

External Dynamic Capabilities: Creating Competitive Advantage in Innovation via External Resource Renewal

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Working Paper - August 2012

The author would like to thank John Hagedoorn, John Ettlé, and Will Mitchell, for their helpful comments and useful suggestions, as well as seminar participants at Maastricht University, ESADE Barcelona, and conference participants at the Tilburg Innovation Conference and the Arlington Globalization of Engineering Workshop. The author would also like to thank Wim Vanhaverbeke for supporting the data collection via Exnovate.

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Abstract: While prior research has examined how firms internally transform their resource base to develop new innovations, less is known about external paths of resource renewal. This study develops an external dynamic capabilities perspective to explain how firms create competitive advantage in innovation by leveraging resources that reside outside their boundaries. Building on Teece's (2007) framework, constructs of external sensing, seizing, and reconfiguring dynamic capabilities are developed and operationalized in terms of organizational processes. Using survey data of firms, the mechanisms by which these external dynamic capabilities modify the firm's resource base and contribute to competitive advantage in innovation are examined. The results show that competitive advantage in innovation rests to a large extent on the ability of innovating firms to sense opportunities for accessing new external resources, seize these external resources, and reconfigure them internally. The core contribution of this paper is to provide insights into the external resource renewal processes; it delivers a deeper understanding of how firms employ external dynamic capabilities to develop new resource positions and how they create competitive advantage in innovation on the basis of external resources.

Keywords: Dynamic capabilities, Innovation, Processes, Renewal

INTRODUCTION

Recent research has highlighted the notion of dynamic capabilities (DCs) to address how firms can adapt to volatile environments and renew their resource base (e.g. Teece et al., 1997). There is a rich stream of literature demonstrating how firms use DCs for adding, shedding, and transforming the resource base (e.g. Cepeda & Vera, 2007; Danneels, 2008; Moliterno & Wiersema, 2007). Most of this research focuses on resource creation and reconfiguration within the firm's boundaries (e.g. Zahra et al., 2006; Zollo & Winter, 2002), such as the creation, integration, and retention of internal knowledge assets (Cepeda & Vera, 2007; Marsh & Stock, 2006), the reconfiguration of resources between internal divisions (Galunic & Eisenhardt, 2001), or the transformation of internal organizational forms and functions (Rindova & Kotha, 2001). In particular, literature has discussed the role of internal R&D for creating new product and process innovations that allow firms to create and sustain competitive advantage in changing market conditions (Helfat, 1997; Macher & Mowery, 2009; Danneels, 2008). Overall, there is a good understanding of the DCs which internally renew the resource base in order to create and sustain competitive advantage in innovation.

However, more recently it has been argued that, due to accelerating environmental and technological complexities, it becomes problematic to rely too much on internal resource creation as the sole foundation for competitive advantage in innovation. Instead, firms need to rely more on external sources of renewal and innovation (Foss et al., 2011; Teece, 2007).

While alliances and acquisitions constitute two traditional ways of accessing external resources (e.g. Karim & Mitchell, 2000), more recent literature suggests that firms increasingly access more diverse external sources in more flexible ways, including competitors, customers, suppliers, universities, and other institutions (Fey & Birkinshaw, 2005; Laursen & Salter, 2006). As a consequence, apart from internal resource creation and reconfiguration, accessing and leveraging external resources becomes increasingly important.

In light of this shift towards external renewal, a crucial question refers to how firms can renew their resource base and create competitive advantage in innovation by tapping into these external sources. So far, external knowledge is considered to be ‘out there’, ready to be exploited by firms, and we have a limited understanding of the capabilities and processes of identifying this knowledge and sourcing it into firms. While existing literature largely unpacks DCs and processes for internal renewal, research on adding, integrating, and recombining external resources is scarce. Finally, it remains unclear how firms can create a competitive advantage in innovation if resources are more and more externally available and transferable. To address this gap, this paper examines the process of external renewal. It aims at enriching our understanding of the DCs required for renewing the firm’s resource base via external paths. Furthermore, this study hypothesizes and tests relationships to clarify the mechanisms by which these external DCs contribute to competitive advantage in innovation.

To shed light on the process of external resource renewal, several objectives will be addressed. First, this study aims at developing the theory of DCs by conceptualizing DCs for accessing, integrating, and reconfiguring external resources. In his seminal contribution, Teece (2007) categorizes DCs into sensing, seizing, and reconfiguring. However, so far, these categories remain broad concepts of thought, which lack more concrete definitions and constructs. In addition, their applicability to external renewal has not been explicitly discussed. To address this shortcoming, this study aims at developing constructs for external sensing, seizing, and reconfiguring DCs. Second, in order to provide a more concrete understanding of these external DCs and to enable subsequent empirical analysis, I operationalize external sensing, seizing, and reconfiguring DCs in terms of specific underlying processes.

In addition, this paper aims at developing a more fine-grained understanding of the mechanisms of external resource renewal. I use survey data to empirically measure and

validate the new constructs of external sensing, seizing, and reconfiguring DCs and to examine how they lead to competitive advantage in innovation. Specifically, I examine how these external DCs affect a subset of the firm's resource base. Subsequently, I investigate how this modified resource base influences competitive advantage in innovation. The results demonstrate that competitive advantage in innovation rests to a large extent on the firm's external DCs. They enable firms to access external resources and utilize them to extend and reconfigure their internal resource base which, in turn, leads to competitive advantage in innovation.

CONCEPTUALIZING EXTERNAL DYNAMIC CAPABILITIES

DCs have been discussed as crucial mechanisms for adding, shedding, and renewing resources and operational capabilities (e.g. Teece et al., 1997; Eisenhardt & Martin, 2000). Resources are stocks of factors or inputs to production that a firm controls or has access to (Amit & Schoemaker, 1993), while operational capabilities refer to the deployment of these resources to attain desired goals on a day-to-day basis (Wang & Ahmed, 2007). Resources and operational capabilities are, however, essentially static in nature and are not capable of explaining competitive advantage in changing environments. As a result, DCs fill this gap by emphasizing the firm's pursuit of the renewal of these resources and operational capabilities to adapt to volatile environments (Winter, 2003; Helfat et al., 2007).

However, there is still much conceptual fuzziness, little operationalization, and a lack of empirical grounding concerning the concept of DCs and the mechanisms by which they change resources and operational capabilities (Barreto, 2010; Wang & Ahmed, 2007). So far, DCs have been poorly specified and hence, researchers may not know what to look for when empirically analyzing DCs (Ambrosini & Bowman, 2009). To address this issue, this section

aims at conceptualizing and operationalizing the concept of DCs further in order to generate a better understanding of DCs and to enable their analysis in the context of external renewal.

For conceptualizing DCs for external resource renewal, it first needs to be noted that DCs can serve various purposes (Helfat & Winter, 2011; Eisenhardt & Martin, 2000), such as external corporate venturing (Keil, 2004), changing the organization's form and function (Rindova & Kotha, 2001), or divesting resources (Moliterno & Wiersema, 2007). In particular, literature has highlighted the role of DCs for developing new technologies and products (e.g. Macher & Mowery, 2009; Marsh & Stock, 2006) and, ultimately, creating new innovations (Lorenzoni & Lipparini, 1999; Karim & Mitchell, 2000). Innovation is a key process of organizational renewal and, therefore, constitutes an ideal setting for studying DCs (Winter, 2003). Hence, in further discussing the nature of DCs, I focus on the purpose of innovation.

TABLE 1 ABOUT HERE

As indicated above, the understanding of DCs can be facilitated by grouping DCs into two different modes of resource alterations – those that use internal resource creation and reconfiguration paths and those that use external resource acquisition and integration paths (see table 1). The left column of table 1 portrays a large number of DCs employed to internally renew resources and operational capabilities. For instance, DCs can refer to internal entrepreneurial efforts that involve formal and informal coordination mechanisms for building new resources (Zahra et al., 2006). Moreover, existing internal resources can be integrated and reconfigured to develop new innovative products (Marsh & Stock, 2006; Pavlou & El Sawy, 2006). Hence, extant literature unpacks many different DCs that use internal mechanisms for changing the firm's resource base.

However, recent literature has shown that in today's context it might be insufficient to rely on internal sources of renewal (Chesbrough, 2003; Fey & Birkinshaw, 2005; Foss et al., 2011). Resources and operational capabilities that were traditionally developed internally are now increasingly being accessed outside the firm's boundaries (Laursen & Salter, 2006). This external perspective on DCs is portrayed on the right hand side of table 1. Although I do not claim that the literature selection in this table is exhaustive, it becomes evident that research on the external mode of DCs is scarce. Nevertheless, previous work on external DCs (see table 1) does suggest that firms may require different DCs for the pursuit of external renewal (e.g. Capron & Annand, 2007; Lorenzoni & Lipparini, 1999). For instance, Karim and Mitchell (2010) examined the acquisition process as a DC for reconfiguring a firm's mix of resources. Other studies investigate inter-firm alliances for combining resources across firm boundaries (Lorenzoni & Lipparini, 1999; Dyer & Kale, 2007). So far, the contributions to external DCs are mainly restricted to bilateral relationships such as alliances and acquisitions. However, more recently it has been shown that this view, needs to be extended to entail much more diverse modes of accessing resources from a wider range of external parties, such as customers, universities, and competitors (Foss et al., 2011; Laursen & Salter, 2006). The small number of contributions on the right column of table 1 and the increasing importance of these diverse external sources call for more research on the external mode of DCs.

I suggest a second classification mechanism in order to provide further insights into the broad concept of DCs (see table 1). Besides differentiating between the internal and external mode of renewal, literature has highlighted the multidimensional nature of DCs (Baretto, 2010). For analytical purposes, DCs need to be disaggregated with respect to different classes in order to explain their underlying mechanisms and relationships (Wang & Ahmed, 2007; Eisenhardt & Martin, 2000). Teece (2007) conceptualizes three classes of DCs at the most comprehensive analytical level. First, 'sensing' refers to the recognition of market

and technological opportunities and the mobilization of requisite resources. Second, ‘seizing’ refers to the organizational strategy and infrastructure for integrating resources to create and capture value from opportunities. Finally, ‘reconfiguring’ refers to the continuous transformation and modification of resources.

As shown in table 1, Teece’s (2007) encompassing framework allows the classification of existing literature into these different classes of DCs. Teece’s (2007) framework most explicitly acknowledges the dispersion of knowledge by suggesting that sources of renewal might lie external to the firm. Hence, internal as well as external modes of DCs can be categorized with respect to sensing, seizing, and reconfiguring. However, as explained above, research on external sensing, seizing, and reconfiguring DCs is scarce and restricted to the context of alliances and acquisitions. Furthermore, Teece’s (2007) explanations regarding the different classes of DCs for the external realm remain rather broad concepts. Hence, the constructs and definitions of sensing, seizing, and reconfiguration in the context of external renewal are, so far, not clearly delineated. In what follows, the nature of these external classes of DCs is further identified.

Due to accelerating globalization and technological complexity, sources of innovation are increasingly distributed and the identification of relevant external knowledge and technology becomes more difficult (Pitelis & Teece, 2010). Furthermore, technological and competitive uncertainties make it difficult to determine which external resources are most likely to support innovative products that fit the firm’s strategic orientation and are relevant for existing or emerging markets (Teece et al., 1997; Grant, 1996). Hence, firms require external sensing DC for recognizing valuable sources of external resource renewal.

While external sensing DC leads to the identification of external resources, a further challenge refers to the actual incorporation of external resources. Once external knowledge sources have been recognized as valuable opportunities for exchange, these opportunities

need to be 'seized' in order to optimize their outcomes (Teece, 2007). Firms need to be able to absorb the knowledge contained in the external sources and integrate it into their internal innovative processes (Wang & Ahmed, 2007). Hence, external seizing DC refers to the capacity to address opportunities for external renewal and implement external resources within the organization.

In the literature, it has been discussed how existing resources can be leveraged by putting them into new uses (Danneels, 2010; Marsh & Stock, 2006). Eisenhardt and Brown (1999), for instance, introduced the concept of 'patching' to describe the ability to reconfigure resources into the right pieces at the right scale to address new opportunities. Similarly, Eisenhardt and Martin (2000) argue that new products can be created by brokering knowledge from previous projects. Such leveraging effects may also exist in the context of externally generated resources. In this context, external reconfiguring DC can be described as a combinative capability (Kogut & Zander, 1992) that refers to the novel synthesis of external and internal resources into new innovations (Bowman & Ambrosini, 2003; Galunic & Rodan, 1998). As such, external reconfiguring DC refers to the capacity to recombine external resources internally in order to achieve novel configurations that serve new purposes.

Having identified the nature of external sensing, seizing, and reconfiguring capabilities, the next step refers to operationalizing these broad constructs. So far, the different classes of DCs have remained inside a black box (Helfat et al., 2007); there is a lack of knowledge about how these DCs are exercised. However, the existence of DCs cannot be assumed without specifying the particular processes that put these capabilities into use (Galunic & Eisenhardt, 2001; Helfat et al., 2007). Processes in terms of repeated sets of actions are crucial for the development and deployment of DCs (e.g. Wang & Ahmed, 2007). Hence, in order to further operationalize external sensing, seizing, and reconfiguring DCs I move to a deeper analytical level by analyzing and disentangling their underlying processes.

Enabling Processes of External Dynamic Capabilities

DCs consist of identifiable and specific processes “that have been subject of extensive empirical research in their own right” (Eisenhardt & Martin, 2000, p. 1107). Drawing on this existing research I identify seven specific underlying processes that put external DCs into use. Below, I delineate how these processes apply to external resource renewal and how they enable external sensing, seizing, and reconfiguring DCs. Table 2 illustrates how external sensing, seizing, and reconfiguring DCs can be understood in terms of these processes. The rightmost column of table 2 lists a wide range of studies that have discussed various underlying activities, skills, and tools of DCs. Although most of the identified papers discuss aspects of DCs in the context of internal renewal, I argue that some of the delineated activities may also be applicable for external resource renewal. Furthermore, I suggest how related activities, skills, and tools can be bundled and how different labels and meanings can be reconciled and aggregated into categories of processes.

TABLE 2 ABOUT HERE

Processes of external sensing DC: As portrayed in table 2, external sensing DC is proposed to be driven by the underlying processes ‘external scanning’ and ‘strategic selection’. The ability to sense opportunities requires the constant surveillance and monitoring of markets and technologies (Teece et al., 1997; Wang & Ahmed, 2007). These surveillance and monitoring activities can be summarized as the process of external scanning, which refers to the wide-range observation of the firm’s environment (Kogut & Zander, 1992; Galunic & Rodan, 1998). External scanning processes enable firms to identify and recognize new and emerging markets and technologies (Danneels, 2008). Such market and technology intelligence drives the firm’s ability to sense opportunities for external resource renewal.

When such opportunities are first glimpsed, firms need to gather and filter technological, market, and competitive information to figure out implications for action (Cepeda & Vera, 2007). In particular, firms need to analyze external knowledge sources and conduct strategic selection processes (Capron & Mitchell, 2009). 'Selection' refers to the organizational activities involved in identifying a preferred alternative for organizational change (Zott, 2003). This selection should occur in accordance with the firm's strategy and internal competencies in order to achieve fit and avoid over-search (Capron & Annand, 2007). Strategic selection leads to a decision of what needs to be done internally and what can be in-sourced from the external world and, therefore, facilitates the firm's capacity to sense and shape opportunities for external resource renewal.

Processes of external seizing DC: The second row of table 2 classifies existing literature to delineate processes that allow firms to seize opportunities for external renewal. Once external knowledge is identified and selected, the firm's knowledge management (KM) infrastructure plays an important role in diffusing, replicating, and maintaining this knowledge within the organization (Cepeda & Vera, 2007; Gold et al., 2001). An effective KM infrastructure supports the articulation and codification of external knowledge resources (Marsh & Stock, 2006). Knowledge articulation and codification have been identified as important driving processes of DCs (Zollo & Winter, 2002), which lends further support for their relevance for external seizing DC. KM infrastructure, knowledge codification and articulation can be summarized as KM processes. These KM processes organize the use and diffusion of external knowledge within the organization so that it can be assimilated and utilized (Verona, 1999; Zollo & Winter, 2002).

In addition, effective incorporation of external resources requires the integration of these resources into the firm's culture (Zahra et al., 1999). Employees' resistance to accept external knowledge can lead to implementation stickiness (Teece, 2007). Hence, conflicts

regarding how to obtain and assemble resources need to be overcome (Zahra et al., 2006).

Corporate values, effective communication, and reward systems help determining the channels and types of knowledge that are tolerated and encouraged (Gold et al., 2001). These activities and tools that stimulate the usage of external resources (Verona & Ravasi, 2003), can be labeled as integrating processes.

As external resources emerge from different thought worlds, they are likely to remain separate from the organization without conscious intervention (Marsh & Stock, 2006).

Effective incorporation requires coordination processes which include the assignment of roles and tasks, and an organic architecture for external knowledge implementation (Helfat & Peteraf, 2003 Eisenhardt & Brown, 1999). Coordination processes are essential for preparing external resources for internal use (Ambrosini & Bowman, 2009). As they have been shown to enhance the speed and efficiency of resource transfer (Verona & Ravasi, 2003) they are suggested to facilitate external seizing DC.

Processes of external reconfiguring DC: As a final category, table 2 portrays the disaggregation of external reconfiguring DC. The capacity to reconfigure external resources internally is driven by the underlying processes 'resource cognition' and 'recombining'. It has been stressed in the literature that managerial cognition about firm resources is crucial for explaining the deployment of DCs (Danneels, 2010). This cognition refers to the active observation and monitoring of the existing resource base in order to identify opportunities for novel configurations (Galunic & Rodan, 1998; Schreyoegg and Kliesch-Eberl, 2007). In order to effectively recombine resources, deep knowledge of the resource base is required (Teece, 2007; Danneels, 2010) and assumptions concerning alternative problem spaces need to be created (Tripsas & Gavetti, 2000; Adner & Helfat, 2003). These cognitive activities can be summarized and labeled as resource cognition processes.

Furthermore, the DCs literature has highlighted that value can be created when firms effectively match up assets (Teece, 2007), bundle relevant resources (Sirmon et al., 2007), and recombine relevant know-how (Grant, 1996). Recombination processes reflect a firm's ability to flexibly reorganize external and internal resources and competencies (Verona & Ravasi, 2003). This means that externally acquired resources are transferred from one concrete economic setting to another (Teece et al., 1997). Hence, recombining reflects knowledge brokering (Eisenhardt & Martin, 2000) from internal and external knowledge resources to address new problems or opportunities. As a consequence it facilitates the capability to reconfigure external knowledge internally to achieve new applications.

In sum, as the existence of DCs cannot be assumed without specifying the particular processes that put these DCs into use, I conceptualize the black box of external DCs with a specific set of measurable processes that are grounded in empirical research (see table 2). These processes may not exhaust all factors that enable the specified DCs, but they are posited as representative of existing literature. Having identified the key processes that explain the abstract concepts of external DCs, the final step is to propose a testable model in order to create a more parsimonious picture of DCs and to enable their empirical analysis.

Higher-Order Models of External Dynamic Capabilities and their Enabling Processes

I propose formative second-order models, which constitute a coherent and parsimonious depiction of the multidimensional nature of external DCs (see figure 1). Second-order models are suggested as classes of DCs reside at a higher level of abstraction than their underlying processes (Law et al., 1998). The underlying reasoning for formative modeling is threefold: (1) the first-order constructs represent distinct processes that are not interchangeable, (2) the first-order processes are not necessarily correlated (Diamantopolous & Winklhofer, 2001), and (3) underlying processes enable the higher-order capability to occur.

FIGURE 1 ABOUT HERE

By conceptualizing and measuring DCs in terms of their underlying processes I can capture the conceptual richness of the constructs, while at the same time making them less vague and confusing (Barreto, 2010; Edwards, 2001). The abstract constructs of external DCs can now be reconceptualized in terms of their underlying processes. External sensing DC refers to the capability to scan the external environment and strategically select resource renewal paths. External seizing DC refers to the capability to coordinate resource transfer, integrate external resources within the organization and apply systematic KM processes. And finally, external reconfiguring DC refers to the capability to develop resource cognition and recombine internal and external resources in order to achieve novel configurations. While the abstract higher-order constructs are theoretically relevant, the lower order constructs describe specific and observable processes. The relationships between these higher-order external DCs, the firm's resource base and competitive advantage in innovation are discussed next.

STRUCTURAL RELATIONSHIPS

In order to renew their resource base, firms need to accumulate new resources as well as build new operational capabilities to be able to deploy these resources (Grant, 1996; Helfat et al., 2007). New resources need to be owned, controlled or accessed on a semi-permanent basis in order to become part of the firm's resource base (Maritan & Peteraf, 2010). In the context of external renewal, resources lie outside the firm's boundaries and are most likely not independently controlled by the individual firm (Zander & Zander, 2005). However, firms may use superior access to external resources in order to augment their own resource base. Hence, this study disentangles the resource base into resource access and operational capabilities (Zahra et al., 2006) to investigate their respective interactions with different

classes of DCs. Resources and operational capabilities can be manifold, including, for instance, marketing-related, managerial-related, and technology-related resources and operational capabilities. Due to the broad scope of the resource base, the analysis in this paper zooms in on a certain subset of resources and operational capabilities. More specifically, it focuses on technology-related resources and capabilities, due to their relevance to innovation (Verona, 1999) and external knowledge sourcing (Fey & Birkinshaw, 2005). Technological resources include engineering and manufacturing know-how, and technological methods and procedures (Danneels, 2008). Technological capabilities aim at producing and developing technology (Song et al., 2005).

Decisions concerning new technological resources are characterized by uncertainty, complexity, and organizational conflict (Amit & Schoemaker, 1993). The firm needs to identify external opportunities and anticipate, *ex ante*, a set of technological assets as grounds for establishing competitive advantage in innovation (Kraaijenbrink et al., 2010). This challenge is accelerating as the firm's asset accumulation is not anymore restricted by its boundaries, but can be augmented to include external resources (Dyer & Kale, 2007; Song et al., 2005). Increasingly, external networks can provide firms with privileged access to new knowledge and technologies (Zander & Zander, 2005).

External sensing DC can help to obtain such privileged access to external technological resources. As explained in the conceptualization of external sensing DC, systematic processes of external scanning and strategic selection enhance the identification of emerging technologies that fit with the firm's strategy. If firms demonstrate strong capabilities in sensing these opportunities for external technological renewal, they are more likely to obtain access to relevant technological resources outside their boundaries. Firms may then use this access to draw upon these resources which they do not independently control in order to augment their internal technological resources (Zander & Zander, 2005). Hence, the

more and the better the firm scans the external environment and selects appropriate opportunities, the more access it will obtain to new technological resources.

H1: External sensing DC increases access to new technological resources.

Recently it has been argued in the literature that resources are for most part tradable and are, therefore, unlikely to be a source of competitive advantage (Fey & Birkinshaw, 2005, Kraaijenbrink et al., 2010). Value is only created when firms make use of their new technological resources and deploy them appropriately within the firm's context (Sirmon et al., 2007; Ambrosini & Bowman, 2009). Hence, firms require operational capabilities in the technical realm to deploy newly accessed technological resources for desired end results (e.g. Amit & Schoemaker, 1993). Operational capabilities are activated and shaped by the firm's resources (Teece et al., 1997; Song et al., 2005; Wang & Ahmed, 2007). In other words, the selection, access and accumulation of resources build the basis for capabilities to perform operational tasks (Zahra et al., 2006; Kogut & Zander, 1992). Therefore, access to technological resource antecedes the deployment of technological capabilities.

The more resources that can be integrated within a certain capability, the greater the difficulty faced by competitors in replicating that capability and the more value that capability can generate (Grant, 1996). In line with this argument Shamsie et al. (2009) show that renewal will achieve better returns when the firm has access to a greater breadth of resources. Furthermore, the more resources a firm accumulates, the more flexibly it can respond to future contingencies (Miller, 2002). Applying this to the technical realm, increasing breadth in technological resources will increase the firm's capacity to quickly adapt technical specifications and optimize technological development according to emerging contingencies. Consequently, it can be expected that the extent to which a firm accesses new external technological resources determines the superiority of a firm's technological capabilities.

H2: The more external technological resources the firm accesses, the more superior will be its technological capabilities.

Value-creating operational capabilities do not only derive from access to resources, but are particularly dependent on *how* resources are integrated and coordinated within the firm (Ambrosini & Bowman, 2009; Teece et al., 1997). Hence, the quantity of technological resources may not be sufficient to create superior technological capabilities that outperform those of competitors. Instead, firms also require distinctive capabilities to make better use of these new technological resources (Wang & Ahmed, 2007) and isolate them from competing firms (Kraaijenbrink et al., 2010). In other words, externally accessed technological resources need to be ‘seized’ in order to optimize their deployment (Teece, 2007). Firms need to be able to effectively incorporate external technological resources into their own innovation processes in order to generate superior technological capabilities (Wang & Ahmed, 2007).

As argued above, the DC to seize external resources is captured by the underlying processes of knowledge management, integration, and coordination. Jointly, these processes allow firms to make better use of their access to external technological resources and to isolate them from competing firms. Hence, the more firms coordinate, integrate, and maintain externally sourced technological resources, the more likely it is that they will be assimilated into high-performing technological capabilities. However, external seizing DC is path-dependent. Previously obtained access to technological resources puts bounds around what kinds of resources can be seized. Thus, access to technological resources and the strength of a firm’s external seizing DC are expected to interact in determining the firm’s technological capabilities. As a consequence, external seizing DC is suggested to moderate the relationship between technological resource access and technological capabilities.

H3: External seizing DC moderates the relationship between new technological resource access and technological capabilities, such that the relationship is weaker under conditions of low external seizing DC and stronger under conditions of high external seizing DC.

In the literature, operational capabilities, particularly those in technological areas, have frequently been stressed as drivers of competitive advantage in innovation (e.g. Amit & Schoemaker, 1993; Verona, 1999; Protojerou et al., 2011). Superior technological capabilities serve as a platform for competitive advantage in innovation (Song et al., 2005). Strong capabilities for technological operations that outperform those of competitors lead to the development of superior products and services that better meet customer needs, while outdated and inadequate technological capabilities would result in poorer process efficiency and product effectiveness (Pavlou & El Sawy, 2006). Superior technical capabilities enable the firm to transform inputs into outputs in an efficient and effective way and therefore to meet an increasing variety of market expectations without excessive costs or time (Protojerou et al., 2011). Consequently, in line with this literature, I suggest that superior technological capabilities are associated with competitive advantage in innovation. Although this hypothesis is not theoretically new, it is a required building block for the completeness of the structural model.

H4: Superior technological capabilities lead to competitive advantage in innovation.

So far, I have argued that external sensing and seizing DCs lead to the augmentation of technological resources and capabilities. A further key to sustained competitive advantage in innovation is the ability to reconfigure (Teece, 2009; Bowman & Ambrosini, 2003).

Reconfiguring is particularly relevant in innovation where most new products and services are inventive recombinations of existing technological resources and capabilities (Henderson & Clark, 1990). It is argued here that external reconfiguring DC can contribute to competitive

advantage in innovation by drawing on externally shaped technological capabilities and applying them to new uses, such as new product categories.

Reconfiguring helps to achieve inimitability, which is crucial for creating and maintaining competitive advantage in innovation (Kraaijenbrink et al., 2010). Novel combinations that combine both externally and internally created technological capabilities are complex and ambiguous and will, therefore, be more difficult to imitate. Externally assembled technological capabilities may further exhibit complementarity in the deployment or application with internal resources; that is, the strategic value of each resource's relative magnitude may increase with an increase in the relative magnitude of other strategic resources (Pitelis & Teece, 2010). As a consequence, the reconfiguration of externally shaped technological capabilities can lead to new innovations (Verona & Ravasi, 2003).

As argued above, the external DC to reconfigure is driven by resource cognition and recombination processes. Resource cognition refers to the active monitoring of the internal resource base to identify opportunities for new applications, while recombination reflects the reorganization of internal and external assets. Jointly, these processes enable firms to leverage externally assembled technological capabilities by putting them into new uses and unanticipated applications. Managerial cognition and recombination processes help to untangle resource configurations embedded within technological capabilities and integrate them with other resources in order to create novel applications for innovations (Galunic & Rodan, 1998; Grant, 1996). Again, the effect of external reconfiguring DC is expected to be path dependent, as novel recombination is contingent on the quality of previously shaped technological capabilities. As a result, external reconfiguring DC is expected to determine the degree to which technological capabilities lead to competitive advantage in innovation. As a consequence, external reconfiguring DC is suggested to moderate the relationship between technological capabilities and competitive advantage in innovation.

H5: External reconfiguring DC moderates the relationship between technological capabilities and competitive advantage in innovation, such that the relationship is weaker under conditions of low external reconfiguring DC and stronger under conditions of high external reconfiguring DC.

The previous hypotheses indicate that the different classes of DCs have indirect effects on competitive advantage in innovation, through increased access to technological resources and superior technological capabilities. Indeed, literature stresses that DCs do not directly lead to competitive advantage (e.g. Zahra et al., 2006), but DCs do change the resource base of the firm which, in turn, affects performance outcomes (e.g. Ambrosini & Bowman, 2009). Zott (2003), for instance, suggests that DCs aim at changing a firm's bundles of resources and operational capabilities, which in turn affect performance outcomes. Similarly, Bowman and Ambrosini (2003) argue that DCs are one step removed from competitive advantage and that, therefore, their impact is indirect. In line with this research, I propose indirect effects of external DCs on competitive advantage in innovation, through the mediating role of the resource base. However, differently from previous research, two separate mediating effects are proposed. As it has been argued above, classes of external DCs operate differently on technological resources and capabilities. This emphasizes the need to disentangle the resource base into technological resource access and technological capabilities and to hypothesize two sequential mediating effects.

H6: Technological resource access mediates the relationship between external sensing DC and technological capabilities.

H7: Technological capabilities mediate the relationship between new technological resource access and competitive advantage in innovation.

METHOD

Measurement Development

Wherever possible, measurement items were adapted from existing scales. For new measures, standard scale development procedures were used (Churchill, 1979; Dillmann, 2007). Based on the literature and interviews with managers in six firms, a large pool of potential items was developed. Face-to-face interviews were conducted with six academics to discuss the appropriateness of these new measurement items. In addition, the survey was pilot-tested with eleven innovation managers. All items are rated on 7-point Likert scales (see appendix).

External Sensing DC is modeled as a formative second-order construct with two reflective dimensions. *Environmental scanning* is adapted from Danneel's (2008) six-item scale to assess the extent to which the firm's employees access outside information regarding technological and market trends. To capture the process of *strategic selection*, a scale by Capron and Mitchell (2009) is adapted to measure the extent to which firms assess the strategic fit between internal competences and external resources.

External Seizing DC is modeled as a formative second-order construct with three reflective dimensions. To operationalize *coordination* processes, a new scale was developed to capture processes for allocating roles and responsibilities (Helfat & Peteraf, 2003; Eisenhardt & Brown, 1999; Verona & Ravasi, 2003). To capture *integrating* processes, a new scale is based on concepts in Gold et al. (2001), Cepeda and Vera (2007), Zahra et al. (1999), and Sirmon et al. (2007). Items focus on the extent to which the implementation of externally generated resources is encouraged, valued, and incentivized. To capture *knowledge management* processes, Cepeda and Vera's (2007) scale of knowledge management infrastructure is adapted to the context of external knowledge sourcing.

External Reconfiguring DC is measured in terms of a formative second-order construct consisting of two dimensions. For *resource cognition* processes, items were derived

from concepts by Danneels (2010) and Schreyoegg & Kliesch-Eberl (2007); they focus on the effective recognition of internal knowledge and technology needs and gaps. To capture the firm's ability to *recombine* external and internal resources, items were derived from theoretical concepts of Pavlou and El Sawy (2005), Sirmon et al. (2007), Gold et al. (2001), Zahra et al. (1999), and Grant (1996). The items focus on the effective assimilation, interaction, and combination of external and internal resources.

Technological Resource Base Danneel's (2008) resource accumulation measure is adapted for the current study to refer to external access to technological resources. Song et al.'s (2005) scale for technological capabilities is used to assess the technology-related subset of operational capabilities. Respondents are asked to rate their technology development and new product development capabilities relative to their main competitors.

Competitive Advantage in Innovation The context of new product development (NPD) is frequently used as an indicator of innovativeness (Verona, 1999; Song et al., 2005). Competitive advantage in innovation can then be assessed by means of the efficiency and effectiveness of the NPD process (Verona, 1999). Scales were adopted from Pavlou and El Sawy (2006). Process efficiency refers to time to market and development costs relative to the main competitors, and is measured with three items. Product effectiveness refers to product quality and innovativeness compared to competitors, also measured with three items. Competitive advantage is then operationalized as the combination between process efficiency and product effectiveness as a nine-item interaction measure (Pavlou & El Sawy, 2006). As this operationalization has one degree of separation from the self-reported measures, it helps to counteract concerns about common method bias. Furthermore, literature shows that subjective scales are widely used and that there are high correlations between subjective and objective measures (Song et al., 2005). In addition, I ensured the validity of this subjective measure by triangulating it with secondary objective data that was available for a subset of 79

firms of my sample. Using the Gale PROMT database, I collected data on new product announcements and analyzed how firms in my sample compare to their three main competitors¹. I correlated this objective information with the average of the corresponding items reported by respondents that is how they rate themselves as compared to their main competitors on ‘major innovations in products’ and ‘creation of new product concepts’. The subjective and objective measures show a strong and significant correlation (0.33, $p < 0.05$), supporting the validity of the subjective measure.

Indicators and Controls To assess the external validity of the higher-order models, eight items were included to assess the strength of overall external sensing, seizing and reconfiguring DCs, as perceived by the respondents. In addition, several control variables were considered. First, the velocity of the firm’s environment may influence the effects of both dynamic and operational capabilities on competitive advantage in innovation (Ettlie & Pavlou, 2006; Pavlou & El Sawy, 2006). A three-item measure is adapted from Jaworski and Kohli (1993) to operationalize technological turbulence. Second, the firm’s internal R&D intensity is measured as yearly R&D expenditure relative to firm size. Finally, firm size and industry effects are evaluated. Information on control variables was collected from secondary data, if available, or requested from respondents.

Survey Administration

The data collection was organized via ‘Exnovate’, the European Network of Excellence on Open and Collaborative Innovation. Firms enrolled on this platform are likely to source external resources, making them theoretically relevant to the research question. Exnovate includes 942 managers from international firms, while a large number of firms are situated in Belgium, Netherlands, UK, or USA. The support of a third-party organization helped to enhance the response rate and to directly address key informants on external knowledge

sourcing and innovation. Respondents mostly held positions of Innovation Directors, Open Innovation managers, CTOs, or R&D managers. The survey was designed and implemented according to Dillman's (2007) tailored design method in spring 2011. Invitation e-mails were sent, explaining the study's purpose and assuring confidentiality. As an incentive, respondents were offered a customized report of the results of the study. During a period of two months, five rounds of contacts were made, which yielded 165 responses (response rate = 17.5 %). Due to missing values and multiple responses per firm, the final sample size amounts to 119. The majority of respondents were from chemical (31%), electronics (11%) and other manufacturing (25%) industries. The size distribution for firms in the sample reveals that large firms are well-represented. Very large firms (>10,000 employees) account for about 60% of the sample. About 20% of the firms are large (1,000-10,000 employees). Small and medium sized firms (<1,000 employees) reach a share of only about 13.5% of our sample, while for about 7% of the firms, the actual size is unknown. The over-representation of larger firms is in line with the size distribution of firms in the initial Exnovate data set.

Assessing Potential Sampling and Method Bias

Several steps helped to reduce potential common method and single respondent biases. First, procedural remedies, such as improving scale items via interviews and pre-testing, and counterbalancing question order, were employed (Podsakoff et al., 2003). In addition, Harman's one-factor test suggests that inter-item correlations are not driven solely by common method variance. Second, multiple responses per firm were collected whenever possible. In total, 12 matched pairs could be collected. The average correlation among these respondents is positive and significant (0.46) and interrater reliability is acceptable (0.61) (Bowman & Ambrosini, 1997). Finally, the above described positive correlation between items of the dependent variable and objective data on new product announcements further

substantiate the validity of the data. Together, this evidence demonstrates that common method bias is not a major concern in this study. To test for nonresponse bias, I compared the first and last 25 percent of respondents on key study variables and demographic characteristics (size, age, relative R&D expenditure). The analysis indicates that the two groups are statistically similar on all demographic and study variables.

DATA ANALYSIS AND RESULTS

The hypotheses were tested using partial least squares (PLS), a structural equation modeling technique employing a principal component-based estimation approach (Chin et al., 2003).

PLS was selected due to the characteristics of the model and sample. The model is based on a relatively small sample, uses formative higher-order constructs, and entails complex relationships in terms of moderating and mediating effects; thus, making PLS more appropriate than covariance-based approaches, such as LISREL.

Measurement Validation

Reflective measurement models: As shown in table 3, composite reliabilities for all reflective constructs are above 0.80, which exceeds the suggested benchmark of 0.70 for early stage research (Nunnally, 1978). All loadings were above 0.70, supporting the reliability of the indicators. In addition, all items load more highly on their own construct than on others and none of the cross-loadings exceed 0.70, thereby demonstrating discriminant validity². The average variances extracted of all constructs exceed the recommended cut-off value of 0.50 (Fornell & Larcker, 1981), thereby demonstrating convergent validity.

TABLE 3 ABOUT HERE

Formative higher-order measurement models: Internal consistency and reliability examinations are not appropriate for formative measures (Bagozzi, 1994). Instead, guidelines

by Diamantopolous and Winklhofer (2001) were followed to validate the higher-order formative constructs³. Furthermore, as the formative measurement model is based on multiple regressions, excessive collinearity among indicators is problematic. However, VIFs of all first-order constructs are close to 1.0, suggesting low collinearity. Finally, several authors suggest testing the external validity of formative constructs (Bagozzi, 1994; Diamantopolous & Winklhofer, 2001). To assess external validity I tested whether the higher-order constructs are highly correlated with their reflective indicators, that assess the overall external sensing, seizing and reconfiguring DCs, as perceived by the respondents.⁴ All first-order indicators are significant and the higher-order constructs strongly and positively correlate (around 0.7) with their reflective indicators, lending support for the higher-order representation.

Testing the Proposed Research Model

The proposed research model was tested with Smart PLS (Ringle et al., 2005) and the significance of path coefficients were assessed with 500 bootstrap runs. A two-stage approach was used for integrating the higher-order models into the structural model. Latent variable scores of the first-order constructs were initially estimated, using repeated indicators. These latent variable scores are subsequently used as formative indicants in a separate structural model analysis. This approach is most in line with the formative modeling of the first-order constructs (Diamantopolous & Winklhofer, 2001).⁵ Figure 2 reveals the results, depicting only significant relationships. The Stone-Geisser criteria of the three endogenous constructs ($Q^2 = .24, .10$ and $.31$) suggest high predictive relevance of the overall structural model.

FIGURE 2 ABOUT HERE

The results support the hypotheses with one exception. External sensing DC has a significant positive impact on technological resource access, thereby supporting H1. The more and the better the firm senses opportunities in the external environment, the more novel technological

resources it can access. Technological resource access has a significant positive impact on technological capabilities, providing support for H2. Technological capabilities, in turn, positively influence competitive advantage in innovation, supporting H4.

Mediation and Moderation Analyses: Next, I investigated whether the technological resource base operates as a mediator between external DCs and competitive advantage in innovation. Using the criteria by Baron and Kenny (1986), it can be concluded that technological capabilities fully mediate the relationship between technological resource access and competitive advantage in innovation, supporting H7. The mediation of technological resource access, stipulated in H6, is more complex, as it entails moderated mediation (H3 hypothesizes that external seizing DC moderates the relationship between technological resource access and technological capabilities). Hence, I evaluated the suggested mediation and moderation effects simultaneously. To test the moderating effects as part of the structural model, I first ran the main effects model in order to obtain estimates for the latent variable scores. The interaction terms are then built up as the element-wise product of the latent variable scores of the predictor and moderator variables. The results show that the impact of technological resource access on technological capabilities is significantly and positively moderated by external seizing DC ($\beta = .291$ and $p\text{-value} < .01$), thus supporting H3. In addition, the f-test comparing the R^2 between the main and interaction effect (Chin et al., 2003) generates a medium effect size ($f^2 = .15$), providing further support for H3.

Interestingly, this moderating effect also has an influence on the mediating role of resource access. While two of Baron and Kenny's criteria for mediation are fulfilled: (1) sensing (x) has a significant positive effect on technological capabilities (y), and (2) the relationship between sensing (x) and technological capabilities (y) becomes weaker when including technological resource access (m), the condition that the mediator has a significant effect on the dependent variable cannot be confirmed. Technological resource access (m) does

not have a significant impact on technological capabilities (y). However, this relationship changes when including the moderating effect of external seizing DC; it becomes significantly positive. When including the moderating effect into the structural model, the interpretation of the relationship between technological resource access and technological capabilities changes. It can now be interpreted as a single effect; it describes the relationship between technological resource access and technological capabilities at the mean value of external seizing DC (as values were standardized before creating the interaction term). Hence, under the condition that external seizing DC is at least 'average' in strength, the relationship between technological resource access and technological capabilities becomes positive and significant. As a consequence, the pattern of mediation varies as a function of the moderator 'external seizing DC', thereby providing partial support for H6.

To further evaluate this finding, I conducted a two group analysis (see figure 3). I separately evaluated the mediating effect of technological resource access for 40 cases that score highest on external seizing DC and for the 40 cases that score lowest on external seizing DC. Figure 3 displays divergent results for the two groups. I find the predicted mediating effect of resource access in the high seizing group. Technological resource access fully mediates the relationship between external sensing DC and technological capabilities and there is a strongly positive and significant relationship between resource access and technological capabilities ($\beta = .553$, p-value < .01). In the low seizing group, however, there is a significant *negative* relationship between technological resource access and technologies capabilities ($\beta = -.274$, p-value < .10).⁶ This means that in cases of weak external seizing DC, externally accessed resources have a negative impact on internal technological capabilities. These contradicting results in the two-group analysis shed some light on the insignificant relationship between technological resource access and technological capabilities in the complete sample, when the moderating effect is disregarded. It illustrates how the mediation

effect differs with respect to different levels of the moderator variable. As a result, the mediating effect stipulated in H6 is supported only for average and high levels of external seizing DC.⁷ Furthermore, this shows that H2 (the more external technological resources the firm accesses, the more superior will be its technological capabilities) is only supported for average and high levels of external seizing DC.

FIGURE 3 ABOUT HERE

To evaluate H5, I tested the proposed moderating effect of external reconfiguring DC. The moderating effect cannot be supported ($\beta = -.049$; p-value $>.10$, not reported). Instead, reconfiguring has a positive and significant direct effect on competitive advantage in innovation ($\beta = .249$; p-value $<.01$) with a medium effect size ($f^2 = .10$).

Control Variables: ‘Technological turbulence’ does not reveal any significant effects in the structural model (to preserve the model’s clarity, these relationships are not reported). This is in line with Helfat and Winter’s (2011) recent assertion that DCs are not restricted to environments of radical change, but are equally important in relatively placid environments. To evaluate R&D intensity, industry effects, and firm size I conducted multi-group analysis. The main findings remain largely robust across industries, firm sizes, and levels of R&D intensity (omitted for brevity). In addition, extensive competing model analyses suggests that alternative models are not better in explaining the dependent variables.⁸

DISCUSSION

Following recent theoretical developments that emphasize the importance of external sources of innovation (Laursen & Salter, 2006; Foss et al., 2011) this study examined the relationships between external DCs and competitive advantage in innovation. While previous literature on DCs has focused mainly on internal resource creation and reconfiguration (Zahra et al., 2006;

Cepeda & Vera, 2007) this study emphasizes the relevance of external sources of resource renewal. In doing so, I unpack the concept of external DCs which aim at renewing the resource base by accessing and integrating resources that reside outside the firm's boundaries. The empirical analysis reveals that competitive advantage in innovation rests to a large extent on three classes of external DCs, which enable firms to sense opportunities to access new external resources, seize these external resources, and reconfigure them internally.

Despite the importance of DCs, there are few empirical studies that operationalize DCs and test their underlying mechanisms (Macher & Mowery, 2009). Hence, this study provides an empirical contribution by developing and testing a specific set of DCs. This study operationalizes three classes of external DCs in terms of observable underlying processes. First, external sensing DC is operationalized in terms of external scanning and strategic selection processes. Second, external seizing DC is captured as the processes to coordinate resource transfer, integrate these resources into the firm's culture, and to provide systematic knowledge management. And finally, external reconfiguring DC refers to the processes of monitoring the resource base and recombining external and internal elements to achieve novel configurations. These multidimensional constructs contribute to the literature of DCs, as they enable testing the relationships between DCs and other constructs, such as competitive advantage, that reside at the same level of abstraction (Edwards, 2001). Furthermore, this operationalization allows testing the joint effects of bundles of processes. I find significant effects of these bundles of processes, which demonstrates that DCs are not simple processes (Eisenhardt & Martin, 2000), but consist of more complex bundles of processes which jointly change the resource base (Baretto, 2010; Zollo & Winter, 2002).

In addition to offering more concrete measures of external DCs, this study explicates empirical links between these DCs, components of the technological resource base, and competitive advantage in innovation. This leads to a better understanding of the content of

external DCs, how they operate and function in combinations (Ambrosini & Bowman, 2009), and how they lead to important outcomes (Barreto, 2010). The results of this study show that external sensing DC leads to new technological resource access. Firms that have systematic external scanning and strategic selection processes in place gain access to a larger range of external technological resources.

However, the analysis also reveals that access to external technological resources is not necessarily beneficial. Instead, I find that external technological resource access harms the focal firm unless it possesses a strong external DC for seizing these resources. The multi-group analysis reveals that for firms with weak external seizing DC, external technological resource access has a significantly *negative* effect on their internal technological capabilities. If a firm accesses external technological resources, but does not have systematic knowledge management, coordination and integration processes in place, this will have detrimental effects on its technology-related operational capabilities. A possible interpretation of this result is that these firms invest time and effort for accessing external resources. However, these resources do not add any value as they are never integrated, coordinated, and diffused within the firm. As an alternative to external renewal, these firms might have been better off by creating and shaping their technological capabilities internally. However, if a firm possesses strong external seizing DC, access to external technological resources has a strong and significantly *positive* effect on technological capabilities. These results highlight the potential benefits and risks of external renewal. In particular, they emphasize the importance for firms to develop systematic coordination, integration, and knowledge management processes in order to be able to seize external technological resource access into superior technological capabilities.

The empirical analysis, in addition, sheds light on the resource base as a mediating factor. While the mediating role of the resource base has been demonstrated in the literature

(e.g. Ambrosini & Bowman, 2009; Cepeda & Vera, 2007), this study adds to this research by differentiating between resource access and operational capabilities. The structural model shows that external technological resource access influences the firm's technology-related operational capabilities, which in turn lead to competitive advantage in innovation. In addition, the analysis shows how the identified classes of external DCs operate at different parts of the resource base. While external sensing DC has a strong and positive direct effect on technological resource access, external seizing DC strongly and positively moderates the relationship between technological resource access and technological capabilities. This interaction effect is in line with the path dependency logic inherent in the DCs literature (Ambrosini & Bowman, 2009; Zollo & Winter, 2002), as the value creation potential of seizing DC is dependent on previously configured resources. Overall, the empirical findings of this study support the differentiation of the technological resource base into technological resource access and technological capabilities. It contributes to the existing literature by conveying a more detailed picture of the composition of a certain subset of the resource base and how it is transformed via different classes of DCs (Amit & Schoemaker, 1993).

Furthermore, this study clarifies the role of external reconfiguring DC which refers to the capacity to monitor and flexibly recombine external and internal elements of the resource base to create novel configurations. Rather than finding a moderating effect of external reconfiguring DC, as hypothesized, I find that this class of external DCs has a direct positive impact on competitive advantage in innovation. This implies that the influence of reconfiguring is independent of previously configured technological resources and capabilities. A possible interpretation is that technological capabilities can be superior or inferior in one organizational setting, such as a certain product category or technological field. However, this superior or inferior position does not automatically determine the value creation potential of these technological capabilities in a different setting or application. Even

if the firm possesses technological capabilities in a certain field that are inferior to those of their main competitors, it can create a competitive advantage in innovation if it has the capacity to reconfigure these capabilities in novel ways that lead to new innovations (Henderson & Clark, 1990; Galunic & Rodan, 1998). Hence, in contrast to most prior work that emphasizes that effects of DCs are always and entirely mediated by the firm's resource base (e.g. Zahra et al., 2006; Zott, 2003), I find that one specific class of external DCs (i.e., reconfiguring DC) directly contributes to competitive advantage in innovation. This is because reconfiguring DC can alter the externally extended resource base further, leading to an additional direct effect on competitive advantage (Helfat & Peteraf, 2009).

In addition to these empirical findings, this study develops a stronger theoretical foundation for external DCs, which have been limited to the context of alliances and acquisitions (e.g. Dyer & Kale, 2007; Ettlie & Pavlou, 2006; Karim & Mitchell, 2000). So far, research has left the processes by which resources and capabilities are externally renewed largely black boxed (Ambrosini & Bowman, 2009; Kraaijenbrink et al., 2010). By explicating specific organizational processes which lead to access, deployment, and reconfiguration of external resources, we are able to look inside this black box. Therefore, this study delivers a more complete understanding of how firms can use external paths for creating new resource positions and developing competitive advantage in innovation. It sheds light on how firms gain access to resources in the external environment and how they can become successful at using and reconfiguring them.

The conceptualization suggested in this study offers a more complete understanding of what external DCs are and how they are put into use. With one notable exception (Pavlou & El Sawy, 2006), most studies have employed a unidimensional approach to DCs and operationalized them through single measures (Helfat, 1997; Macher & Mowery, 2009) or multi-item measures (Danneels, 2008). However, this unidimensional approach ignores the

conceptual richness and complexity of DCs (Baretto, 2010). The second-order models, suggested in this study, are theoretically useful, as they provide a holistic representation of a complex phenomenon and allow matching complex predictors (DCs) with complex outcomes (competitive advantage). Furthermore, these higher-order DCs are not easily mimicked as they are established through a combination of lower-level processes. As a consequence, the operationalizations are in line with theoretical assertions that DCs are difficult to imitate (Teece, 2007), heterogeneous in detail (Eisenhardt & Martin, 2000; Barreto, 2010), and a source of competitive advantage (Ambrosini & Bowman, 2009).

As a result, this study sheds light on the external mode of DCs and how it can contribute to competitive advantage in innovation. It is not external resources per se, but it is the firm-internal DCs and their underlying processes that are a key to competitive advantage in innovation. The more and the better the firm senses opportunities for external renewal, seizes these opportunities by transforming resources into operational capabilities, and boosts the value potential of external resources by reconfiguring them internally, the more effective and efficient will be its innovation process. Hence, the source of competitive advantage in innovation does not lie externally, but moves even deeper inside the firm. External DCs help to explain why some firms are better than others in creating value from external sources and how firms can create competitive advantage in innovation on the basis of external resources, which are for most part tradable (Kraaijenbrink et al., 2010).

Limitations and Future Research

This study has several limitations, which provide opportunities for future research. First, to create higher-order models of DCs, this study uses constructs which have strong theoretical support in the literature. However, these processes are not necessarily exhaustive. Additional processes of the specified external DCs have yet to be identified in order to develop a more

complete picture of the underlying processes that put external sensing, seizing, and reconfiguring DCs into use. Furthermore, literature shows that external resources can be obtained from different sources (Laursen & Salter, 2006). It would be of interest whether external sensing, seizing, and reconfiguring DCs, in combination with their underlying processes, differ for accessing different external sources, such as customers or universities. Furthermore, the empirical analysis of this study focuses on the renewal of technological resources and technologies capabilities. Future studies could extend this research by investigating marketing- and managerial-related resources and capabilities.

Second, the cross-sectional design of the survey does not allow us to observe the short- and long-term effects of the different classes of DCs. While I propose sequenced relationships, all constructs are measured at one point in time. Furthermore, the operationalizations do not directly capture dynamic change in ‘resource access’ and ‘operational capabilities’; instead, a positive association between DCs and the resources are suggested at one point in time. Hence, the results should be treated with caution as causality cannot be inferred with such cross-sectional data. As a consequence, this study could benefit from a more longitudinal approach in order to better establish causality and disentangle temporal and sequential effects. Despite these limitations, by proposing and testing relationships among external DCs, the firm’s technological resource base, and competitive advantage in innovation, this article has brought improved understanding to the concept of external resource renewal.

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Endnotes

¹ In the Gale Group PROMT database, I counted the number of new product announcements from 2010 – 2012 for each firm in my dataset. Collecting this information over a longer time period generates a number that is not likely to be affected by short-term economic or cyclical trends. Based on databases that provide investor information (e.g. Hoovers), each firm's three most important competitors were identified for which product announcement data was then also collected. Subsequently, I calculated the respective differences of new product announcements of the firms in the dataset and the average of their main competitors for the specified time period. I adjusted these numbers for the total number of new product announcements made by the focal firm and its respective competitors in order to account for industry differences. These numbers reveal how the firms in the dataset compare to their main competitors on new product announcements, providing an indication of their competitive advantage in innovation.

² To assess discriminant validity at the construct level, I also followed Fornell and Larcker (1981) by calculating the square roots of the AVE values and comparing these values with the correlations between different constructs. Construct discriminant validity is confirmed as the square roots of the AVE values are greater than the correlations between constructs (all constructs share more variance with their own measures than with others).

³ This includes careful development of higher-order construct definitions and an extensive literature analysis for specifying formative indicators (Diamantopolous & Winklhofer, 2001)

⁴ In order to form the higher-order constructs, paths were modeled from the first- to the second-order constructs, using principal component analysis. The weights of the formative constructs are treated as PLS coefficients, and the variance explained in the second-order construct is unity. In a second step, I used the latent variable (LV) scores from this analysis to model the formative higher-order constructs, taking the LV scores as indicants. These higher-order constructs were then correlated with their reflective indicators.

⁵ A different approach for integrating the higher-order models into the structural model is the hierarchical components model (Wetzels et al., 2009). Here, a second-order factor is directly measured by the observed variables for all first order factors. While this approach repeats the number of manifest variables used, the model can be estimated by the standard PLS algorithm, as the latent variable scores are determinate. This results in a R^2 value of the higher order construct of unity. This is similar to Diamantopolous and

Winklhofer's (2001) suggestion to set the error term to zero to obtain identification in a covariance-based SEM context (Wetzels et al., 2009). Both approaches of higher-order modeling lead to very similar results.

⁶ An adaptation of the t-test for comparing regression coefficients in independent samples was conducted, using the equation suggested by Chin (2003), as described and used by Pavlou and El Sawy (2005). A t-value of 39 implies that the coefficients are significantly different from each other.

⁷ In addition I tested the significance of the two stipulated mediation effects by bootstrapping their indirect effects (product terms of the two indirect paths). Bootstrapping the path coefficients and calculating their standard errors yield significant test statistics of 2.6 (technological resource access as mediator) and 2.8 (technological capabilities as mediator), which lend support for the existence of these mediation effects.

⁸ Three competing models were evaluated as alternative explanations. The first model is a reduced direct one, in which direct paths are modeled from external sensing, seizing, and reconfiguring DCs to competitive advantage in innovation. The second, model is partially indirect, in which 'technological resource access' is included as a single mediator, and external seizing DCs are modeling to moderate the relationship between 'technological resource access' and competitive advantage in innovation.

Analogously, the third model is partially indirect, including 'technological capabilities' as the single mediator, with external seizing DC moderating the relationship between external sensing DCs and 'technological capabilities'. In all three competing models, less variance is explained in the dependent variable (competitive advantage in innovation) as compared to the suggested research model. Further, in the competing models 2 and 3, the moderating effect of external seizing DCs is insignificant. As a final robustness check, I including paths from external 'sensing', 'seizing', and 'reconfiguring' DCs to all endogenous variables in the model ('technological resource access', 'technological capabilities', and 'competitive advantage in innovation'). The only effect that is marginally significant (at the 10 percent level) is the path from 'reconfiguring' to 'technological resource access'. This suggests that there might be some feedback loops in the model, which are to be tested in future longitudinal studies. Overall, the competing model analyses corroborate the relationships in figure 2.

TABLES

Table 1: Classification of the Existing Literature

CLASSES OF DCs	MODES OF RESOURCE ALTERATION	
	INTERNAL RENEWAL	EXTERNAL RENEWAL
SENSING	<ul style="list-style-type: none"> • Entrepreneurial leadership and generation of new alternative strategies (Augier & Teece, 2009) • Defining critical knowledge areas (Cepeda & Vera, 2007) • Internal creative destruction and constructive conflict (Danneels, 2008) • Creative search and strategic sense-making (Pandza & Thorpe, 2009) • Entrepreneurial activities (Zahra et al., 2006) • Knowledge creation routines and experiential action (Eisenhardt & Martin, 2000) • Selection of technologies and business models (Augier & Teece, 2006) 	<ul style="list-style-type: none"> • Environmental scanning (Danneels, 2008) • Selecting appropriate modes of capability sourcing (Capron & Mitchell, 2008) • Search and selection of alliance or acquisition candidates (Helfat et al., 2007; Capron & Anand, 2007)
SEIZING	<ul style="list-style-type: none"> • Commitment to R&D (Helfat, 1997) • Implementation of technologies and business models (Augier & Teece, 2006) • Asset alignment (Augier & Teece, 2006) • Designing near-decomposable systems (Augier & Teece, 2006) • Multi-functional teams to coordinate and integrate resources and skills (Ambrosini & Bowman, 2003; Eisenhardt & Martin, 2000; Macher & Mowery, 2009) • Knowledge management infrastructure (Cepeda & Vera, 2007; Easterby-Smith & Prieto, 2008) • Building new technological or market-related resources (Danneels, 2008) • Strategic decision making to pool resources (Eisenhardt & Martin, 2000) • Divestment of assets (Danneels, 2010; Eisenhardt & Martin, 2000; Moliterno & Wiersema, 2007) 	<ul style="list-style-type: none"> • Alliance and acquisition routines (Danneels, 2010; Eisenhardt & Martin, 2000) • External corporate venturing (Keil, 2004). • Inter-firm collaborations to expand and improve core competencies (Lorenzoni & Lipparini, 1999) • Relational alliance capability (Dyer & Kale, 2007) • Technology-based NPD partnerships (Ettlie & Pavlou, 2006)
RECON-FIGURING	<ul style="list-style-type: none"> • Organizational structure reconfiguration (Karim, 2006) • Consolidating support activities (Ambrosini & Bowman, 2003) • Reconfiguring core processes to exploit economies of scale (Ambrosini & Bowman, 2003) • Knowledge brokering and resource allocation routines; co-evolving and patching (Eisenhardt & Martin, 2000) • Re-combining resources and capabilities between divisions (Galunic & Eisenhardt, 2001) • Building, aligning, and adapting co-specialized assets (Helfat et al., 2007; Teece, 2007) • Effectuating new combinations (Augier & Teece, 2006) • Retention and intertemporal integration of knowledge (Marsh & Stock, 2006) • Continuous morphing of business models, organizational forms and processes (Rindova & Kotha, 2001) • Recognizing replication opportunities (Ambrosini & Bowman, 2003; Danneels, 2010) 	<ul style="list-style-type: none"> • Acquisition reconfiguration capability (Capron & Anand, 2007) • Organizational structure reconfiguration – acquiring business units (Karim, 2006) • Acquisition process for reconfiguring the firm’s mix of resources (Karim & Mitchell, 2000)

Table 2: Conceptualization and Operationalization of External Dynamic Capabilities

Dynamic Capability Class	Process	Definition of process	Related activities identified in the literature
Sensing	External Scanning	The capacity to monitor and recognize new and emerging markets and technologies	<ul style="list-style-type: none"> • Monitoring the external environment (Danneels, 2008) • Constant surveillance of markets and technologies (Teece et al., 1997) • Scanning activities (Teece, 2007) • Sensing environmental trends and discovering new market opportunities (Galunic & Rodan, 1998) • Propagating and interpreting market intelligence (Kogut & Zander, 1992) • Linking the firm to external knowledge sources (Eisenhardt & Martin, 2000; Teece et al., 1997) • Understanding the environment, identifying market needs and spotting new opportunities (Pavlou & El Sawy, 2005)
	Strategic Selection	The capacity to choose appropriately between different resource alteration paths according to strategic and competence-based fit	<ul style="list-style-type: none"> • Figuring out implications for action and achieving strategic fit (Teece, 2007) • Strategically guiding decisions on new initiatives and knowledge needs (Cepeda & Vera, 2007) • Deciding which technologies and markets to pursue (Teece, 2007) • Analyzing information collected during search processes (Pandza & Thorpe, 2009) • Identifying a preferred alternative for organizational change (Zott, 2003) • Selecting appropriately between internal development and external sourcing (Capron & Mitchell, 2009; Capron & Anand, 2007)
Seizing	Knowledge management	The capacity to organize, diffuse and maintain externally generated resources.	<ul style="list-style-type: none"> • Internally diffusing novel solutions (Cepeda & Vera, 2007 ; Zollo & Winter, 2002) • Intra-organizational knowledge transfer to diffuse knowledge from external sources (Easterby-Smith et al., 2008) • Efficient and effective intra-organizational knowledge transfer (Teece, 2007; Zahra & George, 2002) • Knowledge articulation, codification, sharing, and internalization (Dyer & Kale, 2007) • Knowledge management in terms of articulation and codification (Zollo & Winter, 2002; Macher & Mowery, 2009) • Codifying knowledge and making it explicit (Marsh & Stock, 2006) • Integrating fragmented flows of knowledge (Gold et al., 2001) • Learning system/infrastructure consisting of technical procedures and social relationships (Easterby-Smith & Prieto, 2008) • Facilitating easy access to the stock of organizational, codified knowledge (Verona & Ravasi, 2003)
	Integrating	The capacity to shape and manage a context that stimulates the use of externally generated resources.	<ul style="list-style-type: none"> • Embedding acquired knowledge into culture, systems, and operations (Zahra et al., 1999; Zahra & George, 2002) • Formal and informal efforts to resolve disputes and to overcome conflicts on how to obtain resources (Zahra et al., 2006) • Developing a collective activity (Zollo & Winter, 2002) • Creating a collective mind (Pavlou & El Sawy, 2005) • Transforming internal views and dysfunctional features; building loyalty/commitment and defeat naysayers (Teece, 2007) • Rewarding and incentivizing knowledge channels (Gold et al., 2001) • Shaping and managing a context that stimulates use of dispersed knowledge resources (Verona & Ravasi, 2003)

	Coordinating	The capacity to coordinate roles, responsibilities, and tasks for external resource implementation	<ul style="list-style-type: none"> • Coordinating resources by allocating assets, assigning tasks, and coordinating activities (Helfat & Peteraf, 2003; Eisenhardt & Brown, 1999) • Organic architecture to increase the speed and efficiency of transferring ideas and concepts across the organization (Verona & Ravasi, 2003) • Transforming dispersed, tacit, and explicit competencies into a wide body of idiosyncratic organizational knowledge (Grant, 1996; Ambrosini & Bowman, 2009) • Managing dependencies among resources and tasks to create new ways of performing a desired set of activities (Pavlou & El Sawy, 2005)
Recon-figuring	Resource Cognition	The capacity to actively monitor the internal resource base to identify opportunities for novel configurations	<ul style="list-style-type: none"> • Conceptualizing the firm's resources to identify resources and understand their fungibility (Danneels, 2010) • Capability monitoring function (Schreyoegg and Kliesch-Eberl, 2007) • Identifying opportunities for novel reconfigurations (Galunic & Rodan, 1998) • Knowing the fine-grained structure of the firm's asset base and filling in resulting gaps (Teece, 2007) • Identifying critical knowledge areas/assets and assessing a firm's existing resource base relative to desired new resources and capabilities (Cepeda & Vera, 2007) • Defining gaps in terms of the distance between needed capabilities and existing capability base (Capron & Mitchell, 2009) • Developing new problem space and developing strategic prescriptions (Tripsas & Gavetti, 2000) • Managerial cognition that refers to knowledge or assumptions about future events alternatives, and consequences of the alternatives (Adner & Helfat, 2003) • Cognitive orientation and understanding that there is a need for a new initiative (Narayanan et al., 2009)
	Recombining	The capacity to flexibly employ and combine resources across external and internal sources.	<ul style="list-style-type: none"> • Matching up relevant assets and combining know-how (Teece, 2007) • Bundling co-specialized resources and capabilities (Sirmon et al., 2007) • Integrating and combining assets (Kogut & Zander, 1992; Grant, 1996) • Integrating external resources with the firm's own bundles of resources (Sirmon et al., 2007) • Accumulating complementary know-how (Helfat, 1997; Teece et al., 1997) • Transferring or redeploying resources and competences from one concrete economic setting to another (Teece et al., 1997) • Drawing on existing resources and applying them to new uses (Danneels, 2010) • Reorganization of existing knowledge and competencies into other innovative products (Verona & Ravasi, 2003)

Table 3: Correlation Matrix and Reliability of Reflective Constructs

	Rel.	Mean	St. Dev.	ES	SS	CD	Int	KM	Rec	Cog	RA	TC	CA
External Scanning (ES)	0,91	5,12	1,16	0,64									
Strategic Selection (SS)	0,91	5,08	1,16	.39**	0,73								
Coordinating (CD)	0,93	3,84	1,39	.40**	.51**	0,81							
Integrating (Int.)	0,92	4,32	1,40	.41**	.56**	.53**	0,71						
Knowledge Mngmt. (KM)	0,93	3,70	1,35	.42**	.43**	.51**	.41**	0,73					
Recombining (Rec)	0,94	4,47	1,08	.35**	.65**	.61**	.63**	.51**	0,81				
Resource Cognition (Cog)	0,90	4,96	1,07	.39**	.59**	.42**	.58**	.38**	.63**	0,70			
Resource Access (RA)	0,90	5,00	1,21	.51**	.48**	.43**	.45**	.34**	.51**	.45**	0,76		
Technological Capabilities (TC)	0,83	4,98	1,06	.31**	.24**	.20*	.24**	.24**	.31**	.32**	.32**	0,71	
Comp. Adv. in innovation (CA)	0,95	21,29	7,60	.22*	.33**	.22*	.35**	.31**	.40**	.40**	.33**	.64**	0,69

Average variance extracted (AVE) in the diagonal

FIGURES

Figure 1: Conceptualization of Higher-Order External Dynamic Capabilities

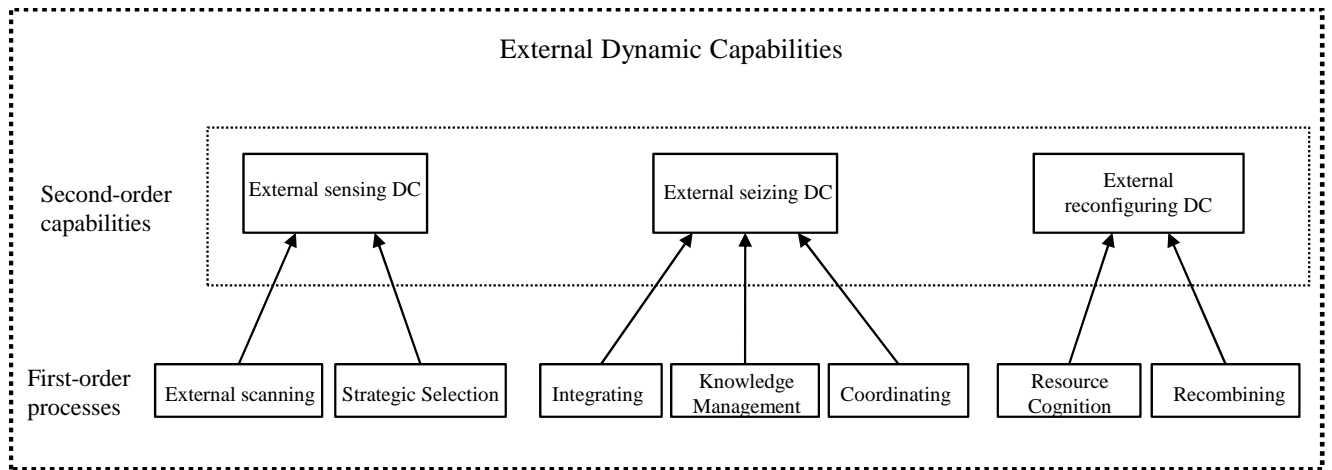
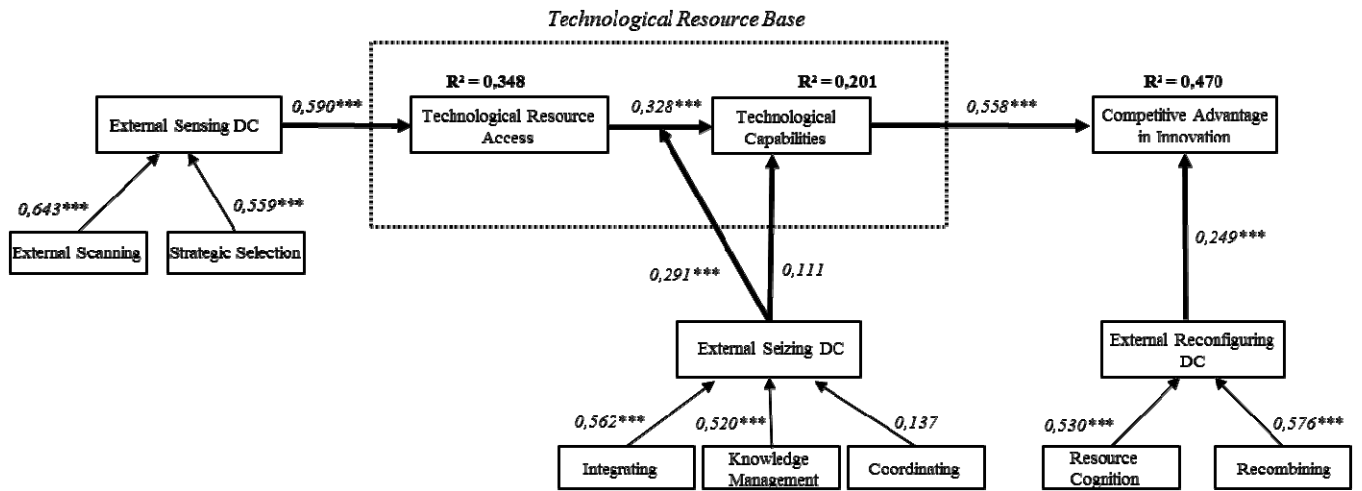
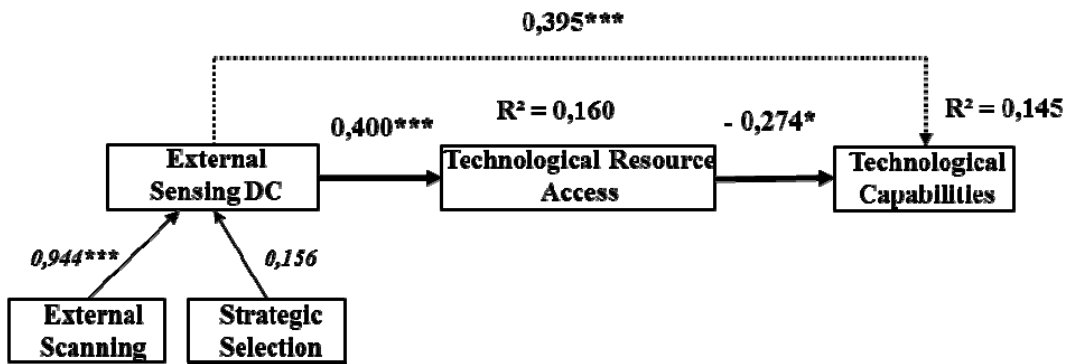
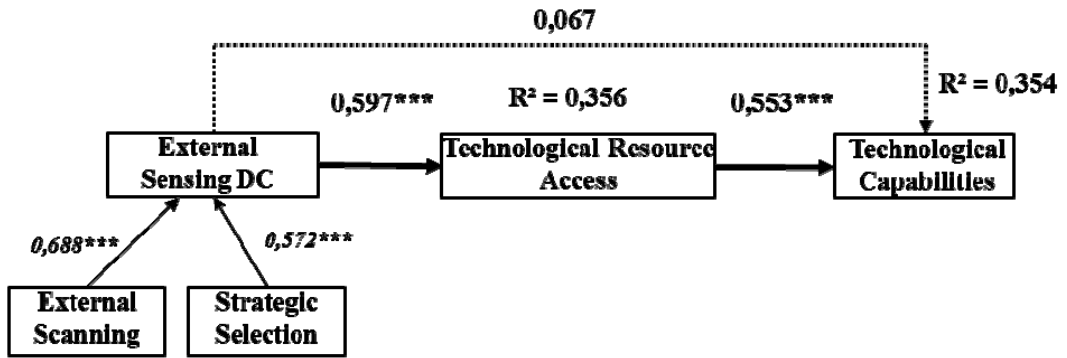


Figure 2: Structural Model



*** p-value < .01, ** p-value < .05, * p-value < .10

Figure 3: Two Groups Mediation Analysis



*** p-value < .01, ** p-value < .05, * p-value < .10

Appendix 1: Measurement Items for Principal Constructs*

External Sensing DCs		
External Scanning Professional association activities Scientific/professional conferences Trade shows Contacts with researchers at universities Specialized journals and magazines Start-up community	Strategic Selection Fit with internal competencies Applicability to market segments Potential strategic benefits to our business Appointing business lines	
External Seizing DCs		
Knowledge Management Analysis and filtration Stored information and codification tools Tools to access stored knowledge Internal search tools Systems for dissemination/allocation	Coordinating Division of roles and responsibilities Knowledge gatekeepers Processes to adapt external knowledge to internal development processes	Integrating Communicating benefits Encouraged to utilize external knowledge Usage of external knowledge sources is valued Reward/incentive systems Legitimize and empower
External Reconfiguring DCs		
Resource Cognition Understanding about firm's technological needs Overview of internal knowledge gaps Recognize internal innovation problems Common / consistent understanding of internal knowledge	Recombining Creating combinations from external and internal knowledge Integrating external and internal knowledge Linking with firm's in-house capabilities Combining into novel configurations	
Technological Resource Base		
Technological Resource Access Technological expertise in new areas R&D skills and resources in new technical areas Engineering skills and resources in new technological areas	Technological Capabilities Technology development capabilities New product development capabilities	
Competitive Advantage in Innovation		
Product Effectiveness Improvement in product quality/functionality Major innovations in products Creation of new product concepts	Process Efficiency Overall development costs Overall efficiencies of new product development processes Time to market	
Indicator Variables		
External Sensing DC Track ideas, knowledge, or technologies Create opportunities through external acquiring Identify relevant external knowledge	External Seizing DC Exploit external resources Translate into internal applications Accelerate firm's R&D speed	External Reconfiguring DC Development of innovation products Analyze different application areas

*An abbreviated version of items is presented here to maintain parsimony.