ways, dynamic capabilities in different organizations and even sectors have elements in common on a high level of abstraction. Eisenhardt and Martin (2000) refer to this as 'commonalities in key features, idiosyncrasy in details'. Assuming there are common characteristics within dynamic capabilities that stretch over a range of industries, it is possible to develop frameworks of distinct general dynamic capabilities. Exemplary is the frequently adopted set of 'distinct clusters of activities' as

proposed by Teece (2007), covering capabilities for sensing, seizing and transforming. Being positioned in a neo-Schumpeterian tradition, the capabilities fit closely with the *evolutionary mechanism* that describes how organizational learning and novelty creation occur (Zollo & Winter, 2002). Firms use dynamic capabilities for exploring new variations, selecting possible courses of action, and exploiting their newly developed organizational competences (Roper et al., 2008; Nelson & Winter, 1982). The framework suggested by Teece incorporates the firm-level processes of knowledge sourcing, transformation and exploitation by stressing the relevance of each capability for, respectively: acquiring new ideas, converting them into (propositions for) new or altered products, and finally, reconfiguring the organization and its output (Teece, 2007; Barreto, 2010). By building and using the sensing, seizing and reconfiguring capabilities, managers can perform the complementary acts of discovering, creating, defining and exploiting entrepreneurial opportunities (Zahra et al., 2006; Salvato, 2003). The offering (i.e. resource configuration) that results from using these dynamic capabilities will be subjected to forces of market selection, thereby influencing the survival probability of the firm (Metcalf, 1995; Zott, 2003).

The second key property of the current DCV refers to attempts to separate dynamic capabilities from their constituent microfoundations (Teece, 2007). This responds directly to the question of what exactly is in the ‘black box’ of dynamic capabilities (Pavlou & El Sawy, 2011). In the quest for a better empirical grounding of the DCV, it has been urged to break capabilities into component elements; their microfoundations (Foss, 2011). This notion is used for activities at lower levels of abstraction, including organizational routines like managerial processes, procedures, systems, and structures (Salvato & Rerup, 2011), down to the behavior of individuals within an organization. According to Foss (2011), establishing the link between microfoundations and capabilities is essential in order to create explanatory leverage for every resource-based theory.

2.2 Dynamic service innovation capabilities

2.2.1 Applying the DCV to service innovation

Dynamic capabilities play a major role in innovation literature (Crossan & Apaydin, 2010). Hogan et al. (2011) note that many attempts to conceptualize dynamic capabilities for innovation are focused on large firms in manufacturing and high-technology industries. Likewise, other scholars question whether innovation capabilities encountered in such industries are relevant in a service context (Kindström et al., 2012). These critiques touch upon a widely expressed concern regarding the neglected specifics of R&D and innovation in ‘non-manufacturing’ firms (Leiponen, 2012). Indeed, literature devoted to service innovation has identified several reasons why existing innovation theories might not hold for services (Gallouj & Djellal, 2010).

Distinctive features of services, as compared to goods, are that they are intangible, heterogeneous, non-stockable (due to simultaneous production and consumption) and coproduced with clients (Parasuraman et al., 1985; Bowen & Ford, 2002). Generally, these characteristics affect the dynamics of processes concerned with service innovation. Compared to strictly technological R&D, the search for new service solutions is hardly organized in a formalized manner, which can for example be concluded from the fact that

R&D-budgets are scarce amongst service industries (Miles, 2005). Rather, the development of services often occurs through implicit and possibly non-systematic ways (Thomke, 2003; Miles, 2007). Partially due to the prominent role of customers in service production, activities related to the development and deployment of new services tend to be distributed throughout (or even beyond) an organization (Gallouj & Weinstein, 1997).

The aforementioned service features suggest that, compared to measuring formal R&D activity, looking at dynamic capabilities for service innovation might be a promising alternative for gauging an organization's ability to develop and implement new service concepts (Teirlinck & Spithoven, 2013; Leiponen, 2012). However, service particularities also have implications for the applicability of DCV conceptualizations. So far, scholars have taken very different approaches when trying to apply the DCV to service innovation. The fact that concurrent perspectives could emerge is highly related to the abstract nature of the concept of capability, which allows for variation in the way the DCV is conceptualized to capture service peculiarities. By using the key properties of the DCV, as outlined in section 2.1, we systematically evaluate existing attempts to conceptualize dynamic capabilities for service innovation. Remarkable is that cross-references tend to be scarce, leading to an unconnected body of research and hampering knowledge accumulation. After an initial proliferation of concepts, it is essential that the literature consolidates and capitalizes on previous research in a more structured way (Baretto, 2010, p. 277). Our overview can also be regarded as a first step in this direction.

2.2.2 *An evaluation of current research on dynamic service innovation capabilities*

While there have been several studies defining and/or measuring capabilities for service innovation, only a selected set of those fulfill in our view the requirements advocated by Teece (2007). When searching for conceptualizations in a services context, we exclude those studies that do not pertain to behavioral foundations.¹ As discussed before, an accurate indication of the strength of service innovation capabilities rests indeed on efforts to identify the microfoundations undergirding a common set of dynamic capabilities (Teece, 2007).

Conceptualizations that do provide a basis for grounded and comparative analysis of firms' abilities to generate and implement new services can be categorized regarding the scope of dynamic capabilities they distinguish. We find that the different attempts so far have followed patterns similar to the application of other innovation theories to the case of services. We recognize three approaches, reflecting how the thinking on service innovation has evolved over the past decades: *assimilation*, *demarcation* and *synthesis* (Gallouj, 1994; Coombs & Miles, 2000). Table 1 shows the corresponding attempts to conceptualize dynamic capabilities with relevance for service innovation, and how they deal with the two key properties of the current DCV as defined in our discussion.

¹ For instance, the studies by Leiponen (2006), Ordanini and Parasuraman (2011), and Forsman (2011) do not specify on what behavioral activities their dynamic capabilities rely. Also studies focusing on (antecedents of) new service development (NSD) are beyond the scope of our evaluation, since they tend to analyze individual practices rather than capability conceptualizations grounded in the current DCV.

INSERT TABLE 1 HERE

First, the assimilation approach (Gallouj, 1994) assumes that service innovation can be analyzed with concepts and tools developed in the context of innovation in mainly manufacturing sectors (Tether, 2005). In this vein, Fischer et al. (2010), as well as Kindström et al. (2012), identify microfoundations that are particularly relevant for manufacturing firms turning towards service development and delivery. By regarding service innovation processes as similar to technological innovation, identification of just service specific innovation routines concerns ‘details’ rather than the key constructs (Eisenhardt and Martin, 2000). As a result, conceptualizations like the ones above are found to be too general to capture accurately the peculiarities of service innovation processes (Salunke et al., 2011). Conceptualizing service innovation capabilities from a manufacturing or technological R&D perspective thus brings the risk of a myopic view, in this case by restricting the scope of which microfoundations to include.

Second, the demarcation approach includes studies and theories addressing the specificities of services and service innovation processes. Instead of searching for microfoundations that can be grouped into an existing framework of dynamic capabilities, studies in this approach introduce service particularities in the capabilities themselves. Thereby, they reveal or pronounce the fundamentally different nature of service innovation (as opposed to innovation in goods). The examples in Table 1 concern sets of dynamic capabilities that are specific for a single type of service, e.g. professional services (Hogan et al., 2011) or ‘elevated service offerings’ (Agarwal & Selen, 2009). Thereby, the conceptualizations are well-suited to capture routines that are idiosyncratic for service innovation processes in these contexts, but limited in their further applicability to other sectoral contexts. Moreover, the theoretical underpinnings diverge from the evolutionary inspired processes prominent in the original DCV.

Finally, the synthesis approach refers to theories and frameworks in which insights from the previous two approaches are integrated into a novel, more integrated view on innovation (Metcalfe, 1998). Although our literature survey does not pretend to be exhaustive, we hardly encountered a conceptualization of dynamic service innovation capabilities that fits within the emerging synthesis approach. An exception is the conceptual framework by Den Hertog et al. (2010), in which six complementary capabilities are proposed as a representation of a firm’s capacity to acquire and apply new knowledge in novel services.

Compared to conceptualizations from the assimilation approach, the extended set of capabilities by Den Hertog et al. (2010) is better suited to grasp the idiosyncrasies of innovation in intangibles. At the same time, it avoids putting emphasis on capabilities that would only be relevant for a single type of (‘pure’) service providers. Additionally, the complementarities between the capabilities offer a basis for studying evolutionary dynamics. As a service-based extension of the original set by Teece (2007), all capabilities can be conceptually associated with the evolutionary mechanism through which entrepreneurial experimentation leads to novelty creation and determines firm evolution (Metcalfe, 1995;

Salvato, 2003). ‘Sensing user needs and (technological) options’, provides ideas for new or altered propositions.² ‘Conceptualizing’ and ‘(un)bundling’ both correspond to capabilities essential for selecting an idea and developing it into a detailed proposition. Finally, ‘(co)producing & orchestrating’, as well as ‘scaling & stretching’, are related to efforts in which a new service is actually delivered to the market. Being a meta-capability, ‘learning & adapting’ corresponds less with the evolutionary mechanism of consecutively generating ideas, converting them into propositions, and exploiting them on the market (see section 3.1).

When introducing their framework, Den Hertog et al. (2010, p. 506), state that it can only be used as a prescriptive tool once empirically tested, which is what we will do in the remainder of this paper. In particular, we will test on the basis of an extensive survey whether the six dynamic capabilities as distinguished by den Hertog et al. (2010) can indeed be identified empirically in service firms.

3. Developing a measurement scale for dynamic capabilities in service innovation

Table 2 shows the research methodology and research design we follow in our scale development and testing process (Anderson & Gerbing, 1988; Churchill, 1979). Using the theoretical lens of the current DCV, we start by refining the selected conceptualization. We then perform an exploratory analysis to assess which items could be included in our measurement scale, followed by confirmatory analysis for validity and reliability checks.

INSERT TABLE 2 HERE

3.1 Refining the selected conceptualization

The key properties we introduced in section 2.1 allowed us to refine and operationalize the selected set of dynamic capabilities for service innovation. Specifically, the theoretical foundations of the modern DCV guided us in the choice of which capabilities of the conceptualization by Den Hertog et al. (2010) to include or exclude, and how to formulate items for their measurement.

First, we applied the perspective of communality. Essential is that conceptualizations entail a multidimensional set of common but empirically distinct capabilities, although co-occurrence might occur in certain patterns. Learning & adapting, however, is explicitly defined as a meta-capability that helps an organization to reflect upon (and improve) the other capabilities. Thereby, it is not a separate dimension of the same order as the others. Den Hertog et al. (2010) expected that learning is linked to all of the other dimensions, which also implies that it cannot be measured as a distinct capability.

Second, we checked whether each capability can be disaggregated into several constituting microfoundations. On this basis we also excluded (un)bundling, since it does not reflect a dynamic capability that can be related to observable activities. The capability, as

² To emphasize that the term ‘technology’ here is consistent with the common meaning of ‘technological knowledge’, which is broader than only artifact-related knowledge, we place it in brackets.

described by Den Hertog et al. (2010), essentially indicates whether an innovation is recombined or not: it is actually a property of innovation and thus a result of the strategic use of dynamic capabilities. Treating information about the outcome of an innovation process as a capability would lead to causal ambiguity, of which the DCV is frequently accused (Williamson, 1999).

3.2 Instrument design

Given the abstract nature of dynamic capabilities, their operationalization provides a considerable challenge (Zahra et al., 2006). We developed multi-item 7-point Likert scales, which respondents rated from “strongly disagree” to “strongly agree”, for each of the four remaining service innovation capabilities. The scales consisted of statements regarding the presence of particular firm activities, reflecting microfoundations at the level of concrete processes and structures (Teece, 2007). Since we are interested in a measurement scale that allows for comparative analysis, focusing on such routines is of greater use than exploring the various ways individuals execute them.

With respect to the development of actual items for the multi-item scale of each capability, the theoretical underpinnings of the original framework discussed at length in Den Hertog et al. (2010) and our own additional refinements discussed above guided us in ensuring content validity, i.e. the requirement that the items truly reflect the constructs they are supposed to measure (Churchill, 1979). Additionally, the dynamic capabilities’ constructs had a prominent role in nine in-depth case studies of firms that varied in the degree to which they could consistently and continuously develop and implement service innovations. Convergent interviewing based on a semi-structured interview protocol enriched our understanding of organizational processes that may be part of the respective capabilities for service innovation.

After formulating our initial set of items, face-to-face interviews with researchers and pre-tests with respondents from various organization types and sizes delivered useful comments on how to improve the clarity and validity of the scales. Comments concerned unknown words, unclear phrases, and queries about what to do when a question was not relevant to the respondent’s situation. The final phrasing of the resulting 18 items, as well as the codes used in the remainder of this analysis, can be found in Table 3. In the design of our questionnaire, we followed procedural precautions like guaranteeing respondent anonymity (Podsakoff et al., 2003).

INSERT TABLE 3 HERE

3.3 Sampling profile

To test the newly developed scale empirically, we drew a sample from multiple industries, warranted by the broad reach of the service innovation phenomenon (Drejer, 2004; Gallouj & Djellal, 2010). Data were collected through a survey of single-business firms or business units, each with more than 10 full-time employees. Using databases from Bureau van Dijk, we retrieved contact information of Dutch firms located in the Northern Randstad, the broad central region of the Netherlands where most national economic activity and

population are concentrated. The questionnaire was sent to 8054 firms and addressed to the CEOs or senior executives to ensure that the respondents were knowledgeable about the key firm processes under investigation in this study (Miller et al., 1998). The questionnaire was administered by mail with the option to be filled in via the web if preferred. We obtained complete responses on our scale from 391 firms, or a 5% response rate, which is common for similar types of research. There were only minor differences in the firm and demographic profiles of respondents versus non-respondents; the majority of respondents were small (84%) or medium-sized firms (13%), mostly stemming from services (76%), industry (11%) or construction sectors (8%).

3.4 Data preparation

Since the constructs we aim to measure have only been developed conceptually in earlier works (Den Hertog et al., 2010; Den Hertog, 2010), our operationalization required an exploratory step (Gerbing & Hamilton, 1996). Following Anderson and Gerbing (1988), we used a two-stage process for the exploration and validation of the factorial structure of questionnaire items. In order to do so, we split our dataset into two equal parts of randomly chosen cases. Dataset 1 (n = 196) was used for principal component analysis, whereas dataset 2 (n = 195) was used for the subsequent confirmatory factor analysis.

4. Data analysis

4.1 Item reduction for measurement purification (exploratory analysis)

Our measurement scale was constructed as follows. We entered all 18 items in a principal component analysis (PCA) on dataset 1. A dataset of 196 responses was sufficient to test all the constructs at once, given the fulfilled requirement of a 5 to 1 ratio of sample size to number of estimated parameters (Shook et al., 2004). The Kaiser-Meyer-Olkin (KMO) measure (0.84) for sample adequacy was sufficient and above the critical value of 0.50.

The Varimax-rotated PCA reproduced the anticipated structure of factor loadings reasonably well. However, the items for sensing user needs and (technological) options appeared to load on two distinct factors. The first three items can be associated with the intelligence-function focused at what customers want, whereas the second set of three items mainly relate to sensing possibilities for producing a new offering. The observation that keeping up-to-date with market developments consists of two (sub)capabilities concerning demand and supply matches the 'customer orientation' and 'competitor orientation' by Menguc and Auh (2006).

Furthermore, four items were dropped from the analysis: three reverse coded items (ConcepB, CoprOrchA, ScaleStretchE) loaded on none of the five factors, and one item (ScaleStretchA) loaded on three of the five factors with factor loadings below the critical threshold of 0.60 (Flynn et al., 1994). Table 4 shows the component structure for the remaining set of items. The items showed also strong internal consistency with Cronbach's alphas above 0.70 (Nunally, 1978).

INSERT Table 4 HERE

4.2 Assessing reliability and validity (confirmatory analysis)

Reliability and validity of the resulting scale were then reassessed by performing confirmatory factor analysis (CFA) on the second dataset (n=195) using AMOS 18.

Table 5 lists the measures for estimation of the model fit, indicating that the five-factor measurement model fits our data rather well. The chi-square/degrees of freedom (χ^2/df), the goodness-of-fit index (GFI), the Tucker-Lewis coefficient (TLI), the normed fit index (NFI), the comparative fit index (CFI), and the root mean square error of approximation (RMSEA) were all above the respective acceptance levels commonly used in the literature (Hair et al., 1998).

INSERT Table 5 HERE

According to the composite reliability measures in Table 6, all above the 0.70 standard, the measurement items sufficiently represented their respective constructs (Bagozzi & Li, 1988). Moreover, the percentages of average variance extracted exceeded 0.50, indicating that for each construct, a sufficient amount of variance is accounted for by the items rather than by measurement error (Fornell & Larcker, 1981).

Apart from supporting construct reliability, Table 6 also provides evidence for convergent validity. The standardized factor loadings of the items were all significant ($p < .05$) and generally above the critical value of 0.60 (Eisenhardt, 1988) or 0.50 (Edvardsson et al., 1997).

INSERT Table 6 HERE

Finally, the discriminant validity of our measurement scale can be assessed with the values in both Table 6 and Table 7. With the exception of one pair of constructs, the correlations between the capabilities were below the square root of variance extracted for each of them (Table 7). This indicates that in general, the items of a dimension are more related to each other than to other dimensions (Fornell and Larcker, 1981). Sensing (technological) options and conceptualizing shared a relatively high amount of variance, but their correlation exceeded the square root of the average variance extracted for each of those respective constructs only minimally (Table 6). Moreover, both the maximum shared squared variance (MSV) and average shared squared variance (ASV) values were below the average variance extracted (Hair, et al., 1998). We also compared the CFA measurement model with nested models where the co-variances between pairs of constructs were each constrained to 1. All these models were found to have a lower goodness-of-fit. The test results imply that the discriminant validity of the constructs is supported, indicating that dynamic capabilities cannot just conceptually, but also empirically be discriminated into several distinct capabilities (Teece, 2007).

INSERT Table 7 HERE

4.3 Assessing common method variance

The factor loadings in the PCA-results suggest convergent validity (or unidimensionality) for the items within the constructs, and the presence of five distinct factors suggests discriminant validity. Harman's one factor test for the possibility of a common method bias showed that restricting the PCA to one factor returns a factor that only explains 40% of the variance, and thus less than 50% of the total variance extracted (Podsakoff et al., 2003). Following Love et al. (2013), an additional test with a marker variable (Lindell & Whitney, 2001) was performed. When we extended our PCA with items for ambiguity tolerance, a theoretically unrelated concept that was part of our survey as well, the original pattern of capability-related item loadings on different factors remained the same. The finding that our marker variable hardly correlates with the earlier retrieved principal components indicates that common method bias is not likely to be an issue (Love et al., 2013).

To validate the discriminant validity of the measurement scale further, we inspected to what extent correlations between constructs might be caused by common method bias. A common latent factor was included in the CFA model (Podsakoff et al., 2003). This did improve significantly the model fit ($\Delta\chi^2/df = 0.246$ $p < 0.001$), but the improvement was only incremental ($\Delta\rho = 0.017$), and the factor loadings for the constructs all remained significant and above the threshold levels. These findings suggest that although some common method variance may be present, it did not bias the structure of the measurement model and the respondents could generally differentiate among the concepts.

4.4 Correlations among the constructs

Our analyses showed that although distinctive, the five dynamic capabilities were also correlated. This begs the question whether a firm can develop a DSIC related to a particular stage of knowledge transformation, without possessing the DSIC that should be enacted in a preceding stage of the innovation process (e.g. searching knowledge). We extended our analysis by building a structural path model among the constructs, using structural equation modeling (SEM) in AMOS 18.

In line with the implicit sequences in the evolutionary processes of novelty creation (Teece, 2007; Zollo & Winter, 2002; Love et al., 2011), our specification followed the order in which capabilities have to be used when acquiring, converting and applying knowledge. Thus, we linked sensing user needs and sensing (technological) options to conceptualizing, which in turn, was linked to co-producing & orchestrating and scaling & stretching. Figure 1 presents the regression coefficients of the structural model. The structural equation model had a similar goodness-of-fit with respect to the CFA model, and shows that all of the structural paths are significant.

Analysis of the correlations among the measured constructs confirms that the capabilities should not be seen as completely orthogonal, but that they form a coherent set of complementary constructs. A significant relation between the two sensing capabilities on the one hand, and conceptualizing on the other hand, suggests that translating rough ideas into detailed propositions occurs more in firms that can sense signals in the first place. Similarly, capabilities for the (co)production and up-scaling of such a proposition are particularly

present in firms that are able to conceptualize. These findings, derived from measuring capabilities, are consistent with the general belief that exploration and conceptualization need to precede exploitation (Roper et al., 2008). It appears to be uncommon for firms in our sample to invest only in one particular type of DSIC: regardless whether it is intentional or not, they rather develop capabilities with relevance through the whole spectrum of knowledge sourcing, transformation and exploitation. To what extent this strategy is preferable for the successful development of service innovations remains to be tested in further research.

INSERT FIGURE 1 HERE

4.5 Nomological validity: the relation with innovativeness and firm performance

Finally, we assess the nomological validity of our constructs by examining whether their occurrence is empirically associated with correlations we would also expect on a theoretical basis. The interest in dynamic capabilities stems from the assumption that they are of importance for realizing new solutions, and ultimately enhancing a firm's competitive position (Teece & Pisano, 1994). By using other variables present in our survey, we are able to put this to the test.

According to the statistics in Table 8, firms who have stronger DSICs also tend to perform better. First, we see that that presence of several capabilities has a positive correlation with gaining turnover from improved rather than existing products (including both goods and services).³ This holds for the sensing capabilities as well as the conceptualizing one, but only the latter is also significantly related to the percentage of sales coming from entirely new products.

The findings for comparative firm performance tell a similar story. In general, there is a positive correlation between the total strength of a firm's capabilities and the variables that reflect its competitive position. We also observe, again, that the relation with individual capabilities might point at more nuanced patterns. For instance, coproducing and orchestrating is significantly correlated with having a rapid growth in market share, whereas scaling and stretching is now related to none of the outcome variables.

Together, the encountered correlations also emphasize the discriminant validity of the constructs: not every capability is related to each performance measure. Empirical evidence of this kind invites us to explore deeper under what exact circumstances the DSICs do relate to innovativeness or firm performance, and whether this is truly a causal relationship.

INSERT TABLE 8 HERE

³ These questions are derived from the Oslo Manual for the CIS.

5. Conclusions

This paper provides a basis for gauging the relative strength of dynamic service innovation capabilities. Our review demonstrates the different paths scholars pursued when translating the recent DCV to the domain of services, thereby answering questions like: how do the various conceptualizations differ, and to what extent are they service specific? Consolidating insights from earlier works, the synthesis approach was identified as a suitable direction for conceptualizing and analyzing the relative strength of DSICs within individual organizations.

Firstly, the framework that was found to fit this approach (by Den Hertog et al., 2010) facilitated the development of a measurement scale by providing detailed clues on actual routines (activities and processes). In our exploratory and confirmatory factor analyses, we identified that sensing user needs and sensing (technological) options rely on routines that essentially differ. Besides the finding that discriminative validity is generally sufficient for each of the five remaining capabilities, the fact that convergent validity is high, reflects that our routine-based items are empirically mostly associated with their respective capabilities.

Secondly, and most importantly, the broad scope of the selected set of DSICs makes it relevant for the comparative perspective that is imperative to develop a relative measure for service innovation activities amongst a wide range of firms. Within a synthesis approach, scholars are being urged to focus on service innovation activity, irrespective of the industry in which it is performed (Rubalcaba et al., 2012). We advance such a synthesis approach to service innovation by operationalizing a capability framework that combines service specificity with the theoretical foundations of the current DCV. Moreover, by building on evolutionary theorizing, we contribute to recent efforts to place service innovation in a (neo-) Schumpeterian perspective (Drejer, 2004; Leiponen, 2012).

Apart from comparisons across firms (individual or clustered by sector, region or any other system), a primary way to determine which capability deserves more attention is by looking at the balance between the various types of capabilities. Besides explicitly involving the idiosyncrasies of services, consistent with the demarcation approach, the framework proposed by Den Hertog et al. (2010) also builds on evolutionary processes of innovation generation that are implicitly present in the assimilative conceptualizations directly based on work by Teece (2007). Therefore, it enables us to identify which specific aspect of novelty exploration and exploitation is strong, and which is weak. Rather than simply inferring low capability levels from observing a lack of realized innovations, a form of tautology heavily criticized in the DCV (Williamson, 1999), the operationalized conceptualization allows for a more detailed diagnosis of what type of routines are perceived to be truly (under)developed.

Besides the common drawbacks of survey research, a limitation of our study is that we cannot exclude the possibility that relevant microfoundations are missing from the set we measured. However, by drawing on a broad body of literature and performing pre-testing interviews, we tried to restrict this possibility. Moreover, Teece (2007) already noted that it is impossible to capture all the relevant microfoundations. The efforts in this paper should be regarded as a first attempt to use actual routines to assess the relative strengths of dynamic service innovation capabilities.

5.1 Research implications

The proposed measurement scale allows for several avenues of future research. First, it provides a comparative measure that can capture the variation in how different organizations or groups of organizations shape their innovative abilities. The proposed scale might be useful for analyzing why differences occur. Apart from firm characteristics such as size, age or geographical location, variation in the perceived strengths of capabilities is likely to depend on the sector where a firm is operating and the strategies it follows (Zahra et al., 2006). Thanks to its high level of communality, the operationalized framework is able to shed light on the question whether manufacturers that successfully engage in servitization have different strengths than innovative ‘pure’ service providers (Kindström et al., 2012; Forsman, 2011). In this light, future research can investigate whether a capability differential is somehow related to issues like industry maturity or market velocity (Baretto, 2010). Various typologies for distinct kinds of service innovators (e.g. Castellacci, 2008) might form an interesting starting point as well.

Uncovering the organizational antecedents of service innovation is still one of the main challenges in (service) innovation literature (Ostrom, et al., 2010). Therefore, a logical complement to descriptive explorations is the further investigation (and contextualization) of the relation between well- or underdeveloped capabilities and measures of innovation output or performance (Protogerou et al., 2012). Having a common basis for comparing the presence of innovation activities within firms allows scholars to address questions regarding service competitiveness (Bryson et al., 2012), and the ‘innovation gap’ in services (Gallouj & Djellal, 2010). So far, studies in the DCV tend to find contradicting results (Zahra et al., 2006; Ray et al., 2004), possibly due to different settings. Looking at the domain of services, the availability of our measurement scale provides opportunities to assess under what conditions firms with strongly developed service innovation capabilities actually do realize innovative output. Thereby, it allows for discrimination between capability failures referring to the absence of routines to transform knowledge on the one hand, and capability failures referring to situations where even firms with strong capabilities do not manage to successfully introduce new service offerings.⁴

The proposed measurement scale gives insight in the extent to which firms possess in-house routines that allow them to generate, transform and apply knowledge. According to some authors, access to the capabilities of partners might be a substitute for developing and maintaining them internally (Van de Vrande et al., 2010). Also in the context of services, the topic of open innovation has been gaining ground in recent years (Chesbrough, 2011; Hsieh & Tidd, 2012). How openness and co-creation should be managed remains unclear (Rubalcaba et al., 2012), but it seems likely that capabilities have distinct roles in the various stages of collaboration (Den Hertog et al., 2010; Love et al., 2011). In this vein, it seems worthwhile to investigate which configuration of service innovation capabilities can be associated with, for example, the success of cooperation patterns (Trigo & Vence, 2012; Tether & Tajar, 2008).

⁴ In such cases, the strong ‘technological fitness’ of the capabilities does not correspond with a high level of evolutionary fitness (Helfat et al., 2007).

5.2 Management implications

The introduction of a measurement scale for service innovation capabilities can serve as a step towards the development of a prescriptive management tool. Managers who are engaged in introducing new or better services within their firm can gauge the presence and strength of their capabilities, helping them to uncover the strengths and weaknesses of their service innovation management strategy. Reasoning from a bottleneck approach, measuring the strength of a firm's DSICs, can provide valuable information on its potential to execute the distinct but complementary processes from which service innovations emerge. Firms might consider investments if the strengths of capabilities are unbalanced, such as when weakly developed sensing capabilities hamper the use or further development of related capabilities (Barreto, 2010).

Thanks to its broad applicability, the operationalized conceptualization provides a basis for diagnostic tools and monitoring or even benchmarking instruments. Operationalizing capabilities with relevance to a wide range of service innovation activities provides ample room for inter-organizational learning – even across sectors, firms can exchange ideas on which processes and practices to deploy in order to reinforce their most critical capabilities.

5.3 Policy implications

Finally, insight in the relative strength and relevance of service innovation capabilities provides a sound basis for policy development. According to evolutionary economists, the fundamental role of (innovation) policy is enabling organizations to engage in experimentation (Metcalf, 1995; Metcalf & Miles, 2000). In this respect, one cannot assume this is simply a matter of having the right funding instruments and framework conditions in place; weak innovation capabilities constitute a systemic failure that is detrimental for the processes of novelty creation within markets (Bleda & Del Rio, 2013). Therefore, the observation that many firms lack skills and competences to realize new services (Sundbo, 1997), can be regarded as a strong justification for policy intervention. By averaging the capability strengths of an aggregation of organizations, our measurement scale can provide a well-grounded alternative to common proxies for capability failures (and presence) at the system level (e.g. Castellacci & Natera, 2012).

Acknowledging systemic failure with respect to service innovation capabilities requires adequate institutional arrangements, like the provision of business services and consultancy aimed at enhancing service innovation skills and competences (Rubalcaba et al., 2010). By using the measurement scale we developed in this paper, governments can monitor the effect of those interventions and evaluate whether the policy measure has any direct impact on the service innovation capabilities of supported firms.

References

- Agarwal, R., & Selen, W. (2009). Dynamic capability building in service value networks for achieving service innovation. *Decision Sciences*, 431-475.
- Anderson, J., & Gerbing, D. (1988). Structural equation modeling in practice: a review and recommended two-step approach. *Psychological Bulletin*, 411-423.
- Bagozzi, R., & Li, Y. (1988). On the evaluation of structural equation models. *Academy of Marketing Science*, 74-94.
- Baretto, I. (2010). Dynamic Capabilities: A Review of Past Research and an Agenda for the Future. *Journal of Management*, 256-280.
- Bleda, M., & Del Río, P. (2013). The market failure and the systemic failure rationales in technological innovation systems. *Research Policy*. Retrieved from <http://dx.doi.org/10.1016/j.respol.2013.02.008>
- Bowen, J., & Ford, R. (2002). Managing service organizations: does having a "thing" make a difference? *Journal of Management*, 28(3), 447-469.
- Bryson, J., Rubalcaba, L., & Strom, P. (2012). Services, innovation, employment and organisation: research gaps and challenges for the next decade. *The Service Industries Journal*, 641-655.
- Castellacci, F. (2008). Technological paradigms, regimes and trajectories: Manufacturing and service industries in a new taxonomy of sectoral patterns of innovation. *Research Policy*, 37, 978-994.
- Castellacci, F., & Natera, J. (2012). The dynamics of national innovation systems: A panel cointegration analysis of the coevolution between innovation capability and absorptive capacity. *Research Policy*. doi:<http://dx.doi.org/10.1016/j.respol.2012.10.006>
- Chesbrough, H. (2011). *Open services innovation: Rethinking your business to grow and compete in a new era*. New York, NY: John Wiley & Sons.
- Churchill, G. (1979). A paradigm for developing better measures of marketing constructs. *Journal of Marketing Research*, 64-73.
- Consoli, D. (2007). Services and systemic innovation: a cross-sectoral analysis. *Journal of Institutional Economics*, 3(1), 71-89.
- Coombs, R., & Miles, I. (2000). Innovation, measurement and services: the new problematique. In J. Metcalfe, & I. Miles, *Innovation systems in the service economy. Measurements and case study analysis* (pp. 83-102). Dordrecht: Kluwer Academic Publishers.
- Crossan, M., & Apaydin, M. (2010). A multi-dimensional framework of organizational innovation: a systematic review of the literature. *Journal of Management Studies*, 1154-1191.
- Den Hertog, P. (2010). *Managing Service Innovation: Firm-level Dynamic Capabilities and Policy Options. PhD-thesis*. Amsterdam: University of Amsterdam.
- Den Hertog, P., Van der Aa, W., & De Jong, M. (2010). Capabilities for managing service innovation: towards a conceptual framework. *Journal of Service Management*, 490-514.
- Di Stefano, G., Peteraf, M., & Verona, G. (2010). Dynamic capabilities deconstructed: a bibliographic investigation into the origins, development, and future directions of the research domain. *Industrial and Corporate Change*, 1187-1204.
- Dosi, G., Lechevalier, S., & Secchi, A. (2010). Introduction: Interfirm heterogeneity - nature, sources and consequences for industrial dynamics. *Industrial and Corporate Change*, 1867-1890.
- Drejer, I. (2004). Identifying Innovation in Surveys of Services: A Schumpeterian Perspective. *Research Policy*, 551-562.
- Edquist, C. (2011). Design of innovation policy through diagnostic analysis: identification of systemic problems (or failures). *Industrial and Corporate Change*, 1725-1753.
- Eisenhardt, K. (1988). Agency- and institutional-theory explanations: The case of retail sales compensation. *Academy of Management Journal*, 488-511.
- Eisenhardt, K., & Martin, J. (2000). Dynamic capabilities: what are they? *Strategic Management Journal*, 1105-1021.
- Fischer, T., Gebauer, H., Gregory, M., Ren, G., & Fleisch, E. (2010). Exploitation or exploration in service business development?: Insights from a dynamic capabilities perspective. *Journal of Service Management*, 591-624.

- Flynn, B., Schroeder, R., & Sakakibara, S. (1994). A framework for quality management research and an associated measurement instrument. *Journal of Operations Management*, 339-375.
- Fornell, C., & Larcker, D. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, 39-50.
- Forsman, H. (2011). Innovation capacity and innovation development in small enterprises. A comparison between the manufacturing and service sectors. *Research Policy*, 739-750.
- Foss, N. (2011). Why micro-foundations for resource-based theory are needed and what they may look like. *Journal of Management*, 1413-1428.
- Gallouj, F. (1994). *Economie de l'innovation dans les services [The economics of innovation in services]*. Paris: Editions L'Harmattan, Logiques économiques.
- Gallouj, F., & Djellal, F. (2010). *The Handbook of Innovation and Services*. Cheltenham, UK: Edward Elgar.
- Gallouj, F., & Weinstein, O. (1997). Innovation in services. *Research Policy*, 26(4-5), 537-556.
- Gebauer, H., Paiola, M., & Edvardsson, B. (2012). A capability perspective on service business development in small and medium-sized suppliers. *Scandinavian Journal of Management*, 321-339.
- Gerbing, D., & Hamilton, J. (1996). Viability of exploratory factor analysis as a precursor to confirmatory factor analysis. *Structural Equation Modeling*, 62-72.
- Hair, J., Anderson, R., Tatham, R., & Black, W. (1998). *Multivariate data analysis, with readings*. Englewood Cliffs, NJ: Prentice-Hall.
- Helfat, C., Finkelstein, S., Mitchell, W., Peteraf, M., Singh, H., Teece, D., & Winter, S. (2007). *Dynamic capabilities: understanding strategic change in organizations*. Malden: Blackwell Publishing.
- Hipp, C., & Grupp, H. (2005). Innovation in the service sector: The demand for service-specific innovation measurement concepts and typologies. *Research Policy*, 517-535.
- Hogan, S., Soutar, G., McColl-Kennedy, J., & Sweeney, J. (2011). Reconceptualizing professional service firm innovation capability: scale development. *Industrial Marketing Management*, 1264-1273.
- Hsieh, K., & Tidd, J. (2012). Open versus closed new service development: The influences of project novelty. *Technovation*, 600-608.
- Katkalo, V., Pitelis, C., & Teece, D. (2010). Introduction: On the nature and scope of dynamic capabilities. *Industrial and Corporate Change*, 19(4), 1175-1186.
- Kindström, D., Kowalkowski, C., & Sandberg, E. (2012). Enabling service innovation: A dynamic capabilities approach. *Journal of Business Research*. doi:10.1016/j.jbusres.2012.03.003
- Leiponen, A. (2006). Managing knowledge for innovation: the case of business-to-business services. *Journal of product innovation management*, 238-258.
- Leiponen, A. (2012). The benefits of R&D and breadth in innovation strategies: a comparison of Finnish service and manufacturing firms. *Industrial and Corporate Change*, 21(5), 1255-1281.
- Lindell, M., & Whitney, D. (2001). Accounting for Common Method Variance in Cross-Sectional Research Designs. *Journal of Applied Psychology*, 114-121.
- Love, J., Roper, S., & Bryson, J. (2011). Openness, knowledge, innovation and growth in UK business services. *Research Policy*, 1438-1452.
- Love, J., Roper, S., & Vahter, P. (2013). Learning from openness: The dynamics of breadth in external innovation linkages. *Strategic Management Journal*. doi:10.1002/smj.2170
- Menguc, B., & Auh, S. (2006). Creating a firm-level dynamic capability through capitalizing on market orientation and innovativeness. *Journal of Academy of Marketing Science*, 63-73.
- Metcalfe, J. (1995). Technology systems and technology policy in an evolutionary framework. *Cambridge Journal of Economics*, 19, 25-47.
- Metcalfe, J. (1998). *Evolutionary Economics and Creative Destruction*. London & New York: Routledge.
- Metcalfe, J., & Miles, I. (2000). *Innovation Systems in the Service Economy: Measurement and Case Study Analysis*. Dordrecht: Kluwer Academic Publishers.
- Miles, I. (2005). Innovation in services. In J. M. Fagerberg, *The Oxford handbook of innovation*. Oxford: Oxford University Press.
- Miles, I. (2007). Research and development (R&D) beyond manufacturing: the strange case of services R&D. *R&D Management*, 249-268.

- Miller, C., Burke, L., & Glick, W. (1998). Cognitive diversity among upper-echelon executives: implications for strategic decision processes. *Strategic Management Journal*, 39-58.
- Muller, E., & Zenker, A. (2001). Business services as actors of knowledge transformation: the role of KIBS in regional and national innovation systems. *Research Policy*, 1501-1516.
- Nunnally, J. (1978). *Psychometric theory*. New York: McGraw-Hill.
- Ordanini, A., & Parasuraman, A. (2011). Service innovation viewed through a service-dominant logic lens: a conceptual framework and empirical analysis. *Journal of Service Research*, 3-23.
- Ostrom, A., Bitner, M., Brown, S., Burkhard, K., Goul, M., Smith-Daniels, V., . . . Rabinovich, E. (2010). Moving forward and making a difference: research priorities for the science of service. *Journal of Service Research*, 4-36.
- Parasuraman, A., Zeithaml, V., & Berry, L. (1985). A conceptual model of service quality and its implications for future research. *Journal of Marketing*, 41-50.
- Pavlou, P., & El Sawy, O. (2011). Understanding the elusive black box of dynamic capabilities. *Decision Sciences*, 239-273.
- Podsakoff, P., MacKenzie, S., Lee, J., & Podsakoff, N. (2003). Common method variance in behavioral research: A critical review of the literature and recommended remedies. *Journal of Applied Psychology*, 879-903.
- Ray, G., Barney, J., & Muhanna, W. (2004). Capabilities, business processes, and competitive advantage: choosing the dependent variable in empirical tests of the resource-based view. *Strategic Management Journal*, 23-37.
- Roper, S., Du, J., & Love, J. (2008). Modelling the innovation value chain. *Research Policy*(37), 961-977.
- Rubalcaba, L., Gallego, J., & Den Hertog, P. (2010). The case of market and system failures in services innovation. *The Service Industries Journal*, 30(4), 549-566.
- Rubalcaba, L., Michel, S., Sundbo, J., Brown, S., & Reynoso, J. (2012). Shaping, organizing, and rethinking service innovation: a multidimensional framework. *Journal of Service Management*, 696-715.
- Salunke, S., Weerawardena, J., & McColl-Kennedy, J. (2011). Towards a model of dynamic capabilities in innovation-based competitive strategy: Insights from project-oriented service firms. *Industrial Marketing Management*, 1261-1263.
- Salvato, C. (2003). The role of micro-strategies in the engineering of firm evolution. *Journal of Management Studies*, 40(1), 83-108.
- Salvato, C., & Rerup, C. (2011). Beyond collective entities: multi-level research on organizational routines and capabilities. *Journal of Management*, 468-490.
- Schumpeter, J. (1934). *The theory of economic development: an inquiry into profits, capital, credit, interest and the business cycle*. Cambridge: Harvard University Press.
- Shook, C., Ketchen, D., Hult, G., & Kacmar, K. (2004). An Assessment of the Use of Structural Equation Modeling in Strategic Management Research. *Strategic Management Journal*, 397-404.
- Smith, A., Fischbacher, M., & Wilson, F. (2007). New service development: from panoramas to precision. *European Management Journal*, 370-383.
- Sundbo, J. (1997). Management of innovation in services. *The Service Industries Journal*, 432-455.
- Teece, D. (2007). Explicating dynamic capabilities: the nature and micro-foundations of (sustainable) enterprise performance. *Strategic Management Journal*, 370-383.
- Teece, D., & Pisano, G. (1994). The dynamic capabilities of firms: An introduction. *Industrial and Corporate Change*, 3(3), 537-556.
- Teece, D., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, 509-533.
- Teirlinck, P., & Spithoven, A. (2013). Formal R&D management and strategic decision making in small firms in knowledge-intensive business services. *R&D Management*, 43(1), 37-51.
- Tether, B. (2005). Do services innovate (differently)? Insights from the European Innobarometer Survey. *Industry and Innovation*, 153-184.
- Tether, B., & Tajar, A. (2008). The organisational-cooperation mode of innovation and its prominence amongst European service firms. *Research Policy*, 720-739.
- Thomke, S. (2003). R&D comes to services. *Harvard Business Review*, 3-11.

- Trigo, A., & Vence, X. (2012). Scope and patterns of innovation cooperation in Spanish service enterprises. *Research Policy*, 602-613.
- Van de Vrande, V., Vanhaverbeke, W., & Gassmann, O. (2010). Broadening the scope of open innovation: past research, current state and future directions. *International Journal of Technology Management*, 221-235.
- Vargo, S., & Lusch, R. (2004). Evolving to a new dominant logic for marketing. *Journal of Marketing*, 1-17.
- Williamson, O. (1999). Strategy research: governance and competence perspectives. *Strategic Management Journal*, 1087-1108.
- Zahra, S., Sapienza, H., & Davidsson, P. (2006). Entrepreneurship and dynamic capabilities: A review, model and research agenda. *Journal of Management Studies*, 917-955.
- Zollo, M., & Winter, S. (2002). Deliberate learning and the evolution of dynamic capabilities. *Organization Science*, 339-351.
- Zott, C. (2003). Dynamic capabilities and the emergence of intraindustry differential firm performance: Insights from a simulation study. *Strategic Management Journal*, 97-125.

Tables

Table 1: Overview of conceptualizations of dynamic capabilities for service innovation

Approach	Key properties of DCV		Example of conceptualization in services		
	Application of communality	Focus of micro-foundations	Authors	Identified capabilities	Sector
Assimilation	Goods-based set of capabilities, associated with evolutionary mechanism*	Service specific translation of goods-based capabilities	Fischer et al. (2010)	Sensing, Seizing, Reconfiguring	servicizing organizations
			Kindström et al. (2012)	Sensing, Seizing, Reconfiguring	servicizing organizations
			Gebauer et al. (2012)	Sensing, Seizing, Reconfiguring	small/medium-sized suppliers
Demarcation	Service specific set of dynamic capabilities, not associated with evolutionary mechanism*	Idiosyncratic (service specific) innovation routines	Agarwal & Selen (2009)	Customer engagement, collaborative agility, entrepreneurial alertness, and collaborative innovative capacity	collaborative services
			Salunke et al. (2011)	Episodic learning , relational learning , client-focused learning ,and combinative capability	(entrepreneurial) project-oriented service firms
			Hogan et al. (2011)	Client-focused, marketing-focused, and technology-focused innovation capability	professional service providers
Synthesis	Extended set of dynamic capabilities, associated with evolutionary mechanism*	Wide range of innovation routines	Den Hertog et al. (2010)	Sensing user needs & technological options, conceptualizing, (un)bundling, coproducing & orchestrating, scaling & stretching, and learning & adapting. capability	(all sectors)

*Association with evolutionary mechanism refers to conceptualizations in which the capabilities match distinct but complementary processes through which firms source, convert and exploit knowledge (Nelson & Winter, 1982; Teece, 2007; Baretto, 2010).

Table 2: Research design for development of measurement scale

Phase	Step	Actions
Theoretical grounding	1. Identify constructs	Literature review
	2. (Re)define constructs	Use key properties of DCV to refine the selected framework
Instrument design	3. Generate scale items	Formulate items by identifying microfoundations (literature review and convergent interviewing)
	4. Test and revise scale items	Deploy pilot survey: interview respondents for ensuring clarity and validity of items
Data analysis	5. Exploratory analysis	Principal component analysis: identification of items that load well on the associated construct (use random half of data)
	6. Confirmatory analysis	Confirmatory factor analysis: assessing reliability as well as convergent and discriminant validity (use other half of data)
	7. Correlation analysis	Estimate structural paths between constructs (using SEM)
	8. External validity	Assess relation with performance measures

Table 3: Survey items

Construct with underlying items	Item code
<p><i>Sensing user needs and (technological) options</i></p> <ul style="list-style-type: none"> • We systematically observe and evaluate the needs of our customers. • We analyze the actual use of our services. • Our organization is strong in distinguishing different groups of users and market segments. • Staying up to date with promising new services and technologies is important for our organization. • In order to identify possibilities for new services, we use different information sources. • We follow which technologies our competitors use. <p><i>Conceptualizing</i></p> <ul style="list-style-type: none"> • We are innovative in coming up with ideas for new service concepts. • We find it hard to translate raw ideas into detailed services.^a • Our organization experiments with new service concepts. • We align new service offerings with our current business and processes. <p><i>Coproducing & orchestrating</i></p> <ul style="list-style-type: none"> • Our organization has problems with initiating and maintaining partnerships.^a • Collaboration with other organizations helps us in improving or introducing new services. • Our organization is strong in coordinating service innovation activities involving several parties. <p><i>Scaling & stretching</i></p> <ul style="list-style-type: none"> • We are able to stretch a successful new service over our entire organization.^a • In the development of new services, we take into account our branding strategy. • Our organization is actively engaged in promoting its new services. • We introduce new services by following our marketing plan. • We find it difficult to scale up a successful new service.^a 	<p>SensingA</p> <p>SensingB</p> <p>SensingC</p> <p>SensingD</p> <p>SensingE</p> <p>SensingF</p> <p>ConcepA</p> <p>ConcepB</p> <p>ConcepC</p> <p>ConcepD</p> <p>CoprOrchA</p> <p>CoprOrchB</p> <p>CoprOrchC</p> <p>ScaleStretchA</p> <p>ScaleStretchB</p> <p>ScaleStretchC</p> <p>ScaleStretchD</p> <p>ScaleStretchE</p>

^a Item removed from final version of the scale.

Table 4: Results from principal component (5 factors) on dataset 1 (n=196), after removing inversely framed items

Items (code)	Factor Loadings				
	F1	F2	F3	F4	F5
SensingA				0.724	
SensingB				0.761	
SensingC				0.666	
SensingD			0.804		
SensingE			0.759		
SensingF			0.760		
ConcepA		0.729			
ConcepC		0.827			
ConcepD		0.695			
CoprOrchB					0.815
CoprOrchC					0.881
ScaleStretchA	0.436	0.409			0.446
ScaleStretchB	0.716				
ScaleStretchC	0.734				
ScaleStretchD	0.800				
Cumulative % of total variance explained	40,07	50,00	58,109	65,30	71,07
Cronbach's alpha	0.748	0.813	0.776	0.753	0.748

Note: Loadings below 0.4 are suppressed.

Cronbach's alpha is calculated on the basis of items loading above 0.6.

Table 5: Model fit values of CFA on five-factor model. Results based on dataset 2 (n=195)

	Value	Acceptable level of excellent fit	Acceptable level of reasonable fit
Df	67		
χ^2	122.6		
χ^2/df	1.83	<3	<5
GFI	0.921	>0.95	>0.90
TLI	0.934	>0.95	>0.90
NFI	0.901	>0.95	>0.90
CFI	0.952	>0.95	>0.90
RMSEA	0.065	<0.05	<0.10

Table 6: Standardized factor loadings, composite reliability (CR), percentage of average variance extracted (AVE), maximum shared squared variance (MSV) and average shared squared variance (ASV). Results based on dataset 2 (n=195)

Construct with underlying items	Factor loading	CR	AVE	MSV	ASV
<i>Sensing user needs</i>		0.791	0.561	0.413	0.313
• SensUserA	0.69				
• SensUserB	0.85				
• SensUserC	0.69				
<i>Sensing (technological) options</i>		0.834	0.629	0.549	0.369
• SensingD	0.86				
• SensingE	0.85				
• SensingF	0.65				
<i>Conceptualizing</i>		0.793	0.564	0.549	0.382
• ConcepA	0.76				
• ConcepC	0.85				
• ConcepD	0.63				
<i>Coproducing & orchestrating</i>		0.794	0.659	0.240	0.161
• CoprOrchB	0.78				
• CoprOrchC	0.84				
<i>Scaling & stretching</i>		0.750	0.505	0.336	0.253
• ScaleStretchB	0.56				
• ScaleStretchC	0.77				
• ScaleStretchD	0.77				

Table 7: Standardized correlations matrix, with square root of variance extracted (on diagonal). Results based on dataset 2 (n=195)

<i>Dimensions</i>	1	2	3	4	5
Sensing user needs (1)	<i>0.71</i>				
Sensing (technological) options (2)	0.643	<i>0.78</i>			
Conceptualizing (3)	0.633	0.741	<i>0.74</i>		
Coproducing & orchestrating (4)	0.375	0.447	0.490	<i>0.77</i>	
Scaling & stretching (5)	0.546	0.559	0.580	0.254	<i>0.72</i>

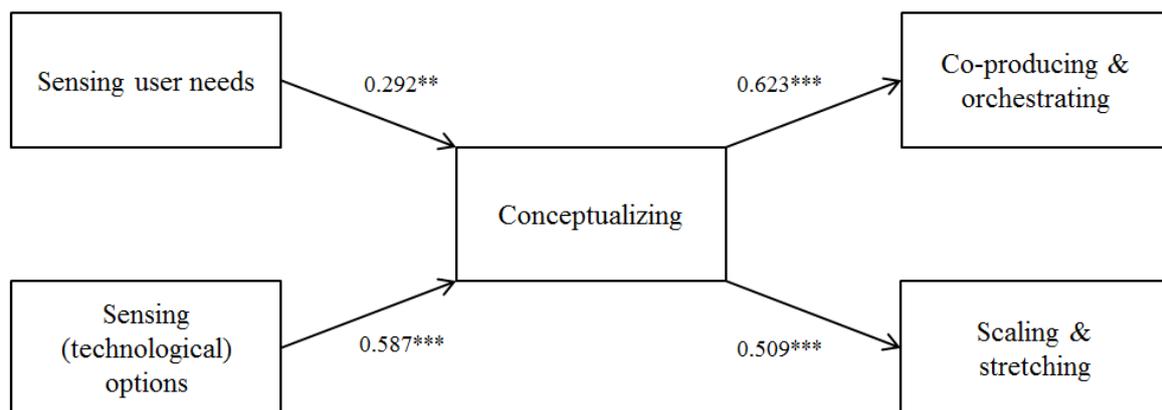
Table 8: Relation between capability strengths and performance measures (n=195)

<i>Percentage of revenues coming from ... (100% in total)</i>	Mean	Std. Dev.	Sensing User Needs	Sensing (Techn.) Options	Conceptualizing	Coproducing and orchestrating	Scaling and Stretching	Sum of capability strengths
... unchanged goods and/or services	71,46	22,26	-,175*	-,280**	-,299**	-0,107	-,182*	-,280**
... improved goods and/or services	17,89	15,76	,193**	,328**	,275**	0,131	0,120	,281**
... new goods and/or services	10,70	12,98	0,058	0,073	,172*	0,021	,162*	0,133
<i>In comparison to our competitors, ... (7-point Likert-scale)</i>	Mean	Std. Dev.	Sensing User Needs	Sensing (Techn.) Options	Conceptualizing	Coproducing and orchestrating	Scaling and Stretching	Sum of capability strengths
...our organization generated a higher return on equity in the past year.	4,16	1,69	,220**	0,124	,163*	0,027	0,095	,169*
...we had more profit growth in the past year.	3,76	1,78	,221**	0,123	,201**	0,134	0,121	,218**
...we had more turnover growth in the past year.	3,92	1,80	,283**	,176*	,204**	0,142	0,137	,256**
...we had a faster growing market share last year.	3,97	1,66	,304**	,202**	,267**	,178*	0,127	,292**

Pearson's correlations, ** = significant at the 0.01 level (2-tailed). * = significant at the 0.05 level (2-tailed).

Figures

Figure 1: Correlations amongst the constructs, standardized regression weights. Results based on dataset 2 (n=195)



$\chi^2/df = 1.85$; GFI = 0.916; TLI = 0.932; NFI = 0.892; CFI = 0.946; RMSEA = 0.066.
 ** = $p < 0.005$; *** = $p < 0.001$