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ON THE CONTINGENT VALUE OF DYNAMIC CAPABILITIES FOR COMPETITIVE ADVANTAGE: THE NONLINEAR MODERATING EFFECT OF ENVIRONMENTAL DYNAMISM

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This article suggests that dynamic capabilities can give the firm competitive advantage, but this effect is contingent on the level of dynamism of the firm's external environment. A nonlinear, inverse U-shaped moderation is proposed, implying that the relationship between dynamic capabilities and competitive advantage is strongest under intermediate levels of dynamism but comparatively weaker when dynamism is low or high. This proposition is tested using data on alliance management capability and new product development capability, two specific dynamic capabilities widely recognized in prior research. Results based on longitudinal key informant data from 279 firms support the account that these dynamic capabilities are more strongly associated with competitive advantage in moderately dynamic than in stable or highly dynamic environments.

INTRODUCTION

The dynamic capabilities perspective has emerged as one of the most influential theoretical lenses in the study of strategic management over the past decade. Despite its popularity in the literature, the dynamic capabilities perspective has been criticized for its ill-defined boundary conditions and its confounding discussion of the effect of dynamic capabilities (e.g., Arend and Bromiley, 2009). One important source of concern is that the presence of dynamic capabilities has frequently been equated with environmental conditions characterized by high dynamism (Zahra, Sapienza, and Davidsson, 2006). A turbulent environment, however, is not necessarily a component or precondition of dynamic capabilities, which can exist even in stable environments (Helfat and Winter, 2011). Further, researchers have tended to identify dynamic capabilities post hoc, often equating their existence with successful organizational outcomes. This practice makes it difficult to separate the existence of dynamic capabilities from their effects (Helfat and Peteraf, 2009). Given the above limitations, it has remained difficult to ascertain the value of dynamic capabilities for a firm's competitive advantage, especially under different degrees of dynamism.

This article empirically investigates the link between dynamic capabilities and competitive advantage and examines the efficacy of dynamic capabilities under conditions of varying environmental dynamism. To accomplish this goal, I conceptualize dynamic capabilities in terms of organizational routines, thus making them measurable and distinct from a firm's competitive advantage (Eisenhardt and Martin, 2000). I also separate

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dynamic capabilities from the firm's external environment, which I identify and measure as a contingency factor (Helfat *et al.*, 2007). Making this distinction allows for considering and ultimately reconciling the competing claims regarding the effect of environmental dynamism on the relationship between dynamic capabilities and competitive advantage. Some propose that the dynamism of a firm's environment may enhance the efficacy of dynamic capabilities and their potential for competitive advantage (Drnevich and Kriauciunas, 2011; Winter, 2003; Zollo and Winter, 2002). Other scholars, however, suggest that, on the contrary, dynamic capabilities may prove less effective in highly dynamic environments (Eisenhardt and Martin, 2000; Schreyögg and Kliesch-Eberl, 2007).

The key contributions of this research are twofold. First, this article makes a theoretical contribution by offering a new, integrative position on the relationship between dynamic capabilities, environmental dynamism, and competitive advantage. Integrating existing views, I propose a novel inverse U-shaped moderating effect, implying that the association between dynamic capabilities and competitive advantage is strongest under intermediate levels of dynamism but comparatively weaker when dynamism is low or high. Second, this study makes an empirical contribution by testing this nonlinear interaction effect. In doing so, this article contributes to reducing the scarcity of empirical research on the consequences of dynamic capabilities for organizational outcomes (e.g., Helfat and Peteraf, 2009).

THEORETICAL BACKGROUND

Dynamic capabilities and competitive advantage

The dynamic capabilities view may be regarded as an extension of the resource-based view (RBV); while the RBV primarily addresses a firm's existing resources, the dynamic capabilities view emphasizes the reconfiguration of these resources (Helfat and Peteraf, 2003). Prior research suggests that dynamic capabilities are organizational routines that affect change in the firm's existing resource base (Eisenhardt and Martin, 2000; Helfat, 1997; Teece, Pisano, and Shuen, 1997). This definition emphasizes that dynamic capabilities are based on organizational routines, commonly understood as learned, highly patterned, repetitious behavioral patterns for interdependent corporate actions (Pierce, Boerner, and Teece, 2002; Winter, 2003; Zollo and Winter, 2002). Although the routines underlying dynamic capabilities are not entirely fixed as people perform them across time and space, interpret them subjectively, and ultimately introduce variations (Feldman and Pentland, 2003), Winter (2003) emphasizes that there are clear limits to the degree to which they reflect flexible action with modest continuity across occasions (also see Weick and Sutcliffe, 2006). Therefore, it is important to note that not all organizational change needs to originate from dynamic capabilities; in particular, contingent, creative improvisation is typically not associated with dynamic capabilities as defined here (Winter, 2003).

Interest in dynamic capabilities stems from their potential influence on competitive advantage, the key outcome variable in dynamic capabilities theory (Teece *et al.*, 1997). A firm is said to have a competitive advantage when it enjoys greater success than current or potential competitors in its industry (Peteraf and Barney, 2003). Consistent with this conceptualization, superior firm performance relative to rivals commonly serves as an empirical indicator of competitive advantage.

Traditionally, the literature has assumed a universally positive effect of dynamic capabilities on competitive advantage. By replacing existing resources, dynamic capabilities have been suggested to create better matches between the configuration of a firm's resources and external environmental conditions (e.g., Teece and Pisano, 1994).

The contingent role of environmental dynamism

However, researchers have started to disagree in their assessments of the value of dynamic capabilities. Advocates of a more contingent view posit that the benefits of dynamic capabilities depend not only on the existence of the underlying organizational routines, but also on the context in which these capabilities are deployed (Levinthal, 2000; Sirmon and Hitt, 2009). Recognizing that effective modes of organizational adaptation are at least partly determined by environmental forces (Hrebiniak and Joyce, 1985), recent theoretical

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accounts on dynamic capabilities have emphasized particularly the role of environmental dynamism as a potentially important contextual variable (Helfat *et al.*, 2007; Helfat and Winter, 2011; Zahra *et al.*, 2006).

In defining environmental dynamism, this article builds on Miller and Friesen's (1983) influential conception that views both volatility (rate and amount of change) and unpredictability (uncertainty) as fundamental characteristics of environmental dynamism. For example, changes in industry structure, the instability of market demand, and the probability of environmental shocks are important elements of environmental dynamism (e.g., Jansen, Van Den Bosch, and Volberda, 2006; Levinthal and Myatt, 1994; Sirmon, Hitt, and Ireland, 2007). Consequently, environments with little dynamism are characterized by infrequent changes, and market participants usually anticipate those changes that do occur. In contrast, highly dynamic environments are those where rapid and discontinuous changes are common. In the middle lie moderately dynamic environments with regular changes that occur along roughly predictable and linear paths.

Currently, there are two competing views on the effect of environmental dynamism on the link between dynamic capabilities and competitive advantage, with little integration of both perspectives. The first view posits that there has to be a critical need to change in order to gain significant value from these capabilities (Drnevich and Kriauciunas, 2011; Helfat *et al.*, 2007; Winter, 2003; Zahra *et al.*, 2006; Zollo and Winter, 2002). This is because building and using dynamic capabilities are costly. These costs typically arise from various activities involved in devising new resources, reconfiguring existing ones, and combinations thereof. Additional costs might accrue if continual reconfigurations of resources unnecessarily disrupt ongoing learning activities by preventing the firm from recognizing potential differences in the outcome of its resources under different conditions. Other significant costs may result from wrongly estimating the need for resource alterations, which happens when firms use their dynamic capabilities when there is no compelling need for change (Winter, 2003). This can create significant costs because the frequent disruption of the underlying resource base may degrade structural reproducibility and hence decrease an organization's ability to act as a reliable and accountable collective entity.

Clearly, acknowledging that developing dynamic capabilities involves serious costs has implications for their potential value. If a firm rarely has a need to change, its performance relative to competitors may suffer when it devotes significant resources to developing these capabilities. This observation emphasizes the importance of balancing the costs of a given dynamic capability and its actual use. As such, dynamic capabilities can be viewed as 'strategic options' (Kogut and Zander, 1996) that allow firms to (re)shape their existing resource base when the opportunity or need arises. The lower the need for change, the less likely the opportunity to 'strike' the option, making dynamic capabilities comparatively less valuable. This implies that a firm needs to use its dynamic capabilities repeatedly in order for them to produce significant value (Helfat and Winter, 2011).

Following this logic, in environments characterized by low dynamism, dynamic capabilities can be expected to be of relatively less importance for a firm's competitive advantage. These environments typically reward consistent exploitation of existing resources (Leonard-Barton, 1992; Teece, 2007), whereas constantly reconfiguring resources may disrupt the efficiency and value potential of the firm's resources. Consequently, the positive effect of dynamic capabilities on a firm's competitive advantage will be comparatively low when environmental dynamism is low.

Another group of researchers has stressed that routine-based dynamic capabilities are not always an adequate means of change, even if there is a significant need for resource configurations (Eisenhardt and Martin, 2000; Schreyögg and Kliesch-Eberl, 2007). An important feature of the routines underlying dynamic capabilities is that they are path dependent and therefore based on interpretations and outcomes of past actions (Schreyögg and Kliesch-Eberl, 2007). Routine-based, history-dependent organizational change is typically very effective for adapting locally and incrementally based on past experiences, but research on experiential learning argues that this type of organizational change may prove problematic when previously unknown forces continuously alter the basis of competitive success (Levinthal and Rerup, 2006; March and Levinthal, 1993), as is the case in highly dynamic environments. More specifically, contexts where change is frequent and

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unpredictable and the environment shifts uncertainly among states that place novel demands on the organization produce two kinds of problems for dynamic capabilities, the first of which I call a 'matching problem' and the second an 'inertia problem.'

The matching problem is intrinsic to the way in which dynamic capabilities work. Following a patterned stimulus–response logic, they match particular environmental states with certain avenues for organizational change (Levinthal, 2000; Pierce *et al.*, 2002). For this purpose, the environment is monitored, and appropriate organizational changes that proved successful under similar conditions in the past are invoked (Levinthal and Rerup, 2006; March and Levinthal, 1993). For this experience-based matching process to work, however, the organization must have encountered the particular (or at least a comparable) environmental state before. In Weick and Sutcliffe's (2006) terminology, the environment needs to be in an 'in-family' state—a situation that was previously experienced, analyzed, and understood. 'Out-of-family' states, which are common when environmental dynamism is high, pose problems to the effectiveness of dynamic capabilities in that they do not trigger a programmed reactivation of matching organizational change. Given the absence of relevant stimulus knowledge, an out-of-family state may either be ignored or become normalized—that is, treated as if it were a familiar event already encountered and understood in the past—, and potentially inappropriate organizational responses may in turn be matched to these normalized situations (Levinthal and Rerup, 2006; Weick and Sutcliffe, 2006).

Second, even when environmental states appear familiar and previously successful organizational responses can be identified, this does not necessarily ensure that the same response will again and again be the most effective one (Jansen *et al.*, 2006; Pierce *et al.*, 2002). The automated stimulus–response logic underlying dynamic capabilities, however, tends not to incentivize scrutiny. Given that a proven response to an identified problem exists in organizational memory, experimentation with alternatives becomes less attractive, crowding out explorative activities that would go beyond the beaten track (Levinthal, 1991; Levinthal and Myatt, 1994; Sørensen and Stuart, 2000). This issue is what I call an inertia problem. Importantly, it can pertain not only to an organization's zero-order capabilities but to its dynamic capabilities as well, since routine-based organizational change tends to favor local adaptations (Collis, 1994; Levinthal, 1997; Schreyögg and Kliesch-Eberl, 2007). Especially when environmental dynamism is high and contextual change is fundamental and discontinuous, long-jump reorientations that require entirely novel solutions often prove more beneficial for a firm's competitive advantage than local adaptations from within the current set of available actions (Levinthal, 1997, 2000; Sørensen and Stuart, 2000).

In sum, I propose that highly dynamic environments with their unfamiliar states and demand for novel actions pose distinct challenges to the effectiveness of dynamic capabilities. Matching unfamiliar situations with organizational changes proves difficult and may lead either to unresponsiveness or normalization and, in turn, implementation of inappropriate responses. Additionally, experience-based adaptation is often associated with inertial forces that impede employing less local, more path-breaking changes that are often required for organizations in highly dynamic environments to create a competitive advantage.

Overall, I recognize that environmental dynamism affects both the extent of opportunities to change and the organizational capacity to exploit these opportunities via routine-based change, thus acknowledging the validity of the arguments from both research camps. When environmental dynamism is *low*, the potential of dynamic capabilities is limited because there are few occasions to exercise them effectively. In these situations, organizational routines for adapting the resource base may be of reduced value, in particular when considering the costs associated with them. Therefore, when environmental dynamism is low, I suggest that dynamic capabilities exert a relatively weak influence on the competitive advantage of firms.

I expect that when environmental dynamism is *high*, dynamic capabilities may also have a relatively weak impact on the competitive advantage of firms. Although highly dynamic environments provide ample opportunities for resource reconfigurations, the high frequency of novel situations and the necessity to bring about discontinuous organizational change in these settings make the routine-based mechanisms dynamic capabilities rest on comparatively less appropriate, given the matching and inertia problems associated with them.

In contrast, I expect that dynamic capabilities have the relatively strongest positive effect on the competitive advantage of firms when environmental dynamism is *intermediate*. These environments are dynamic enough to create opportunities for change but stable enough for organizations to recognize reoccurring problem structures and successfully leverage solutions existing in organizational memory. When environmental dynamism is at the intermediate level, there is both a potential for organizational change and the capacity to make good use of the routinized practices that underlie dynamic capabilities. In summary, I expect the positive effect of dynamic capabilities first to increase but then to diminish as environmental dynamism continues to rise, eventually declining at high levels of dynamism. I test this position empirically below.

HYPOTHESES

Dynamic capabilities manifest themselves in various identifiable and specific business processes (Eisenhardt and Martin, 2000; Helfat *et al.*, 2007; Helfat and Winter, 2011). Thus, rather than measuring a necessarily vague, generic dynamic capability, empirical researchers have been advised to carefully select a set of relevant business processes in which these capabilities exist to test their hypotheses (Gruber *et al.*, 2010; Helfat and Peteraf, 2009; Helfat and Winter, 2011). Although selecting a limited number of specific processes as proxies for dynamic capabilities may affect the universality of results, doing so is necessary for empirical research on dynamic capabilities to be practicable. It is through theoretical induction that such empirical research on specific types of dynamic capabilities 'sheds light not only on these specific processes, but also on the generalized nature of dynamic capabilities' (Eisenhardt and Martin, 2000: 1108).

In this study, I develop and test hypotheses on the contingent dynamic capabilities–competitive advantage link using data on *alliance management capability* and *new product development capability*. I selected these two dynamic capabilities for various related reasons. First, strategic alliances and new product development are essential means for reconfiguring the organizational resource base. While strategic alliances give firms access to resources that lie outside of their boundaries (Das and Teng, 2000), new product development aims at updating the firm's product portfolio (Helfat and Raubitschek, 2000). Second, existing definitions of both alliance management capability and new product development capability are a good match with the conceptualization of dynamic capabilities adopted here. Helfat *et al.* (2007: 66) define alliance management capability as a 'type of dynamic capability with the capacity to purposefully create, extend, or modify the firm's resource base, augmented to include the resources of its alliance partners' (see also Schilke and Goerzen, 2010). New product development capability is commonly defined as organizational routines that purposefully reconfigure the organizational product portfolio (Danneels, 2008; Lawson and Samson, 2001; Subramaniam and Venkatraman, 2001). Third, alliance management capability and new product development capability are among the most frequently mentioned types of dynamic capabilities in the extant literature (e.g., Eisenhardt and Martin, 2000; Helfat *et al.*, 2007; Helfat and Winter, 2011; Teece and Pisano, 1994). Fourth, in the explorative fieldwork, alliance management and new product development were the most frequently named types of routine activities for adapting organizations to changes in the environment (see the Method section). Taken together, these two capabilities are particularly representative for the dynamic capabilities concept, which makes them ideal candidates for this study.

In what follows, I develop two hypotheses for the contingent effects of alliance management capability and new product development capability with strong reference to the theoretical argument developed in the preceding section. In line with my more general reasoning, I expect the relationship between these two capabilities and competitive advantage to be the strongest when environmental dynamism is at intermediate levels and comparatively weaker when dynamism is low or high, as elaborated in greater detail below.

Alliance management capability and competitive advantage

The extant empirical literature finds that alliance management capability tends to be positively related to performance (see Sluyts *et al.*, 2011 for a recent review). Organizations with a strong alliance management capability possess routines that support various alliance-related tasks, such as partner identification and interorganizational learning, that facilitate an effective execution of

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interfirm relationships (Schilke and Goerzen, 2010; Schreiner, Kale, and Corsten, 2009).

However, building and maintaining an alliance management capability usually requires substantial investments in, for example, a dedicated alliance function that oversees and supports alliance operations (Heimeriks and Duysters, 2007; Helfat *et al.*, 2007; Kale, Dyer, and Singh, 2002). Such a separate, specialized organizational unit captures and codifies alliance-related knowledge from ongoing alliance relationships and disseminates it throughout the firm. Other relevant investments may include setting up alliance-specific intranet databases or holding regular alliance management workshops (Heimeriks, 2010).

While supporting the institutionalization of alliance management capability, such investments are typically associated with nontrivial costs. Consistent with my general theoretical argument regarding the amortization of dynamic capabilities, I suggest that such costs may not be fully justified when the firm has no need to employ alliance management routines on a frequent basis—that it, when it only rarely engages in strategic alliances. One contextual factor that significantly affects the extent of alliance opportunities is environmental dynamism. Analyzing alliance use of manufacturing firms, Dickson and Weaver (1997) find the dynamism of the environment to be a key driver. Similarly, Rosenkopf and Schilling (2007) report that industries low in dynamism (such as clothing and construction supplies) also scored in the lowest tertile for both alliance participation rates and number of alliances per firm. Thus, the extent to which firms engage in alliances depends (*ceteris paribus*) on the degree of environmental dynamism, with low dynamism providing relatively little need to make sufficient use of alliance management routines so that the costs from alliance management capability would be far outweighed by its gains. Beyond considerations related to direct costs, another source of concern when investing in alliance management capability in relatively stable contexts with few needs for alliances is managers' tendency to feel a necessity to legitimize those investments by promoting, and at times imposing, the use of alliances and related management practices beyond a functional level (Heimeriks, 2010). Based on this reasoning, I suggest that the positive effect of alliance management capability in creating competitive advantage is comparatively small when environmental dynamism is low.

Further, consistent with my earlier general argument regarding the effectiveness of dynamic capabilities in highly dynamic environments, I also submit that very high levels of dynamism may reduce the value-creation potential of alliance management capability. This is because alliance management capability rests on routinized practices that leverage lessons learned from prior alliances (Anand and Khanna, 2000; Heimeriks, 2010). In highly dynamic environments, however, the nature of alliances may drastically differ from one relationship to the next. Terjesen, Patel, and Covin (2011), for example, report significant positive associations between environmental dynamism and alliance partner diversity as well as alliance geographic diversity. Given the high degree of novelty that firms operating in highly dynamic environments are likely to face in their alliances, matching appropriate routines to these novel settings will prove challenging (matching problem). Additionally, highly dynamic environments may cause an inertia problem in that alliance management capability may limit a firm's tendency to experiment with alternative behavior. Continued reliance on established information transfer processes, for example, can prevent acquiring new types of knowledge that may prove critical under drastically altered environmental conditions (Hoang and Rothaermel, 2005; Sampson, 2005). Also, firms with strong alliance management capability tend to follow established partner selection protocols (Heimeriks, 2010) and tend to engage in social bonding with their partners (Schreiner *et al.*, 2009), both of which favor repeated ties with the same portfolio of alliance partners. Restricted partner selection, however, may prove particularly detrimental when operating in highly dynamic environments where frequently switching alliance partners is often required in order to gain access to the currently most relevant resources (Kandemir, Yaprak, and Cavusgil, 2006).

At intermediate levels of dynamism, finally, I expect a balance to exist between firms' ability to leverage their alliance management investments and to effectively exploit their experience-based alliance management routines. In these settings, alliances are frequent enough to justify the costs of developing alliance management capability, and environmental states are similar enough to pursue alliance management in a routinized fashion that strongly builds on past experiences and to make effective use of similar types of alliances.

Hypothesis 1: The relationship between alliance management capability and competitive advantage is strongest under intermediate levels of environmental dynamism but comparatively weaker when dynamism is low or high.

New product development capability and competitive advantage

A new product development capability is reflected in organizational routines that structure innovation processes aimed at reconfiguring the firm's product portfolio (Danneels, 2008; Lawson and Samson, 2001; Subramaniam and Venkatraman, 2001). It is commonly assumed that such routines lead to new product innovations that in turn result in competitive advantage (Lawson and Samson, 2001). However, there is reason to believe that the strength of this positive effect varies across levels of environmental dynamism.

Similar to my discussion of alliance management capability, it is important to note that a new product development capability usually entails durable commitment of funds—e.g., to support skilled personnel, specialized facilities, and state-of-the-art equipment (Helfat *et al.*, 2007). For example, Clark and Fujimoto (1990) find that investing in specialized coordination committees promotes routinized product development. Given the costs of such investments in developing new product development capability, firms need to deploy this capability repeatedly in order to generate revenues from new or improved products for these expenses to pay off (Helfat and Winter, 2011). Whereas new product launches and product overhauls are critical to firms' competitive advantage when contextual conditions change relatively frequently (Song *et al.*, 2005), stable environments often allow firms to sell existing products profitably without much alteration (Hambrick, 1983), making a new product development capability relatively less central to competitive advantage.

In highly dynamic environments, on the other hand, product lifecycles tend to be comparatively short and technological paradigm shifts relatively frequent. Although they provide ample product development opportunities, I propose that environments characterized by high dynamism pose considerable matching and inertia problems that may decrease the relative effectiveness of an experience-based new product development capability. As Brown and Eisenhardt's (1997) study illustrates, highly structured new product development processes are able to rapidly and flawlessly capture opportunities that build on prior product features, but these routines are often unable to accommodate opportunities that are different in kind, suggesting a possible matching problem between unfamiliar environmental opportunities and appropriate new product development activities. Additionally, relying on experience-based new product development can result in inertia, which can prove particularly problematic when environmental change is frequent and discontinuous. Firms with a strong established new product development capability tend to develop a preference for pursuing incremental product improvements along existing trajectories rather than exploring radically different innovations (Levinthal and Myatt, 1994; Sørensen and Stuart, 2000). The empirical study by Leonard-Barton (1992) corroborates this view, showing that it was precisely new product development routines that brought about dysfunctional restrictions in exploring the scope of alternatives. Further illustrative evidence comes from Helfat *et al.*'s (2007: 49ff.) Rubbermaid case study. Long known as a best-in-class 'new product machine' with highly professionalized innovation routines that allowed for continuously and quickly bringing a large number of products to the market, the firm began to struggle when the environment was beginning to change drastically in the early 1990s. During that time, customers became significantly more price conscious and large retailers such as Wal-Mart gained substantial power. These were fundamental changes that Rubbermaid too long seemed to ignore while continuing to reinforce previous recipes for new product innovation success that no longer were appropriate, which ultimately resulted in a deterioration of the firm's competitive advantage.

Overall, I expect new product development capability to be most valuable in moderately dynamic contexts, where product innovation opportunities occur in a relatively frequent but rather incremental fashion. Extant qualitative comparative studies support the notion that environments with moderate dynamism provide an ideal context for new product development capability to unleash its greatest potential. In the moderately dynamic

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mainframe sector, for example, Eisenhardt and Tabrizi (1995) find the capability's underlying routines to substantially enhance predictability and effectiveness by coordinating the entire new product development process from initial specification through manufacturing ramp-up whereas such routines were less beneficial in the more dynamic personal computing industry. In summary, when environmental dynamism is at an intermediate level, there is a potential for repeated new product launches that make investments in capability development worthwhile and firms also have the capacity to utilize effectively experience-based new product development routines to create new, successful products that build on existing solutions.

Hypothesis 2: The relationship between new product development capability and competitive advantage is strongest under intermediate levels of environmental dynamism but comparatively weaker when dynamism is low or high.

DATA

The empirical research comprised three sequential stages. I first conducted qualitative field interviews to learn about types of capabilities relevant to organizational resource reconfiguration, their potential implications for competitive advantage, as well as the intelligibility of a preliminary survey questionnaire. I next developed and conducted a large-scale survey. Three years later, I collected measures for the dependent variable from the same firms that had participated in the previous survey.

Qualitative field interviews

The fieldwork included 13 interviews with top-level managers from various industries. Each interview lasted between 45 and 90 minutes and consisted of three parts. In the first part, managers were asked to elaborate on relevant types of routine activities for adapting their organization to changes in the environment. New product development and alliancing turned out to be among the most frequent responses.[1] In the second part, I scrutinized the study's hypotheses by asking managers how critical these activities are for competitive advantage—both in general and, more specifically, when comparing environments characterized by little, moderate, and substantial changes. There was considerable agreement that organizational change routines can support firms' competitive advantage. Managers disagreed, however, with regard to the relative performance implications under varying degrees of environmental dynamism. Mirroring the different perspectives in the academic literature (see the literature review), some managers maintained that those routines would be valuable in virtually any context. Others suggested that the strongest effect on competitive advantage should be observed in highly dynamic environments, whereas a few managers indicated that routine activities might prove comparatively less useful in highly turbulent environments. In the third and final part of the interviews, managers were asked to fill out a preliminary version of the questionnaire to be used in the subsequent survey study while providing feedback on the clarity of items as well as difficulties in responding to them. As a result of this process, several questionnaire items were reworded or eliminated. Another important insight came from a comment by two managers that, for diversified firms, all questionnaire items should pertain to the business unit rather than the corporate level, as practices may differ substantially between business units, and managers can also provide more reliable information about the particular business unit they are most strongly involved in.

Sample and data for the survey study

The two focal predictor variables in the hypotheses-testing survey study were alliance management capability and new product development capability. In conceptualizing alliance management capability, I followed prior alliance research (e.g., Eisenhardt and Schoonhoven, 1996) and focused on alliances in research and development (R&D), given the diversity of different forms of alliances and their idiosyncratic goals, policies, and structures. R&D alliances (as opposed to production or marketing alliances, for example) have been argued to be more clearly directed toward reconfiguring organizational resources (Eisenhardt and Schoonhoven, 1996),

[1] Other routine activities that were mentioned pertained to information technology, marketing, and mergers.

making them ideal for the purpose of studying an instance of dynamic capability.

The study population comprised firms in the chemicals, machinery, and motor vehicle industries: (1) because alliances are frequent in these sectors (Hagedoorn, 1993); (2) because new product development activities play a key role in these industries (Centre for European Economic Research, 2004); and (3) in order to capture a wide variance in the moderating variable environmental dynamism. I obtained contact data for 2,226 firms through Hoppenstedt Firmendatenbank, a large commercial database containing a comprehensive listing of firms located in Germany. Consistent with the relationship criterion approach commonly adopted in alliance research (Koka and Prescott, 2002), I only included firms in this study that were involved in at least one R&D alliance. For this purpose, I employed a professional call center that contacted each of the 2,226 initial firms by telephone and determined whether they currently participated in R&D alliances.[2] This led me to exclude 840 firms that were not engaged in R&D alliances, resulting in a target population of 1,386 firms who were asked for their participation in this study.

I received 302 usable responses, reflecting a response rate of 21.8 percent, which is consistent with comparable studies using key informant methodology (e.g., Capron and Mitchell, 2009). These 302 informants provided information on all constructs except for the dependent variable (competitive advantage), which I measured with a three-year time lag through a separate survey. My objectives were to establish temporal order of the independent variables (preceding in time) to the dependent variables to enhance causal inference (Biddle, Slavings, and Anderson, 1985) as well as to allow time for the performance effects of dynamic capabilities to materialize (Zahra *et al.*, 2006: 947) and also to reduce the threat of a potential common method bias that could have been present had I collected both independent and dependent variables simultaneously (Podsakoff and Organ, 1986). I chose a time lag of three years based on: (1) Rindfleisch *et al.*'s (2008) assessment that three years is an appropriate compromise between enhancing causal inference by implementing temporal order in the empirical design while not passing the outcome's end date; (2) Kor and Mahoney's (2005: 495) finding in the medical instruments industry that 'R&D investments convert into revenue-generating products typically within a period of three years'; and (3) prior usage of a three-year lag in longitudinal survey studies on strategic alliances (Rindfleisch and Moorman, 2001, 2003). Of the 302 firms that responded to the first survey in 2006, nine had ceased to exist because they were acquired or dissolved. In the remaining 293 firms, I contacted the same key informant who had participated three years earlier. After several reminders, I received 204 responses from these informants. In order to further increase the number of responses, I tried to contact an alternative top manager if the original informant was no longer available or remained unresponsive. This allowed me to gather information on competitive advantage from an additional 75 firms; thus, the study's final sample consists of 279 matched questionnaires across times 1 and 2. While this sample size may not be considered very large, it is much in line with sample sizes in other strategy studies (Phelan, Ferreira, and Salvador, 2002) and exceeds common recommendations for advanced statistical analyses (e.g., MacCallum *et al.*, 1999).

Characteristics of the firms and informants in the sample are provided in Table 1. To verify the appropriateness of the key informants, questionnaire items asked about their tenure and expertise (Kumar, Stern, and Anderson, 1993). Overall, 73.5 percent of the participants in the final dataset had been with their current firm for six years or longer (see Table 1). In addition, I assessed respondents' self-reported knowledge of the firm's R&D alliances and innovation-related activities on five-point answer scales ranging from 1 ('poor') to 5 ('excellent'). The means of 4.07 ($SD = 0.84$) and 4.12 ($SD = 0.72$), respectively, suggested that the informants were very well informed.

I checked for nonresponse bias in three ways. First, I assessed a nonresponse bias by comparing early and late respondents (Armstrong and Overton, 1977). The results of the t-tests indicated no significant differences ($p > 0.05$) across means for each of the theoretical constructs between early and late respondents. Second, I examined whether the nonresponding firms differed from the

[2] The call center employees were trained extensively and provided with a detailed interview guide. They were instructed to contact top-level managers, preferably heads of R&D or members of the executive board. Names of adequate contact persons were partly extracted from Hoppenstedt or other public sources and partly asked at the telephone switchboard.

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Table 1. Sample composition

	Sample in t = 1 (n = 302) (%)	Sample in t = 2 (n = 279) (%)
Industry		
Machinery	55.2	54.1
Chemicals	21.0	22.6
Motor vehicles	23.8	23.3
Firm size		
<100 employees	4.3	3.2
100–249 employees	34.8	35.5
250–499 employees	23.8	24.4
500–999 employees	16.2	15.4
1,000–4,999 employees	12.3	12.5
≥5,000 employees	8.6	9.0
Firm age (years)		
<5	2.6	2.9
5–9	4.0	3.9
10–19	12.9	11.1
20–29	8.9	9.7
30–49	16.9	18.3
≥50	54.6	54.1
Position of respondent		
Head of R&D	62.8	63.8
R&D project leader	17.0	15.4
Member of executive board	8.7	8.2
Other (e.g., head of construction, CTO)	11.6	12.5
Tenure of respondent in firm (years)		
≤1	4.6	3.3
2–5	21.8	16.3
6–10	24.9	29.3
11–15	15.3	16.3
≥16	33.3	35.0

responding firms in terms of size and industry segment using information from Hoppenstedt Firmendatenbank. I found no significant differences in either variable ($p > 0.05$). Third, I contacted a random sample of nonrespondents and asked them to answer one item for each theoretical construct (Mentzer, Flint, and Hult, 2001). Based on information from 30 nonrespondents, the t-tests of group means revealed no significant differences between respondents and nonrespondents on any of the questions ($p > 0.05$). These findings provide consistent evidence that nonresponse bias is not a problem. Kruskal Wallis H tests also showed no significant differences in responses of the four informant groups (i.e., heads of R&D, project leaders in R&D, members of the executive board, miscellaneous).

Measures

I used multi-item scales to measure the independent, dependent, and moderating variables. Consistent with the qualitative interviews, if the respondent worked for a diversified firm, he/she was asked to answer all questions with reference to the business unit for which he/she worked.[3] Table 2 lists the measurement items used to operationalize the constructs. When adequate measures were available, I adapted them from prior studies. Following the recommendations of DeVellis (2003), the questionnaire items were further refined through in-depth interviews with 13 managers (described above), an item sorting pretest based on Anderson and Gerbing (1991) administered to 15 scholars, and a pretest of the questionnaire conducted with 21 managers. When possible, survey information obtained from the key informant in the main study was triangulated with complementary data sources to establish its accuracy (Homburg *et al.*, 2012), as described below.

Competitive advantage

A firm is said to have a competitive advantage when it enjoys greater success than current or potential competitors in its industry, suggesting that superior firm performance serves as a key indicator of competitive advantage (Barnett, Greve, and Park, 1994; Ghemawat and Rivkin, 1999). Specifically, I operationalized competitive advantage as a two dimensional construct, with the first-order dimensions of (1) strategic performance (qualitative dimension) and (2) financial performance (quantitative dimension), both of which were measured in comparison to competition. Items for the two performance dimensions were adapted from Jap (1999) and Weerawardena (2003).

To corroborate the performance information obtained from key informants, I collected accounting performance data for a subset of 48 companies for which such information was available. Using a public financial database and company reports available on the firms' websites, I obtained information on return on investment (ROI) and return

[3] While the fact that the sample consists of both firms and business units may be viewed as a limitation, I control for this issue in the empirical analysis as described further below. Reported results are also robust to dropping business units.

Table 2. Measurement scales

					Mean/SD
Competitive advantage					4.80/0.95
('Strongly disagree' [1] to 'strongly agree' [7])					
Strategic performance		$\alpha = 0.73$	CR = 0.75	AVE = 0.50	
1a	We have gained strategic advantages over our competitors.				5.29/1.10
1b	We have a large market share.				5.13/1.39
1c	Overall, we are more successful than our major competitors.				4.98/1.20
Financial performance		$\alpha = 0.93$	CR = 0.93	AVE = 0.81	
2a	Our EBIT (earnings before interest and taxes) is continuously above industry average.				4.49/1.37
2b	Our ROI (return on investment) is continuously above industry average.				4.42/1.27
2c	Our ROS (return on sales) is continuously above industry average.				4.47/1.31
Alliance management capability					4.61/1.06
('Strongly disagree' [1] to 'strongly agree' [7])					
Interorganizational coordination		$\alpha = 0.85$	CR = 0.85	AVE = 0.59	
3a	Our activities with R&D alliance partners are well coordinated.				5.18/1.67
3b	We ensure that our work tasks fit with those of our R&D alliance partners very well.				4.84/1.70
3c	We ensure that our work is synchronized with the work of our R&D alliance partners.				4.59/1.67
3d	There is a great deal of interaction with our R&D alliance partners on most decisions.				4.96/1.53
Alliance portfolio coordination		$\alpha = 0.91$	CR = 0.91	AVE = 0.73	
4a	We ensure an appropriate coordination among the activities of our different R&D alliances.				4.25/1.72
4b	We determine areas of synergy in our R&D alliance portfolio.				4.32/1.74
4c	We ensure that interdependencies between our R&D alliances are identified.				4.02/1.67
4d	We determine if there are overlaps between our different R&D alliances.				4.59/1.73
Interorganizational learning		$\alpha = 0.88$	CR = 0.88	AVE = 0.64	
5a	We have the capability to learn from our R&D alliance partners.				5.20/1.37
5b	We have the managerial competence to absorb new knowledge from our R&D alliance partners.				4.71/1.47
5c	We have adequate routines to analyze the information obtained from our R&D alliance partners.				4.93/1.49
5d	We can successfully integrate our existing knowledge with new information acquired from our R&D alliance partners.				4.86/1.48
Alliance proactiveness		$\alpha = 0.88$	CR = 0.88	AVE = 0.65	
6a	We strive to preempt our competition by entering into R&D alliance opportunities.				4.46/1.74
6b	We often take the initiative in approaching firms with R&D alliance proposals.				4.20/1.71
6c	Compared to our competitors, we are far more proactive and responsive in finding and 'going after' R&D partnerships.				3.89/1.61
6d	We actively monitor our environment to identify R&D partnership opportunities.				4.57/1.50

Table 2. *(Continued)*

					Mean/SD
Alliance transformation		$\alpha = 0.83$	CR = 0.83	AVE = 0.62	
7a	We are willing to put aside contractual terms to improve the outcome of our R&D alliances.				4.18/1.60
7b	When an unexpected situation arises, we would rather modify an R&D alliance agreement than insist on the original terms.				4.90/1.46
7c	Flexibility, in response to a request for change, is characteristic of our R&D alliance management process.				4.89/1.43
New product development capability		$\alpha = 0.81$	CR = 0.83	AVE = 0.55	
Objectives for undertaking innovation projects in the last three years:					
('Not important' [1] to 'very important' [7])					
8a	Introduce new generation of products				5.77/1.34
8b	Extend product range				5.42/1.42
8c	Open up new markets.				6.02/1.04
8d	Enter new technology fields				4.68/1.58
Environmental dynamism		$\alpha = 0.81$	CR = 0.81	AVE = 0.47	
('Strongly disagree' [1] to 'strongly agree' [7])					
9a	The modes of production/service change often and in a major way.				2.73/1.18
9b	The environmental demands on us are constantly changing.				3.80/1.47
9c	Marketing practices in our industry are constantly changing.				3.18/1.27
9d	Environmental changes in our industry are unpredictable.				3.51/1.40
9e	In our environment, new business models evolve frequently.				2.85/1.29
Alliance portfolio size					
10a	How many alliances is your firm/business unit involved in at present?				7.08/18.68
Product scope					
Strategic objectives:					
('Not important' [1] to 'very important' [7])					
11a	Breadth of product offering (pursuing a narrow, focused product scope)				4.67/1.45
Market scope					
Strategic objectives:					
('Not important' [1] to 'very important' [7])					
12a	Breadth of targeted market segments (pursuing a narrow, focused market scope)				3.85/1.52
Process innovation					
('Strongly disagree' [1] to 'strongly agree' [7])					
13a	We have frequently improved manufacturing or operational processes.				5.04/1.45
Firm unit of analysis					
('No' [0], 'yes' [1])					
14a	Please indicate whether your responses pertain to a non-diversified firm (as opposed to a business unit in a diversified firm with several business units).				0.89/0.32

on sales (ROS) for each of the three years preceding the second survey. I then computed the average ROI and ROS for those years and standardized the measures by industry. Subsequently, I correlated this archival data with perceptual responses averaged across the six competitive advantage items. Both measures were significantly correlated (ROI: $r = 0.44$, $p \leq 0.001$; ROS: $r = 0.48$, $p \leq 0.001$). Although these correlations were relatively lower compared to what Robson, Katsikeas, and Bello (2008) obtained using a similar approach, they compare favorably to several other studies reporting correlations between subjective and archival performance data (e.g., Boyer, 1999; Douglas and Judge, 2001; Krishnan, Martin, and Noorderhaven, 2006).

To provide further evidence for sufficient accuracy, I gathered performance information from a second key informant in a total of 36 firms and calculated ICC(1) to determine the level of interrater reliability. I obtained an ICC(1) of 0.24, which clearly exceeded Bliese's (1998) 0.1 cutoff. Finally, I relied on information on organizational growth, which population ecologists often use as a proxy for competitive advantage (Baum, 1996), to triangulate the dependent variable. For the firms for which such information was available, I computed three-year percentage changes in sales revenues ($n = 48$), number of employees ($n = 279$), and accounting value of assets ($n = 48$) (Helfat *et al.*, 2007) and then correlated these three measures with the average of the items of the competitive advantage construct. I found significant associations for growth in sales revenues ($r = 0.32$, $p \leq 0.01$), number of employees ($r = 0.28$, $p \leq 0.001$), and accounting value of assets ($r = 0.39$, $p \leq 0.001$), which lends further credibility to the perceptual competitive advantage measure.

Alliance management capability

I used the measure developed by Schilke and Goerzen (2010), which suggests a five-dimensional, second-order structure of the construct, with the underlying dimensions of (1) interorganizational coordination; (2) alliance portfolio coordination; (3) interorganizational learning; (4) alliance proactiveness; and (5) alliance transformation. Interorganizational coordination pertains to the governance of individual alliances, whereas alliance portfolio management involves the integration of the firm's various strategic alliances. Interorganizational learning reflects routines designed to facilitate knowledge transfers across organizational boundaries. Alliance proactiveness can be defined as routine efforts to identify potentially valuable partnering opportunities. Finally, alliance transformation concerns routines to modify alliances over the course of the alliance process.

I corroborated the subjective alliance management capability measure by correlating it with the firm's prior alliance experience, a widely used proxy for alliance management capability (Anand and Khanna, 2000; Hoang and Rothaermel, 2005). To measure alliance experience, I asked respondents to indicate the number of prior agreements with R&D alliance partners within the last five years and used a logarithmic transformation to correct skewness. This variable was then correlated with the composite score of the alliance management capability construct, computed as the simple average of its dimensions' items. Both measures were significantly correlated ($r = 0.27$; $p \leq 0.001$), which supported the validity of the perceptual measure.

New product development capability

To capture the firm's new product development capability, I relied on the measurement items introduced by He and Wong (2004). These items gauge the extent to which a firm routinely carries out innovation projects aimed at entering new product domains. I triangulated this measure with archival information on R&D intensity (R&D expenditures divided by revenues), which has often been used as a proxy for innovation-related dynamic capabilities in archival research (Helfat, 1994a, 1994b, 1997). For the 48 firms for which relevant secondary data were available, I found a strong positive association with the average of the survey items ($r = 0.30$; $p \leq 0.001$).

Environmental dynamism

Environmental dynamism refers to the volatility and unpredictability of the firm's external environment (Miller and Friesen, 1983). To capture dynamism, I used items developed by Miller and Friesen (1982) and Jap (1999). For the purpose of validating managers' perceptions of environmental dynamism, I applied two archival indexes

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measuring instability in sales and net assets (Sutcliffe, 1994). To compute these indexes, I regressed sales and net assets for a period of three years prior to the survey on a variable representing the time period and divided the standard errors of the regression by the mean level of the dependent variable (Dess and Beard, 1984). Correlations of these indexes with the subjective measure of dynamism were 0.36 ($n = 48$) and 0.38 ($n = 48$), respectively; both were significant at $p \leq 0.001$. These positive and highly significant correlations exceeded those obtained by Sharfman and Dean (1991) in a similar analysis and supported the validity of the perceptual measure of environmental dynamism. Furthermore, complementary perceptual information from 36 secondary key informants was used to determine interrater reliability. I obtained an ICC(1) of 0.20, which clearly exceeds the common 0.1 threshold.

Control variables

Consistent with Li, Poppo, and Zhou (2008), I considered industry effects, firm size, and firm age as controls. In addition, I controlled for the firm's alliance portfolio size, product scope, market scope, and process innovation, responses pertaining to either a firm or a business unit, and the use of either the same or a different respondent during the second data collection wave, as elaborated below.

1. *Industry effects*. The importance of the industry in which a firm competes as a predictor of firm-level variables is widely recognized in the literature (Dess, Ireland, and Hitt, 1990). To control for industry effects, I used dummy variables, specifying the chemicals industry as the base to which the effects of the other dummies (machinery and motor vehicles) were compared.
2. *Firm age*. Firm age has been suggested to influence a firm's competitive advantage (Zahra, Ireland, and Hitt, 2000) as well as the extent of patterned forms of behavior that underpin dynamic capabilities (Helfat and Peteraf, 2003). I measured firm age in terms of the number of years since the establishment of the firm, classifying the number of years into six categories (ranging from 1 for firms that are younger than 5 years to 6 for firms that are 50 years or older) (Capron and Mitchell, 2009).
3. *Firm size*. Firm size can enhance competitive advantage by, for example, facilitating access to a lower cost of capital while simultaneously lowering risk (Chang and Thomas, 1989). Firm size may also influence the firm's dynamic capabilities, with larger firms being able to dedicate more resources to developing their change routines. Size was assessed based on a firm's total number of full-time employees (ranging from 1 for firms that have fewer than 100 employees to 6 for firms that have 5,000 or more employees).
4. *Alliance portfolio size*. Previous research has associated a firm's number of alliances with performance outcomes (Powell, Koput, and Smith-Doerr, 1996) and with innovation intensity (Hagedoorn and Schakenraad, 1994). Additionally, firms with a large alliance portfolio can be expected to have strongly institutionalized alliance management routines. I measured alliance portfolio size by the firm's total number of current alliances (Jiang, Tao, and Santoro, 2010) and logarithmized this measure to reduce skewness.
5. *Product and market scope*. In line with Zott and Amit (2008), I controlled for the breadth of the firm's product offering and targeted market, as these are key dimensions of a firm's strategy that may affect its competitive advantage and capability development. I adapted the questionnaire items for these two variables from Zott and Amit (2008).
6. *Process innovation*. Process innovation refers to the introduction of new elements into an organization's operations. I measured process innovation with the item 'We have frequently improved manufacturing or operational processes,' which has previously been used by Su, Tsang, and Peng (2009).
7. *Firm unit of analysis*. Because the sample comprises one set of observations for firms and another set of observations for business units within firms (as mentioned above), I followed the approach by Mithas, Ramasubbu, and Sambamurthy (2011) and used a dummy ($1 =$ firms and $0 =$ business units) to account for this difference.
8. *Same respondent*. I used a dummy variable to control for the fact that in a subset of firms, the informant used in $t = 2$ differed from the informant used in $t = 1$. The dummy was coded

as 1 when the identical respondent was used in both waves of data collection.

Measurement properties of constructs

Table 2 reports coefficient alphas (α), composite reliabilities (CR), and average variances extracted (AVE) for the study's first-order, multi-item constructs. The values obtained indicate reliable and valid measures of the individual constructs. After assessing the constructs individually, I performed a confirmatory factor analysis among all first-order factors, using the structural equation modeling software AMOS 16.0 (Arbuckle, 2007) and the maximum likelihood (ML) procedure (Hair *et al.*, 2006). The measures of goodness of fit had satisfactory values ($\chi^2 = 1{,}013.80$; $df = 741$; $\chi^2/df = 1.37$; $CFI = 0.95$; $GFI = 0.87$; $TLI = 0.94$; $RMSEA = 0.04$). Following Fornell and Larcker (1981), I assessed the discriminant validity of the factors in the model and found that the square root of the average variance extracted by the measure of each factor is larger than the absolute value of the correlation of that factor's measure with all measures of other factors in the model, as reported in Table 3.

Common method bias

Although using key informants is common in research on organizational capabilities in order to obtain required data on intrafirm processes (e.g., Capron and Mitchell, 2009; Danneels, 2008; Gruber *et al.*, 2010; Kemper, Schilke, and Brettel, forthcoming), common method bias might pose a problem in such studies (Podsakoff and Organ, 1986). To safeguard against this possibility, I undertook several steps. First, and most importantly, measures of the dependent variable were collected in a separate survey (Podsakoff and Organ, 1986). Second, I performed Harman's one-factor test by loading all indicators of the study constructs into an exploratory factor analysis. Results revealed that no single factor explained more than 30 percent of the total variance in the variables, suggesting that common method bias was unlikely to be a serious problem in this study. Additionally, I also applied Harman's one-factor test using confirmatory factor analyses (McFarlin and Sweeney, 1992), which compared a single-factor model with the proposed 19-factor model. Results showed that the single-factor model had a significantly worse fit ($\chi^2_{diff} = 1{,}232.33$; $df_{diff} = 170$; $p \leq 0.01$). These findings, along with those reported earlier regarding the significant associations between subjective and archival measures, indicated that common method bias was not a serious concern in this study.

METHOD AND RESULTS

To test the hypotheses, I analyzed nonlinear interactions using OLS regression based on the procedure outlined by Jaccard (2003). This involved averaging the items for each construct (in case of a multi-dimensional construct, averaging the items for all of the construct's dimensions), mean-centering interacting variables, calculating the square of the moderating variable (environmental dynamism), constructing linear as well as squared product terms, and finally estimating the following regression equation:

$$
\begin{aligned}
\text{Competitive advantage} &= \text{a} + \text{b}_1 \text{ machinery} \\
&+ \text{b}_2 \text{ motor vehicles} + \text{b}_3 \text{ firm age} \\
&+ \text{b}_4 \text{ firm size} + \text{b}_5 \text{ alliance portfolio size} \\
&+ \text{b}_6 \text{ product scope} + \text{b}_7 \text{ market scope} \\
&+ \text{b}_8 \text{ process innovation} \\
&+ \text{b}_9 \text{ firm unit of analysis} \\
&+ \text{b}_{10} \text{ same respondent} \\
&+ \text{b}_{11} \text{ alliance management capability} \\
&+ \text{b}_{12} \text{ new product development capability} \\
&+ \text{b}_{13} \text{ environmental dynamism} \\
&+ \text{b}_{14} \text{ environmental dynamism squared} \\
&+ \text{b}_{15} \text{ alliance management capability} \\
&\times \text{ environmental dynamism} \\
&+ \text{b}_{16} \text{ new product development capability} \\
&\times \text{ environmental dynamism} \\
&+ \text{b}_{17} \text{ alliance management capability} \\
&\times \text{ environmental dynamism squared} \\
&+ \text{b}_{18} \text{ new product development capability} \\
&\times \text{ environmental dynamism squared} + \text{e}
\end{aligned}
$$

A significant coefficient of the squared moderator product term (here: b_{17} and b_{18}) would indicate the

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Table 3. Descriptive statistics and discriminant validity

	Factor	Scale range	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
1	Strategic performance	1–7	5.13	0.99	0.71																		
2	Financial performance	1–7	4.46	1.23	0.56	0.90																	
3	Interorganizational coordination	1–7	4.89	1.37	0.33	0.16	0.77																
4	Alliance portfolio coordination	1–7	4.30	1.52	0.28	0.25	0.63	0.85															
5	Interorganizational learning	1–7	4.93	1.24	0.33	0.29	0.68	0.60	0.80														
6	Alliance proactiveness	1–7	4.28	1.41	0.44	0.33	0.61	0.54	0.67	0.81													
7	Alliance transformation	1–7	4.66	1.29	0.16	0.12	0.50	0.34	0.51	0.49	0.79												
8	New product development capability	1–7	5.47	1.09	0.56	0.30	0.39	0.29	0.43	0.49	0.25	0.74											
9	Environmental dynamism	1–7	3.21	1.00	−0.03	0.07	−0.02	0.03	−0.04	0.04	0.01	0.11	0.69										
10	Machinery	0/1	0.54	0.50	0.09	−0.06	−0.09	−0.06	−0.12	−0.10	−0.05	0.00	0.03	n/a									
11	Motor vehicles	0/1	0.23	0.42	−0.04	−0.05	0.12	0.03	0.08	0.03	0.03	−0.02	−0.07	−0.60	n/a								
12	Firm age	1–6	4.99	1.38	0.17	0.03	0.04	0.00	0.06	0.03	0.16	0.09	−0.08	0.01	−0.02	n/a							
13	Firm size	1–6	3.25	1.37	0.24	0.16	0.20	0.15	0.19	0.17	0.03	0.19	−0.08	−0.22	0.26	0.28	n/a						
14	Alliance portfolio size	0-∞	1.32	0.92	0.15	0.08	0.11	0.13	0.18	0.28	0.01	0.24	0.08	−0.06	−0.11	0.02	0.22	n/a					
15	Product scope	1–7	4.67	1.45	−0.01	−0.04	−0.01	−0.01	−0.04	0.00	0.15	−0.04	0.22	0.15	−0.05	−0.04	−0.16	−0.07	n/a				
16	Market scope	1–7	3.85	1.52	−0.05	−0.12	−0.03	−0.04	0.02	−0.05	−0.03	−0.01	0.10	0.04	0.03	−0.03	−0.21	−0.10	0.42	n/a			
17	Process innovation	1–7	5.04	1.45	0.17	0.09	0.26	0.13	0.18	0.27	0.17	0.47	0.16	0.12	−0.05	−0.09	0.00	0.12	−0.03	−0.02	n/a		
18	Firm unit of analysis	0/1	0.89	0.32	−0.03	−0.02	−0.09	−0.14	−0.09	0.00	−0.02	−0.05	0.02	0.05	−0.07	−0.04	−0.22	−0.09	0.00	−0.01	0.10	n/a	
19	Same respondent	0/1	0.73	0.44	−0.10	−0.13	0.00	−0.01	−0.03	0.00	−0.05	−0.08	−0.04	0.07	−0.05	−0.03	−0.11	0.07	0.03	0.03	0.01	0.01	n/a

n = 279; numbers on the diagonal show square roots of AVE, numbers below the diagonal show correlations; AVE not available for single-item constructs; correlations with absolute value >0.17 are significant at the 1% level and >0.12 at the 5% level.

presence of quadratic moderation, suggesting that the relationship between the independent variable and the outcome varies as a nonlinear function of the moderator. More specifically, a positive coefficient suggests a U-shaped pattern whereas a negative coefficient indicates an inverse U-shaped pattern, the latter of which would be in line with the hypotheses.

Table 4 summarizes the regression results. Model 1 includes controls only, and model 2 adds the direct effects of alliance management capability, new product development capability, and environmental dynamism. Model 3 additionally includes linear interaction terms. Model 4 is my main model and introduces squared interaction terms. Inspection of variance inflation factors (VIF) among the explanatory variables in all four models revealed the highest VIF to be 2.49. This suggests that no problematic multicollinearity is present (Kleinbaum, Kupper, and Muller, 1988). Regarding the main effects in model 4, the regression coefficient of 0.37 indicates a positive and highly significant ($p \leq 0.01$) relationship between alliance management capability and competitive advantage. The coefficient of new product development capability shows that firms with a stronger new product development capability have a significantly higher competitive advantage ($b = 0.39$; $p \leq 0.01$). As such, both dynamic capabilities have a positive relationship with competitive advantage. Among the control variables, firm size is significantly related to competitive advantage ($b = 0.12$; $p \leq 0.01$).

With regard to the hypotheses, the negative and highly significant coefficients of the two squared product terms suggest that the relationships between the two dynamic capabilities and competitive advantage vary across different levels of environmental dynamism in a quadratic manner. The nature of the interactions is illustrated in Figure 1. The graphs in this figure represent associations between alliance management capability and competitive advantage (Figure 1a) and new product development capability and competitive advantage (Figure 1b) across different levels of environmental dynamism. To create these graphs, the regression equation was examined at different levels of environmental dynamism, using the margins command implemented in STATA 11. The vertical axes of the graphs represent values of regression coefficients for alliance management capability and new product development capability, respectively; and the horizontal axes represent values of environmental dynamism between two standard deviations below and above the mean (i.e., between 1.21 and 5.21).

The proposed inverse U-shaped relationship between dynamic capability and competitive advantage across increasing levels of environmental dynamism is apparent in both graphs. As shown in Figure 1(a), for firms that experience a low or a high level of environmental dynamism, the coefficient for the regression of competitive advantage on alliance management capability is comparatively low and, at very low levels of environmental dynamism, nonsignificant. However, at intermediate levels of environmental dynamism, the association was strongly positive and significant. Figure 1(b) shows an analogous inverse U-shaped graph for the regression of competitive advantage on new product development capability. These illustrations, together with the significant quadratic interaction terms, provide empirical support for Hypotheses 1 and 2.

In comparing the two graphs, it becomes apparent that the range for which the respective regression coefficient is significant is located at slightly higher levels of environmental dynamism in the case of alliance management capability (between 2.3 and 4.9) as compared to new product development capability (between 2.1 and 4.4). This observation suggests that alliance management capability has a positive impact on competitive advantage at relatively higher levels of environmental dynamism when compared to new product development capability.

POST-HOC ANALYSES

Four supplemental analyses demonstrated the robustness of the results. First, I conducted the Hausman (1978) endogeneity test (e.g., Wooldridge, 2008), using two instruments that have previously been identified as correlates of dynamic capabilities: willingness to cannibalize and organizational slack (Danneels, 2008). The first instrument was measured with the item 'We support projects even if they could potentially take away sales from existing products' and the second instrument was captured by 'My firm has a reasonable amount of resources in reserve' (Danneels, 2008). Hausman's (1978) endogeneity test was not significant for either alliance management capability or new

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Table 4. Regression results

Variables	Coefficient	Model 1	Model 2	Model 3	Model 4
Intercept	a	3.94**	2.33**	4.84**	4.91**
		(0.44)	(0.46)	(0.42)	(0.39)
Controls					
Machinery	b_1	−0.05	0.01	0.00	0.05
		(0.14)	(0.13)	(0.13)	(0.12)
Motor vehicles	b_2	−0.24	−0.22	−0.23	−0.09
		(0.17)	(0.16)	(0.16)	(0.15)
Firm age	b_3	0.03	0.00	0.00	0.00
		(0.04)	(0.04)	(0.04)	(0.04)
Firm size	b_4	0.14**	0.10**	0.11**	0.12**
		(0.05)	(0.04)	(0.04)	(0.04)
Alliance portfolio size	b_5	0.05	−0.03	−0.06	−0.09
		(0.06)	(0.06)	(0.06)	(0.06)
Product scope	b_6	0.02	0.01	0.01	0.02
		(0.04)	(0.04)	(0.04)	(0.04)
Market scope	b_7	−0.03	−0.04	−0.04	−0.05
		(0.04)	(0.04)	(0.04)	(0.04)
Process innovation	b_8	0.09**	−0.05	−0.04	−0.04
		(0.04)	(0.04)	(0.04)	(0.04)
Firm unit of analysis	b_9	0.02	0.12	0.16	0.10
		(0.18)	(0.16)	(0.16)	(0.15)
Same respondent	b_{10}	−0.24*	−0.20†	−0.21†	−0.16
		(0.13)	(0.11)	(0.11)	(0.11)
Predictors					
Alliance management capability	b_{11}		0.22**	0.22**	0.37**
			(0.05)	(0.05)	(0.07)
New product development capability	b_{12}		0.27**	0.28**	0.39**
			(0.06)	(0.06)	(0.07)
Environmental dynamism	b_{13}		0.03	0.01	0.05
			(0.05)	(0.05)	(0.05)
Environmental dynamism squared	b_{14}				0.00
					(0.04)
Alliance management capability × environmental dynamism	b_{15}			0.08	0.18**
				(0.05)	(0.06)
New product development capability × environmental dynamism	b_{16}			0.11†	0.04
				(0.06)	(0.05)
Alliance management capability × environmental dynamism squared	b_{17}				−0.16**
					(0.04)
New product development capability × environmental dynamism squared	b_{18}				−0.17**
					(0.05)
R-squared		0.10	0.26	0.28	0.37
Adjusted R-squared		0.06	0.22	0.24	0.33

n = 279; unstandardized coefficients and standard errors (in parentheses) are reported.
† $p \leq 0.10$; * $p \leq 0.05$; ** $p \leq 0.01$.

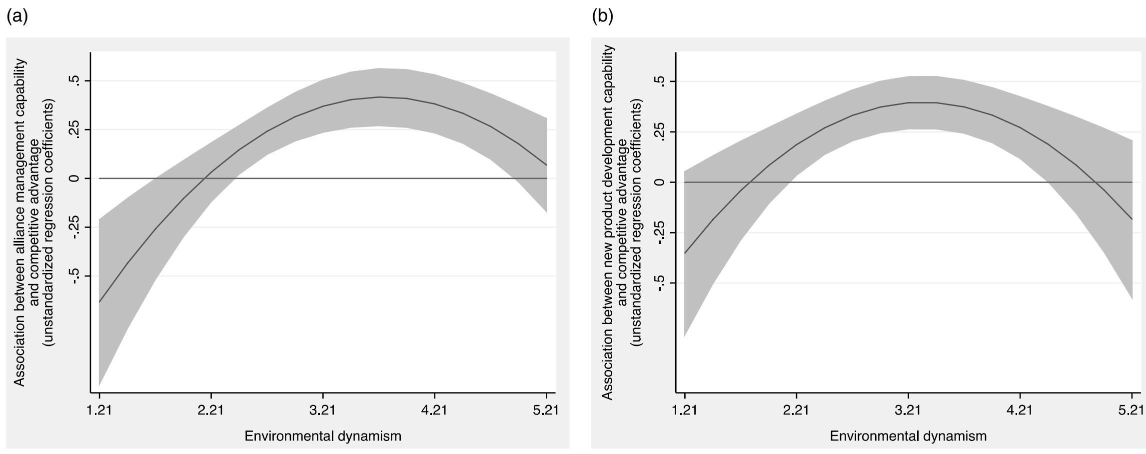

Figure 1. The relationship between dynamic capabilities and competitive advantage as a function of environmental dynamism (with 95% confidence interval). (a) Alliance management capability. (b) New product development capability

product development capability ($p > 0.1$), which attenuated concerns of endogeneity in the empirical analysis. Second, I reestimated the regression model using strategic and financial performance (instead of the competitive advantage construct) as dependent variables. Results did not change qualitatively from the original model specification. The effects of alliance management capability and new product development capability remained positive and statistically significant at $p \leq 0.01$, and the effects of the squared interaction terms remained negative and statistically significant at $p \leq 0.01$ in both alternative models. Third, as an alternative approach for examining nonlinear moderation, I estimated a spline (instead of a polynomial) specification, in which I broke environmental dynamism into linear splines knotted at the median and interacted these splines with alliance management capability and new product development capability. The interactions were positive up to the median and then became negative, in line with Hypotheses 1 and 2 (full results for this specification are available upon request). Fourth, I also used multi-group structural equation modeling to test for moderation (Byrne, 2001; Hair *et al.*, 2006). Please see the Appendix S1 for details. The results of the multi-group analyses lent further support to the hypotheses.

DISCUSSION

This paper presented two hypotheses suggesting that the effects of both alliance management capability and new product development capability on a firm's competitive advantage vary as a nonlinear function of environmental dynamism. More specifically, building on dynamic capabilities theory as well as alliance and new product development literature, I proposed that these two capabilities would have the strongest positive impact on competitive advantage under intermediate levels of environmental dynamism, whereas their impact would be comparatively weaker in stable and highly dynamic contexts. I tested these hypotheses empirically and found strong support for my position. The analyses indicated that the effects of the two capabilities on competitive advantage are highest when environmental dynamism is moderate and comparatively lower when environmental dynamism is low or high.

Two somewhat contradictory positions exist on the value of dynamic capabilities under different levels of environmental dynamism. One suggests that their effect on competitive advantage is comparatively smaller at low levels of dynamism (Drnevich and Kriauciunas, 2011; Helfat *et al.*, 2007; Winter, 2003; Zahra *et al.*, 2006; Zollo and Winter, 2002), while the other raises doubts about their effectiveness in highly dynamic environments (Eisenhardt and Martin, 2000; Schreyögg and Kliesch-Eberl, 2007). Integrating these views, I found evidence for an inverse U-shaped contingent relationship where the effect of dynamic capabilities on competitive advantage is highest in moderately dynamic environments but lower under low and high levels of environmental dynamism.

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Interestingly, the multi-group analyses (see Appendix S1) showed that the positive effects of the two capabilities on competitive advantage were still statistically significant in the high dynamism subgroup. This finding appears to contradict Eisenhardt and Martin's (2000) and Schreyögg and Kliesch-Eberl's (2007) argument that dynamic capabilities do not confer a competitive advantage in these settings. It suggests a less extreme position in that these capabilities can be strategically valuable even in high velocity environments, possibly because an inventory of established change repertories can indirectly facilitate novel action by providing the fodder for new recombinations (Levinthal and Rerup, 2006; Wirtz, Mathieu, and Schilke, 2007). Nonetheless, it is important to note that the efficacy of dynamic capabilities decreased significantly when moving from medium to high environmental dynamism, consistent with this article's argument that they exert their relatively strongest positive impact when dynamism is at intermediate levels.

This study contributes to research on dynamic capabilities in several ways. First, it provides empirical support for the notion that dynamic capabilities, like most ways of organizing, should not be regarded as a universal, one-fits-all solution. The study's findings help delineate boundary conditions for dynamic capabilities theory—an important precondition for any theory to move forward. Second, the study establishes that environmental dynamism plays a key role in the link between dynamic capabilities and competitive advantage. The article therefore contributes to answering '"under what conditions does the presence of DC in firms generate competitive advantage?": arguably one of the most interesting questions in the field of strategic management today' (Verona and Zollo, 2011: 537). Rather than focusing on dynamic contexts only, the study's multi-industry design allowed for contrasting the efficacy of dynamic capabilities in settings with varying dynamism. This research, thus, heeds calls for empirical studies that 'explicitly compare the effects of similar dynamic capabilities in two or more clearly distinct environmental conditions' (Barreto, 2010: 276). Results indicate significant differences among these settings, underlining the importance of considering the degree of environmental dynamism when making claims about performance implications of dynamic capabilities. Overall, this study thus helps reduce ambiguities regarding the role of environmental dynamism in the dynamic capabilities framework (Zahra *et al.*, 2006). Third, this work makes a theoretical contribution by integrating existing theorizing on the contribution of dynamic capabilities under varying levels of dynamism. I acknowledge both the cost argument (Winter, 2003; Zahra *et al.*, 2006; Zollo and Winter, 2002), which suggests that stable environments may not provide sufficient opportunities to cover the costs of developing dynamic capabilities, as well as the familiarity/discontinuity argument (Eisenhardt and Martin, 2000; Schreyögg and Kliesch-Eberl, 2007), which implies that rule-based, experiential routines may be inappropriate to deal with unfamiliar situations and abrupt change typical for highly dynamic environments. The U-shaped moderation proposed and tested here implies that both arguments are valid and that the interaction among dynamic capabilities, environmental dynamism, and competitive advantage may be more complex than a simple linear relationship considered by earlier work (e.g., Drnevich and Kriauciunas, 2011).

In terms of managerial implications, the results suggest that investments in building dynamic capabilities (such as alliance management capability and new product development capability) are strategically justified in many firm environments. As noted, dynamic capabilities reconfigure a firm's resource base, and managers need to pay attention to building and exploiting these capabilities in ways that generate a competitive advantage. Even though some of the routines develop accidentally, others require managers' patient investments and foresight in deciding where and how to build these capabilities as well as how to deploy them to achieve a competitive advantage. Dynamism could alter the fabric of the industry and cause the decay of the firm's resources or render them strategically irrelevant. Therefore, managers need to ensure the effectiveness of their firm's dynamic capabilities.

The study's empirical findings help clarify a key contingency that influences the efficacy of dynamic capabilities. They point to striking differences in the dynamic capabilities–competitive advantage relationship between settings characterized by different degrees of environmental dynamism. Nonetheless, several limitations need to be acknowledged, some of which suggest important avenues for future research. For example, although this dataset included a broad range of manufacturing firms representing a variety of industries, care should be exercised in generalizing the results. Future studies may scrutinize the study's findings in other settings, possibly incorporating a greater number of different industries, countries, and/or time periods in order to ensure even higher levels of variance of environmental dynamism in the dataset. Future researchers also need to determine whether the moderating role of the environment on the relationship between dynamic capabilities and competitive advantage also extends to other environmental characteristics, such as the type of industry (e.g., goods vs. services) and its stage of evolution (e.g., emerging vs. mature). Going beyond context-specific differences, future research should also engage with firm-specific differences in the link between dynamic capabilities and competitive advantage, exploring organizational characteristics (such as organizational culture or organizational structure) that may influence the effectiveness of dynamic capabilities.[4]

Furthermore, firms develop multiple types of dynamic capabilities (e.g., in the fields of alliances and new product development, but also in information technology, marketing, and mergers); thus, the effects of other capabilities, along with their potential complementarities (Levinthal, 2000), should also be investigated. Moreover, we need deeper insight into the variety of mechanisms that underlie the performance effects of capabilities. For example, future research should study the intervening role of inertia by controlling for how long a firm has retained a given capability. Other research may also shed light on the amount of time it takes for different types of capabilities in different industries to materialize in measurable outcomes.

Moreover, this study has adopted a rather narrow definition of dynamic capabilities that focuses on experience-based, rather static routines and excludes more flexible forms of organizational change (consistent with, for example, Pierce *et al.*, 2002; Winter, 2003; Zollo and Winter, 2002). Future (possibly qualitative) research should take up the challenge of investigating the interplay between highly routinized and ad hoc resource reconfiguration in greater detail. Finally, I also expect interactions between dynamic capabilities and higher-order dynamic capabilities (routines for adapting established change routines) to play a significant role (Collis, 1994; Levinthal and Rerup, 2006), an important topic, which warrants further theorizing and empirical investigation.

In conclusion, the findings presented here suggest that dynamic capabilities have more complicated performance effects than previously assumed, ranging from nonsignificant in very stable and very dynamic settings to strongly positive in moderately dynamic environments. I hope that the more nuanced approach developed here spurs further empirical research that helps us better understand the intricacies of the consequences of dynamic capabilities.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article:

Appendix S1. Multi-group analyses

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