ARTICLE IN PRESS

Long Range Planning xxx (xxxx) xxx

Contents lists available at ScienceDirect

Long Range Planning

journal homepage: www.elsevier.com/locate/lrp

Beggars can be choosers: Resource scarcity, dynamism, search activities, and their joint impact on performance

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ARTICLE INFO

Keywords:
Exploration
Exploitation
Dynamism
Resource scarcity
Financial performance

ABSTRACT

Research on firm search stresses the need for firms to adapt and align concurrently with their environment to optimize the ability to sense and seize opportunities for sustained performance. We postulate resource scarcity as an important contingency factor for the search-performance relationship, and assess its joint influence with high and low dynamism. Using a dataset spanning 23 years, we examine the performance implications of combinations of internal and external exploratory and exploitative search in resource-scarce environments, under conditions of high and low dynamism. We find that resource scarcity is an important condition for performance stemming from exploratory and exploitative search: even under conditions that involve low dynamism, but joined with resource scarcity, firms may benefit from pursuing exploratory and exploitative knowledge simultaneously.

Introduction

Many firms have to deal with changing circumstances in their business environment, including variation in the availability of resources, as well as dynamism. These changing circumstances have a non-trivial effect on organizational outcomes like innovation output and financial performance (Dess and Beard, 1984; Keil, 2004). For instance, resource scarcity constrains the possibilities for firms to obtain resources for growth, while dynamism makes it harder to commit to resources as the future state of the market is uncertain. As firms navigate through a changing world, they are in constant flux between adapting to shifting circumstances and improving their alignment with existing conditions. An important determinant of a firm's ability to navigate successfully is the way in which a firm searches for knowledge (Levinthal and March 1993). Firms that are able to efficiently and effectively combine the search for *new* knowledge, i.e. exploratory search, with the incremental expansion of their *existing* knowledge base over time, i.e. exploitative search, are better equipped to adapt to and align with changing environmental circumstances (Billinger et al., 2013; Katila and Ahuja, 2002).

While firms may benefit from combining exploratory and exploitative search, this requires excess resources as these activities detract from ongoing business (Cao et al., 2009). In industries where firms pursue innovation in order to compete, a large amount of capital is devoted to the search for novel knowledge (Rowley et al., 2000). However, what if industry-level resources are scarce? Are there still benefits when firms deploy exploitative and exploratory search patterns efficiently and effectively? Resource scarcity lowers

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https://doi.org/10.1016/j.lrp.2021.102074
Received 9 May 2018; Received in revised form 6 November 2020; Accepted 14 January 2021
Available online 18 January 2021

Please cite this article as: Michiel P. Tempelaar, Vareska van de Vrande, *Long Range Planning*, https://doi.org/10.1016/j.lrp.2021.102074

the capacity for industry growth, which impairs a firm's ability to enact changes in its environment (Sirmon et al., 2007). Here, firms are more dependent on the availability of resources and enjoy less strategic latitude (Baum and Wally, 2003; Koka et al., 2006); every attempt to control a resource elicits a reaction from other firms trying to exploit the resource in question or one that is akin to it (Aldrich, 2008). Exploring novel ways to exploit or develop resources is paramount in such circumstances, as firms experience concurrent pressure to make use of their existing resources to maximum effect (Levinthal and Posen, 2007; Sirmon et al., 2007). In spite of this, the question of how firms might reap the benefits of exploratory and exploitative search in resource-scarce environments has remained understudied. This question warrants attention, as, according to Laursen (2012), more research is required on the appropriability conditions of the context within which search activities take place and on how firms may select types of search to achieve the best performance outcomes.

To delineate boundary conditions of the impact of resource scarcity on the relationship between search and performance, we investigate its impact conjointly with dynamism. Dynamism in the environment may increase uncertainty about the future state of an industry, which, in turn, impacts the consequences of simultaneously combining exploratory and exploitative search (Fleming, 2001; Sidhu et al., 2007). Past research has conceptualized how the interplay between dynamism and scarcity creates fundamentally different environments (Dess and Beard, 1984), Research to date, nonetheless, has not investigated the implications of these environmental conditions together, but has postulated the importance of pursuing both exploration and exploitation in resource-scarce or dynamic environments (Cao et al., 2009; Eklund and Mannor, 2020; Jansen et al., 2006; Posen and Levinthal, 2012). To address this gap in the literature and to further specify the search-performance relationship, we ask the question: 'to what extent can firms capitalize on exploratory and exploitative search in resource-scarce environments, under conditions of high and low dynamism?'

In exploring this question, the choice of sourcing exploration or exploitation internally or externally is particularly important. Internal sourcing, which refers to the development and maintenance of knowledge within the boundaries of the organization, capitalizes on a firm's coordinative capabilities, which increases the efficiency of the internalized activities (Williamson, 1975). At the same time, internal sourcing helps create unique, firm-specific knowledge and capabilities which potentially raise barriers against imitation (Barney, 1991; Grant, 1996). External sourcing (i.e. tapping into extra-organizational knowledge sources), on the other hand, exposes firms to new areas of expertise and expands a firm's knowledge base, which, in turn, increases a firm's effectiveness in pursuing novel knowledge (Miller et al., 2007). However, the results of previous research have been inconclusive with regard to the impact of *combinations* of internalized and externalized search (Hoang and Rothaermel, 2010; Stettner and Lavie, 2014; Lavie et al., 2011). We contend that these differences may be attributable to external circumstances and seek to reconcile these seemingly disparate results.

We analyze a multi-industry, objective dataset covering a 23-year time period. In doing so, we are able to examine the longitudinal effects of different combinations of search on financial performance. This allows us to contribute to the existing literature in at least three important ways. First, we examine the performance effects of exploratory and exploitative search in resource-scarce environments. Past research has highlighted the influence of (firm-level) scarcity on firm behavior, indicating that low availability of resources induces firms to focus on exploitation over exploration (Greve, 2003; Laursen, 2012). Less is known, however, about the impact of search activities on performance in resource-scarce business environments. Environmental scarcity adversely affects the collective resource pool from which firms withdraw the resources required to compete, thereby increasing rivalry within such environments (Levinthal and Warglien, 1999). Notwithstanding firm-level contingencies, this scarcity should have an impact on the way in which firms appropriate rents in their search for knowledge (Zahra and George, 2002).

Second, we combine the concept of resource scarcity with environmental dynamism. High dynamism requires firms to be flexible in order to react quickly to changes. Conversely, low dynamism prompts firms to specialize and focus on efficiency and dependability (Dess and Beard, 1984). Existing research has advocated the use of a variance-increasing approach under dynamic conditions - which increases a firm's ability to deal with uncertainty - without much consideration for the availability of resources. However, the combination of dynamism with resource scarcity requires firms to develop an approach that takes both effectiveness *and* efficiency into account (Aldrich, 2008). By combining scarcity and dynamism, we aim to provide a more refined conception of the competitive business environment and its impact on firm search behavior and associated performance.

Third, in contrast with previous research (Katila and Ahuja, 2002; Sidhu et al., 2007), we examine the combined effect of both internal and external exploratory and exploitative search on firm financial performance. As such, we disentangle source, i.e. internal vs. external, and type, i.e. exploratory and exploitative knowledge. External sourcing of exploratory and exploitative search means building on knowledge that was developed elsewhere, while internal sourcing typifies either unique internal development processes with which firms generate new knowledge, or the incremental expansion over time of their existing knowledge base. In making this distinction, we respond to the call by Rosenkopf and McGrath (2011), who indicate that the separate perspectives of technology, i.e. exploratory and exploitative search, and internal and external sourcing, may not fully capture nuances in exploratory and exploitative search activities. By conceptualizing and testing a model that incorporates both, we are able to uncover the search sources and types that are beneficial and/or detrimental to superior performance.

The next section covers our theory and hypotheses, followed by a description of our applied method and an analysis of our results. Finally, we discuss our findings and present the limitations of our research and suggestions for future research.

Theoretical background

The impact of resource scarcity on competition

A large part of a firm's orientation and behavior is determined by the characteristics of its business environment (Cyert and March

1963; Hawawini et al., 2003; Mauri and Michaels, 1998; Miller and Friesen, 1983). Theories such as evolutionary fitness (Helfat et al., 2007), contingency theory (Lawrence and Lorsch, 1967) and organization ecology (Hannan and Freeman, 1977) all assume that the environment possesses objective, material properties that shape firm behavior (Edelman and Yli-Renko, 2010; Kaplan, 2011; Miller and Friesen, 1983). An important property of the environment is the availability of resources needed for growth (Wan and Hoskisson, 2003). Such resources can for example entail the availability of supply and suppliers, financing, access to talent, and segmentation possibilities. Ample opportunities to access, develop and employ such resources gives strategic latitude to firms. Kotha and Nair (1995), for instance, show how the Japanese tool manufacturing industry benefitted from the rise of other Japanese manufacturing industries. As a result of the rise of manufacturing, demand for automation dramatically increased, as did the demand for tools. At the same time, the industry enjoyed easy and cheap access to financial capital (increasing their debt-to-equity ratios) and the Japanese government implemented policies that stimulated further growth. In this study, these environmental conditions had a much stronger effect on performance than did the firm-specific strategies employed. Thus, the conditions affected all firms a great deal, even though they may have exhibited idiosyncratic strategic behavior.

Conversely, Hambrick and D'Aveni (1988) show how an environment's limited growth-carrying capacity can have a dramatic impact on even the largest of firms, potentially leading to bankruptcy. A limited carrying capacity for growth, or environmental resource scarcity, makes it hard for firms to attain and retain the resources they need to facilitate growth and innovation (Castrogiovanni, 1991; Cyert and March 1963; Oxenfeldt and Kelly, 1968). Therefore, the range of strategic and organizational options available to firms in this situation is low (Tushman and Anderson, 1986). One typically sees fewer competitors, homogeneous supplies and low differentiation among competitors in such environments (Aragon-Correa and Sharma, 2003). Under conditions of resource scarcity, competition tends to intensify (Dess and Beard, 1984; Sirmon et al., 2010), which has a detrimental effect on performance (Castrogiovanni, 1991; Child, 1972). Firm-level contingencies such as financial slack may allow organizations to buffer against these effects to some extent (Bradley et al., 2011), but there remains an overall negative impact of industry-level scarcity on firm success (Staw and Szwajkowski, 1975). In general, organizations become more dependent on their competitive environment. Firms that are able to extract resources more readily, or are innovative in the application of their resources, are better than their competitors at finding growth opportunities and generating a competitive advantage (McEvily and Zaheer, 1999).

How the sourcing of search affects knowledge development and performance

Research on exploration and exploitation has linked resource scarcity to constraints on resource allocation: the fewer resources that are available in the environment, the more often firms are presented with a trade-off between exploration and exploitation, forcing them to carefully consider the extraction and subsequent allocation of these scarce resources to both activities (Cao et al., 2009). We extend this idea by investigating how, under resource-scarce conditions, firms may benefit from considering the *sourcing* of search. First, the internalization of search activities helps firms to leverage coordination capabilities and learning effects that foster efficiency (Liebeskind, 1996). In doing so, firms may experiment with exploratory knowledge to enjoy learning effects (Holmqvist, 2004), while the focus on refinement inherent in the pursuit of exploitative knowledge stimulates a stream of applications and efficiency gains (Raisch and Birkinshaw, 2008). Furthermore, internal development processes help firms create firm-specificity, which safeguards against knowledge spillovers to competitors (Postrel, 2002). On the other hand, externalization of search helps firms to extend their knowledge base (Grant and Baden-Fuller, 2004) and allows access to a wide variety of non-redundant knowledge (Lane and Lubatkin, 1998). In this way, firms may compensate for shortcomings in their internal knowledge base and processes, and enjoy greater effectiveness as a result of their externalized search activities (Grant and Baden-Fuller, 2004; Lavie and Rosenkopf, 2006).

Past exploration-exploitation research has investigated the way in which firms may move between internal and external exploration and exploitation (Holmqvist, 2004). However, the performance implications of combining these search activities remain unclear. Hoang and Rothaermel (2010), for example, find that R&D project performance is positively affected by external exploitation and internal exploration, and negatively by internal exploitation and external exploration. Hess and Rothaermel (2011), on the other hand, describe how firms may benefit from internal exploitation and external exploration, highlighting the positive effects of star scientists, acquisitions, and downstream alliances. Furthermore, Stettner and Lavie (2014) find that internal exploitation combined with alliance exploration yields the strongest correlation with improved performance. They also find decreased performance when balancing exploration and exploitation internally or externally exclusively. Other studies, however, have highlighted the positive performance effects of balancing exploration and exploitation within organizational boundaries (Gibson and Birkinshaw, 2004; Jansen et al., 2012), or exclusively through alliances (Lavie et al., 2011). These varied results led us to undertake this project, as we seek to uncover whether different combinations of sourcing may be beneficial under different types of resource-scarce environments.

Resource scarcity and search

Under conditions of resource scarcity, firms have a natural tendency to choose to engage in exploitation (Ezzamel and Bourn, 1995). Doing so at the detriment of exploration would be a mistake, as these firms overcommit to an exploitative trajectory in an environment which is dominated by environmental constraints (Yin and Shanley, 2008). This leaves them vulnerable to competitors, as, in resource-scarce environments, the utilization of resources is under constant pressure and changing, and firms constantly converge and collide on these resources. Firms that do explore have the potential to open up new market opportunities and enjoy superior first-mover advantages (Lieberman and Montgomery, 1988), or find new, effective ways to apply resources or to attract more resources from the environment (Levinthal and Warglien, 1999). Performance when there is limited potential for growth hinges on identifying those rare opportunities that do (Eklund and Mannor, 2020). Such opportunities are more aptly discovered or developed,

and subsequently seized when firms maintain a capacity to explore for novel knowledge, thus increasing the likelihood that they possess the right capabilities to find ways to continue growing when the occasion arises.

Under resource-scarce conditions, we posit that firms do well to internalize search activities. In resource-scarce environments, companies must survive on a small resource pool and tend to have little strategic latitude (Levinthal and Warglien, 1999). They cannot afford to search more widely for novel knowledge (McGrath, 1997). Competition intensifies (Koberg, 1987), and companies that make the most of the limited availability of resources may gain a competitive advantage (Wan and Hoskisson, 2003). Consequently, search becomes costlier when resources are difficult to attain (Laursen, 2012), as scarce resources need to be applied to search processes, which go beyond the primary activities of firms. Investing in particular search trajectories presents firms with opportunity costs: investing in one search process means forgoing others. Internal knowledge development is more efficient, requiring less knowledge-transfer effort, and thus making knowledge integration more effective (Kogut and Zander, 1992; Grant, 1996). Furthermore, internalizing development makes for more causally ambiguous knowledge resources, which temporarily shields firms from having their competition imitate and use (scarce) resources and associated opportunities in similar ways (Breton-Miller and Miller, 2015; Reed and DeFillipi, 1990). In general, we expect firms that internalize (part of) their search to perform better in resource-scarce circumstances. What to internalize, co-depends on the level of environmental dynamism.

Environmental dynamism and search

In line with assertions that have been made in the literature, we argue that a more comprehensive account of the influence of resource scarcity requires an assessment of its joint impact with dynamism (Bradley et al., 2011; Sirmon et al., 2007). Dynamism refers to the predictability of change in the environment, which influences the extent to which organizations are able to foresee future conditions and assess the economic potential of resources (Courtney et al., 1997).

When dynamism is high, conditions change in an unpredictable fashion, the impact of these changes is unclear, and planning horizons are extremely short (Milliken, 1987). Highly dynamic environments carry with them great uncertainty, but they also create opportunities (Bradley et al., 2011). Competition in dynamic environments revolves around innovation in order to increase (knowledge) variation, which drives adaptation (Miller and Friesen, 1982). All else equal, successful adaptation requires having access to varied, non-redundant knowledge, paired with capabilities to incorporate and monetize this knowledge (Zahra and George, 2002). This implies that firms require counteracting forces to variety: knowledge and mechanisms that provide the due diligence to properly assess and make sense of novel knowledge (Kim and Rhee, 2009). A crucial driver for such a balancing act is the ability to engage in both exploratory and exploitative search simultaneously.

Low dynamism, on the other hand, allows firms to extrapolate the future state of the environment (Courtney et al., 1997; Milliken, 1987). This also means firms are able to more accurately assess the value of a resource and its economic potential. In such environments, one often sees similar structures and strategies as firms converge on dominant designs, and imitation is a concern. Superior performance in these contexts revolves around the development over time of path-dependent strategic resources that are difficult to imitate (Dierickx and Cool, 1989). This warrants consistency and commitment from firms: focused investment in the knowledge to apply sustainable resources more effectively or efficiently (Rowley et al., 2000), or the knowledge to find unique ways to differentiate from competition (Wiklund and Shepherd, 2005).

We argue, however, that the impact of dynamism is modified and specified by resource scarcity.

Hyper-competition - resource scarcity and high dynamism

When resource scarcity is combined with high dynamism, the environment is characterized by a high frequency of change, negatively affecting the ability of firms to evaluate the value of resources (Dess and Beard, 1984), paired with strong competition for these resources (Koberg, 1987). Taken together, they have an amplifying effect on one another: changes are frequent and firms are likely to be unable to capture a stable resource base to consistently adapt to these changes. As a result, firms have very low freedom of movement (Aldrich, 2008) and the environment becomes hypercompetitive (D'Aveni, 1994; Hanssen-Bauer and Snow, 1996). In this most extreme of dynamic conditions, firms are constantly subject to *the Red Queen Effect*, a term that describes a situation in which any strategic action taken is almost instantly obsolete (Kauffman, 1995). Under such circumstances, the ability of firms to adapt efficiently is important to gaining competitive advantage (Posen and Levinthal, 2012; Rosenkopf and Nerkar, 2001). Because resources are scarce, there is less differentiation between competitors (Aragon-Correa and Sharma, 2003), thus increasing competitive rivalry. It is imperative that firms capitalize on internal resource development to facilitate the efficient creation of knowledge that allows them to gain a temporary competitive advantage (Anderson and Tushman, 2001; Sirmon et al., 2007).

In the computer processor industry, for example, Intel Corporation and Advanced Micro Devices (AMD) have been engaged in a technological leap-frogging game for years (Pacheco-de-Almeida and Zemsky, 2012). Despite continuous - internally driven - innovations, revenue patterns over the recent years are similar between Intel and AMD, indicating that this industry is subject to the red-queen effect. At the same time, the CPU industry is heavily dependent on specific resources. For instance, Intel has reported problems with their supply of processors which have impact their production schedules for the larger part of three years. Consequently, AMD found their market share increasing. This effect is further exacerbated due to AMDs exploitative capabilities, yielding better price-performance ratio of their recent CPUs.[2]

[2] https://www.nasdaq.com/articles/amd-vs-intel%3A-a-detailed-comparison-of-revenue-and-key-operating-metrics-2019-09-26.

To survive and thrive in resource-scarce, dynamic environments, firms need a combination of unique, firm-specific knowledge to safeguard against mimicking behavior, as well as a diverse portfolio of knowledge to increase variance (Fleming, 2001). The aim here is to own both firm-specific, as well as flexible-usage knowledge resources (Ghemawat and Del Sol, 1998; Wang and Chen, 2010). As the development of firm-specific knowledge sets is largely driven by internal processes (Miller et al., 2007), and diversity is fostered by exploration, it is crucial that firms facilitate the search for exploratory knowledge in addition to carrying out exploitative search internally. Firms that fail to do so may not be able to develop the uniqueness *and* flexibility that they desperately need to perform well in a hypercompetitive environment (Lane et al., 2006). Firms that internalize both exploratory and exploitative search develop and maintain capabilities that encompass both search activities, as well as capabilities involving interfacing between exploration and exploitation, and finding synergies between them (He and Wong, 2004). Consequently, these firms make the most of the few resources available to them, as combining exploration and exploitation internally fosters a capability to allocate, reallocate, combine, and recombine resources (Jansen et al., 2009). As a result, these firms maximize efficient resource development and application, as they can exploit complementarities, engage in faster knowledge integration, and enjoy general coordination benefits, thereby increasing the efficiency and speed with which they translate exploratory and exploitative search into performance (Cao et al., 2009; Zahra and George, 2002), while also creating firm-specific (search) capabilities that are harder to mimic.

Conversely, firms that (partially) externalize their search activities exhibit a lower efficiency factor, and, as a consequence, may fail to establish a stable foundation for competitive advantage, be too slow in adapting to new developments, and consequently underperform while engaged in almost constant competition for scarce resources in the environment. Therefore, we hypothesize the following:

Hypothesis 1. When resource scarcity is combined with high dynamism, firms that combine internal exploratory and internal exploitative search will enjoy increased performance, whereas firms that combine search types in other ways will not.

Chess game - resource scarcity and low dynamism

When resource scarcity is combined with low dynamism, rivalry increases until competition resembles a chess game: a firm is able to oversee competition, assess the value of resources, and each step a firm takes elicits a reaction from its competitors, and vice versa. As a result, the competitive environment becomes one in which everyone competes for resources (Pfeffer and Salancik, 1978), and resource instabilities and the inability of organizations to acquire and control critical and scarce resources drive strategic change (Koberg, 1987). Differentiation in the market is likely to be low, so it is very difficult to break free from the rules of the game (Sirmon et al., 2010).

One example of an environment that is characterized by resource scarcity and low dynamism is the watch industry in the late 1970s. Due to the introduction of quartz watches, the Swiss watchmaking industry, which competed on mechanical watches, saw a significant decline. ETA SA, a Swiss watchmaking company, responded to this decline by investing in an injection-molding machine and the design of a durable and inexpensive plastic watch.[3] This internal exploration of new techniques and capabilities allowed them to introduce a new product that would change the nature of the game: Swatch (Avery, 2004; Taylor, 1993). Exploiting these new capabilities externally through third-party designers allowed them to quickly gain a first-mover advantage.

Previous research suggests that when the trade-offs between exploration and exploitation are particularly zero sum, firms may be better off organizing and investing in *either* exploration or exploitation internally, while externalizing the other activity (Laursen and Salter, 2006; Stettner and Lavie, 2014). Since dynamism is also low here, firms should be able to assess the value of resources. However, due to resource scarcity, achieving this value is co-determined strongly by changes in the utilization and development of resources by competitors. This creates uncertainty. Thus, we argue that firms should combine a focus on the development of unique, hard-to-imitate, valuable knowledge resources with a commitment to be on top of 'the rules of the game' as is co-determined by their industries. The former is better served through internalization, the latter through externalization. This is indicative of boundary-spanning combinations of exploration and exploitation (Stettner and Lavie, 2014). Such boundary-spanning search behavior might lead firms to forgo part of the (internal) efficiency benefits. However, it does make them more effective, as this allows firms to overcome local search (Rosenkopf and Nerkar, 2001), thereby creating new opportunities that help them to sustain their competitive advantage. Through an internal focus on either exploration or exploitation, firms are able to develop unique competencies that allow them to compete in low-dynamic, resource-constrained environments. At the same time, external inflow of exploitative or exploratory knowledge ensures recombination and/or improvement of existing knowledge, and novel applications. Consequently, there are two possible avenues to be taken for firms in low-dynamic, resource-scarce environments.

The first approach is an internal focus on exploratory knowledge development, combined with external exploitative search. Firms develop firm-specific, value-creating routines to develop idiosyncratic resources (Barney, 1991; Grant, 1996). These idiosyncrasies raise barriers to imitation and help firms to sustain first-mover advantages delivered through their unique exploratory knowledge development processes. In essence, they become inventors of ways to change the game, which allows them to play a leading role in defining how the industry operates (Courtney et al., 1997). Such firms progressively expand their technological domains, thus limiting the possibilities for competitors to move into those spaces (Wang and Chen, 2010). This domain expansion comes with inventive ways of applying scarce resources. An external exploitative focus allows firms to stay abreast of best practices and dominant design in their business environments (Soh, 2010). Hoang and Rothaermel (2010) indicate that internal exploration enables firms to more fully

[3] https://www.swatch.com/nl_nl/explore/swatch-chronology/.

assimilate and transform the learning benefits from external exploitation. Therefore, through their internal exploratory competence, they are better able to give these best practices a 'twist' and proactively shape the rules of the game or even change it.

The second approach entails an internal focus on exploitation, combined with an external search for exploratory knowledge. Firms invest in the improvement of firm-specific knowledge that is difficult to evaluate, and thus imitate, allowing them to appropriate higher value (Barney, 1991; Grant, 1996). The path-dependent buildup and use of incremental knowledge increases a firm's competence in these areas (Cohen and Levinthal, 1990; Stuart and Podolny, 1996; Wang and Chen, 2010). As a result, these firms are able to extend the benefits of pre-existing, exploitative knowledge. In a complementary fashion, the external search for exploratory knowledge yields competence in the recognition of novel knowledge developed elsewhere (Rosenkopf and Nerkar, 2001). This allows firms to combine superior knowledge acquisition capability with an internal capability to lengthen exploitative knowledge trajectories (Zahra and George, 2002). As a result, internal exploiters are more likely to integrate external exploratory knowledge into their exploitative base (Choi and McNamara, 2018). Therefore, these firms are well equipped to deal with attempted changes to the rules of the chess-game and to effectively adapt to the future (Courtney et al., 1997).

On the contrary, firms that combine exploration and exploitation internally forego the opportunity to respond to external developments, while firms that combine explorative and exploitative search externally do not benefit from the so-needed internal development of resources that are unique and difficult to imitate. Taken together, we propose that:

Hypothesis 2. When resource scarcity is combined with low dynamism, firms that (a) combine internal exploratory and external exploitative search, or (b) combine internal exploitative and external exploratory search will enjoy increased performance, whereas firms that combine search types in other ways will not.

Methods

Data and sample

To test the hypotheses, we analyze a dataset covering the innovation activities of the largest manufacturing firms (SIC codes 2000–3999) active in the period between 1980 and 2003. Our sample was drawn from the *Standard and Poor's 500* list, which lists the largest, publicly held companies in the US. To avoid survivor bias (Ahuja and Katila, 2004), the sample was selected based on the 1980 edition of the list. This first step yielded 257 companies. For some of them, however, we could not find accompanying financial information, leading us to drop those firms from the initial sample. This resulted in our final sample of 234 companies representing over 19 different industries (as defined by their two-digit SIC code). As some of these firms have merged or been acquired over time, our final sample is an unbalanced panel dataset of 3366 observations. For each firm in the sample, we collected patent data using the NBER data file (Hall et al., 2005) and financial indicators, drawn from the *Center for Research in Security Prices* (CRSP). Data related to the value of shipments was obtained from the US Census Bureau Annual Survey of Manufacturers.

Measures

Dependent variable. The dependent variable of this study, firm performance, is measured using the firm's Tobin's Q. Market-based indicators such as market value and Tobin's Q are preferred over accounting-based measures (such as sales, profits, ROA, etc.) because they take into account both short-term performance, as well as long-term prospects (Lubatkin and Shrieves, 1986). In line with Belderbos et al. (2010) and Uotila et al. (2009), we use Tobin's Q, as this measure also controls for firm size by including the replacement (book) value of the firm's assets. Tobin's Q is calculated as the market value of common stock + book value of total assets – book value of common equity, all divided by the book value of total assets. The market value of common stock is calculated by multiplying the firm's stock price by its number of common shares outstanding. In line with previous research, we utilize a one-year lag to facilitate causal interpretation (Lavie et al., 2011). Because this measure is highly volatile, we used the annual average of the monthly values (Lavie, 2007). Moreover, in line with Lavie (2007), we use an adjusted measure to control for stock market fluctuations and annual trends. Since 1980 is the first year of observation, we took 1980 as the base year. Furthermore, as this variable is skewed, we use the natural log in our analysis.

Independent variables. To identify the different types of exploratory and exploitative search conducted by the firms in our sample, we use patents and patent citations data. Patent citations refer to the prior art that a new patent builds upon and can therefore be regarded as an indicator of knowledge flows (Jaffe et al., 2000; Rosenkopf and Nerkar, 2001; Ahuja and Katila, 2004). Although the use of patent indicators is sometimes criticized because of the differences in patenting between industries, sectors and different types of firms, and because they do not encompass all the aspects of the R&D process and innovation (Hagedoorn and Cloodt, 2003), there are also many good reasons to use patent indicators in this study. First of all, using patents and patent citations provides us with the opportunity to follow a firm's innovation activities and the origin of their innovative search behavior over a long period of time - information that is otherwise extremely difficult to collect on a longitudinal basis (Katila, 2002). Second, patent-based indicators have been used frequently in prior studies of exploratory and exploitative search (e.g. Benner and Tushman, 2002; Fleming, 2001; Katila, 2002; Katila and Ahuja, 2002; Rosenkopf and Nerkar, 2001; Schildt et al., 2005; Sorenson and Stuart, 2000), so our use of a similar indicator increases the comparability of this study to prior research.

To capture the extent to which firms engage in exploratory and exploitative search, we rely on a two-step approach. First, we identify the backward citations for each patent in the firm's patent portfolio and classify each citation along two dimensions: internal versus external search and exploitative versus exploratory search. We build upon two well-established approaches to classification

seen in the literature. First, we follow Rosenkopf and Nerkar (2001) in distinguishing between internal and external search. In doing so, we distinguish between citations to own prior patents (self-citations) and citations to patents that are owned by another company. Citations to *own* prior patents indicate that the firm has built upon the knowledge they have in-house, or has engaged in internal search. Citations to *other firms'* patents, conversely, are indicative of external search behavior (Rosenkopf and Nerkar, 2001; Sorenson and Stuart, 2000). Next, we follow Katila and Ahuja's (2002) approach to measuring exploratory and exploitative search. According to these authors, when firms cite patents they have cited before, they seek to accumulate and deepen existing knowledge, which is tied to exploitation. Alternatively, citations to patents that were not cited before indicate search behavior that is more exploratory in nature (Benner and Tushman, 2002; Katila and Ahuja, 2002; Phelps, 2010). We use a five-year moving window to assess whether a patent was cited before (in other words: when a citation was made to a patent that was cited in the five years preceding the patent application, it is considered exploitative; otherwise we consider this citation to be of explorative nature). We combine these two aspects of search behavior and use a simple classification scheme (see Fig. 1) to identify internal and external exploratory and exploitative search.[4]

As seen in Fig. 1, we are able to identify the number of citations for each firm-year observation in each category. Our next step is to identify the presence of different combinations of exploratory and exploitative search within firms. To measure the extent to which firms focus on combinations of internal and external exploratory and exploitative search, we identify an emphasis on these activities using the following approach. First, we calculate the share of patent citations in each category. Next, we determine whether or not a firm exhibits a high level of activity for a given firm-year observation relative to its peers in the industry (as defined by two-digit SIC codes), using the mean. If a firm has a share in a particular category that is higher than the mean value in the industry, this variable is set to 1. Next, we identify the combinations of interest using the dummy variables created in Step 1. For example, if a firm has a higher share in, let's say, internal exploratory search than its peers, *as well as* a higher share in internal exploitative search, the dummy variable *internal exploratory and exploitative search* is set to 1. This leads to the creation of four dummy variables: *internal exploratory and exploitative search*, *external exploratory and internal exploitative search*, *internal exploratory and external exploitative search*, and *external exploratory and exploitative search*, respectively.

Control variables. Because firm performance is known to be affected by other factors as well, we include a number of firm-level controls in our analysis. As prior research has shown that market value is affected by a firm's technological activities (Griliches, 1981; Pakes, 1985), we include *R&D intensity* to account for annual R&D spending by the firms in our sample. R&D intensity is calculated by dividing R&D expenditures over total assets (Belderbos et al., 2013). To control for the size of the firm and its possible effect on our dependent variable, we include *firm size* as a control variable, which is measured as the firm's annual sales. Because both variables are highly skewed, we log-transformed them before including them in the analyses. In addition, because the value of the firm's technological activities also affects firm performance (e.g. Hall et al., 2005; Harhoff et al., 1999), we control for *technological value*, by including the forward citations received by the patents in the portfolio. Technological value is measured as the total number of citations received by the patents that were applied for in the year prior to the observation year. In light of the right-censored nature of this variable, we count the number of citations a patent has received in the first five years after the patent was granted. Again, this variable is log-transformed because of its skewness. Furthermore, we include *technological capital* as an additional control variable. Technological capital is the count of the number of patent applications in the five years prior to the observation year (t-1 to t-5). Moreover, we include *weighted industry concentration* to account for concentration in the industry. Weighted industry concentration is calculated as the proportion of a firm's sales in industry *i*, multiplied by that industry's four-firm concentration ratio (CR4), in line with Bharadwaj et al. (1999). All these variables are lagged by one year. Finally, in order to control for unobserved, year-specific effects, we also introduce year dummy variables.

Method

Because we are interested in the effects of internal and external exploration and exploitation under conditions of resource scarcity, we collected information pertaining to the growth of the different industries in our sample for each year. To operationalize resource scarcity, we turn to the concept of munificence, which refers to available resources for growth in industries (Dess and Beard, 1984). In accordance with prior studies, we calculate industry munificence based on the value of shipments to capture the annual growth in each industry. Data on the value of shipments was obtained from the US Census Bureau Annual Survey of Manufacturers. For each industry-year observation, we follow the method proposed by Dess and Beard (1984) and calculate industry growth by regressing time against the value of shipments, using a five-year, moving window, lagged by one year (Boyd, 1995). Munificence is captured by the coefficient (beta) of the regression slope of the value of shipments, divided by the mean value (Dess and Beard, 1984: 71). Specifically, we use the measure 'growth in total sales', which is captured by the value of shipments and measured as the regression sales slope coefficient (B) divided by the mean value (Y) of the dependent variable. Industries are defined according to their two-digit SIC code.

Next, we calculate the mean level of munificence for *each* industry (as defined by their 2-digit SIC codes) in each year. Observations in an industry-year setting that is characterized by below-mean munificence are labeled as operating in a resource-scarce environment

[4] As pointed out by one of the reviewers, internal exploratory search thus includes citations to patents that the firm owns, but has not yet cited. These may include patents that were recently applied for and a first citation would, therefore, be classified as exploratory search rather than exploitative (accumulative) search. To address this issue, we have also included alternative measures of internal exploratory search. For example, we have conducted additional analyses in which we classify citations to a patent the firm owns as internal exploration, when the owned patent was applied for at least three years before the citation event. In this case, a patent applied for in 2001 would only be classified as internal exploration if the cited patent was owned by the firm *and* at least three years old. The results of these analyses confirm the results that are presented in the paper.

Classification scheme to determine internal and external exploitative and exploratory search

		Cite own patents?	
		Yes	**No**
Patents cited before?	**Yes**	Internal exploitative search	External exploitative search
	No	Internal exploratory search	External exploratory search

Fig. 1. Classification scheme to determine internal and external exploitative and exploratory search.

and are, thus, included in our analysis. This classification is dynamic in the sense that a firm-year observation can be labeled as operating in a resource-scarce environment in one year and a resource-rich environment in another. We believe this dynamic classification is important, as industry growth may vary over time. In particular, given our longitudinal design, spanning a 23-year period, it is likely that some of these environments became more (or less) resource-scare over time.

To estimate the effects of different types of search on firm performance, we use linear regression. Because the Tobin's Q of firms is likely to be affected by unobserved heterogeneity, we use the Arellano-Bond estimator with a one-year lagged dependent variable to estimate the model. The analysis is conducted using the XTABOND procedure in STATA. Further, because we are interested in the effects of exploratory and exploitative search under different levels of environmental dynamism, we estimate two models, each representing a situation with low/high dynamism, respectively.

To capture environmental dynamism, we use an approach similar to the one use to capture munificence. Keeping prior studies in mind (e.g. Bakker and Shepherd, 2017; Boyd, 1990; Edelman and Yli-Renko, 2010; Girod and Whittington, 2017; Nadkarni and Chen, 2014; Schilke, 2014), we once again use the value of shipments for each industry to capture industry volatility. Next, we use the standard errors to calculate dynamism. Dynamism is captured by the standard error of the regression slope of the value of shipments, divided by the mean value. In line with our sample design and control variables, we use two-digit SIC codes to define the industries. To group the observations according to low/high levels of dynamism, the sample was split using the mean value of dynamism.

Results

Table 1 below presents the summary statistics. Table 2 presents the results of the regression analyses for different subsamples characterized by low and high dynamism.

Models 1 and 2 in Table 2 show the results for the different subsamples, respectively. Model 1 represents a situation in which resource scarcity coincides with high dynamism (hyper-competition). As indicated by the results, only the combination of internal exploratory and exploitative search appears to have a positive and significant effect on company performance ($\beta = 0.0200$, $p = 0.005$). This indicates that companies that focus on a combination of internal exploratory and exploitative search perform approximately 2% better than other firms. At the same time, the coefficient for internal exploratory and external exploitative search is negative and significant ($\beta = -0.0149$, $p = 0.024$), indicating that firms that combine internal exploration and external exploitation experience, on average, 1.5% lower performance. This finding lends support to our first hypothesis; in a resource-scarce setting in which dynamism is high, firms that combine internal exploratory search with internal exploitative search perform better than others. As such, Hypothesis 1 is confirmed.

Next, Model 2 represents environments that are characterized by resource scarcity and low dynamism (chess game). As indicated by the results shown in Table 2, in this environment, boundary-spanning ambidexterity plays an important role. In line with our

Table 1
Summary and correlation statistics[a].

	Mean	S.D.	1	2	3	4	5	6	7	8	9
1. Tobin's Q (indexed)	0.43	0.19									
2. R&D intensity	0.18	0.93	−0.01								
3. Firm size (natural log sales)	8.47	1.18	−0.09	0.18							
4. Technological value (natural log)	4.49	1.93	0.04	0.16	0.53						
5. Technological capital (natural log)	3.22	1.48	0.04	0.16	0.59	0.93					
6. Industry concentration (natural log)	0.24	0.23	−0.12	0.03	0.19	0.13	0.17				
7. Internal exploratory and exploitative search	0.21	0.41	0.09	0.02	0.15	0.24	0.29	0.04			
8. External exploratory and internal exploitative search	0.06	0.24	−0.00	−0.01	0.07	0.01	0.02	−0.04	0.17		
9. Internal exploratory and external exploitative search	0.15	0.36	0.05	−0.00	0.08	0.18	0.22	0.08	0.51	−0.11	
10. External exploratory and exploitative search	0.06	0.24	0.03	0.00	−0.01	0.03	0.02	−0.01	−0.15	−0.05	−0.07

a. N = 3366, Correlations above |0.06| are significant at $p < 0.05$.

Table 2
Regression results for search combinations and Tobin's Q under resource scarcity.

Dynamism	(1)	(2)
	Hyper-competition	Chess Game
	High	Low
Tobin's Q (1-year lag)	0.461	0.388
	(0.0600)	(0.0367)
R&D intensity	−0.00790	0.00103
	(0.00624)	(0.00173)
Firm size	−0.0693	−0.0472
	(0.0161)	(0.0152)
Technological value	0.0151	0.000702
	(0.00686)	(0.00517)
Technological capital	−0.0180	0.00531
	(0.00878)	(0.00743)
Industry concentration	0.0269	0.00776
	(0.0361)	(0.0501)
Internal exploratory and exploitative search	0.0200	8.69e-05
	(0.00719)	(0.00660)
External exploratory and internal exploitative search	0.00137	0.0159
	(0.0105)	(0.00800)
Internal exploratory and external exploitative search	−0.0149	0.0129
	(0.00657)	(0.00637)
External exploratory and exploitative search	−0.00483	−0.00526
	(0.00790)	(0.00807)
Year dummies	Yes	Yes
Constant	0.920	0.736
	(0.132)	(0.125)
Observations	488	902
Number of firms	106	125
Wald Chi^2	393.73	728.09

Standard errors in parentheses.

expectations, combining external exploratory search with internal exploitative search enhances firm performance ($\beta = 0.0159$, p = 0.047), and the combination of internal exploratory and external exploitative search is also positive and significant ($\beta = 0.0129$, p = 0.043). The results support Hypothesis 2: in a resource-scarce situation in which dynamism is low, innovative search takes the form of a chess game in which firms that are able to combine exploration and exploitation across firm boundaries (i.e. external exploration (exploitation) with internal exploitation (exploration)) outperform others.

Post-hoc analysis: exploring the boundary conditions of our model

In our model, we assume that resource-scarce conditions parsimoniously estimate the impact of a lack of resources on the extent to which firms capitalize on their search activities. In this post-hoc analysis, we aim to further explore the boundary conditions of this assumption of resource scarcity. To do this, we examine the impact of munificent, or resource abundant, environments. In such environments, resources are readily available and there are ample opportunities for growth (Castrogiovanni, 1991). Similar to our previous analyses, we now hold high munificence constant in our models, while varying between high and low dynamism. The results are presented in Table 3.

As is shown in the models presented in Table 3, none of the combinations of exploratory and exploitative search have a significant positive effect on Tobin's Q. This provides further evidence of the pervasive influence of resource scarcity on the relationship between exploratory and exploitative search and performance.

Table 3
Post-hoc analysis: regression results of search and Tobin's Q for environments with high munificence.

Dynamism	(1)	(2)
	High	Low
Tobin's Q (1-year lag)	0.483	0.475
	(0.0796)	(0.0826)
R&D intensity	−0.000755	−0.00374
	(0.00216)	(0.00542)
Firm size	−0.0329	−0.0160
	(0.0299)	(0.0272)
Technological value	0.00720	−0.0203
	(0.00932)	(0.00927)
Technological capital	−0.00776	0.0285
	(0.0127)	(0.0132)
Industry concentration	−0.111	0.0885
	(0.137)	(0.100)
Internal exploratory and exploitative search	0.00397	0.00268
	(0.00956)	(0.0101)
External exploratory and internal exploitative search	−0.00697	−0.0223
	(0.0129)	(0.0128)
Internal exploratory and external exploitative search	−0.000663	0.00271
	(0.00845)	(0.00864)
External exploratory and exploitative search	0.00329	0.0163
	(0.01000)	(0.0120)
Year dummies	Yes	Yes
Constant	0.475	0.427
	(0.254)	(0.223)
Observations	313	447
Number of id	116	111
Wald Chi^2	457.88	312.60

Standard errors in parentheses.

Discussion

In this study, we set out to explore the relationship between firms' search behavior and performance in resource-scarce environments. In line with previous theoretical assertions, we have shown that an environment characterized by resource scarcity in combination with a low or high level of dynamism requires markedly different search strategies (Sirmon et al., 2007; Aldrich and Mindlin, 1978). Pursuing exploration and exploitation often requires significant resources, which are difficult to obtain in resource-scarce environments. Our results indicate that even such conditions, careful sourcing of search may still yield positive performance.

In the context of hyper-competition, characterized by a high level of resource scarcity and high dynamism, we confirm that firms are well served by internalizing search. Pursuing exploratory and exploitative search internally allows firms to effectively and efficiently find combinations and re-combinations of knowledge resources. This result echoes research on organizational ambidexterity, in which, despite the inherent contradictions, firms divide resources between exploration and exploitation within firm boundaries (Jansen et al., 2012; Tushman and O'Reilly, 1996). Past research has argued against this, emphasizing the importance of boundary-crossing arrangements to alleviate some resource constraints (Stettner and Lavie, 2014). However, our results show that in a hyper-competitive environment, external search is not rewarded, or even punished, as indicated by the negative impact of internal exploratory and external exploitative search. Our findings have important implications for research on ambidexterity: in a general sense, research on exploration and exploitation is divided into two streams. One stream emphasizes a resource allocation trade-off and negative selection in this regard between exploration and exploitation (Lavie et al., 2010). The other stream emphasizes synergies between exploration and exploitation in stimulating efficient and effective adaptation and alignment in response to changing circumstances (Gibson and Birkinshaw, 2004; Jansen et al., 2009). Even though resource-scarcity renders the resource-allocation trade

off more salient (Cao et al., 2009), it would seem the latter stream is more applicable in resource-scarce, dynamic environments. As our results show, internal efforts to create value lead to more value appropriation under these conditions.

These findings differ markedly from the outcome of our investigation into the 'chess game' (a situation characterized by high resource scarcity and low dynamism). Here, our results speak to the power of complementary knowledge (Lavie, 2006; Zahra and George, 2002). Firms may opt to change the rules of the game (internalize exploration) or play the game better than competitors (internalize exploitation). This exclusive internalization yields firm-specific knowledge that is more difficult for others to imitate (Wang and Chen, 2010). Since dynamism is low, firms can afford to focus on either one, while outsourcing the exploratory or exploitative counterpart. The infusion of either novel knowledge or best practices complements their internal focus. Our findings echo previous research on boundary-crossing exploration and exploitation, confirming that it "… enhances performance by retaining the benefits of balance and specialization while avoiding negative transfer and the adverse consequences of conflicting organizational routines" (Stettner and Lavie, 2014, p1909). Our research indicates that this is rewarded when firms are a) limited in the amount of resources that can be extracted from the environment; and b) can afford a more singular, internal focus since the future state of the environment can be extrapolated from its current state. Not surprisingly, our data shows that the chess-game environment is home to industries that are relatively low-tech (such as stone, clay or glass products) or ones in which inexpensive and reliable manufacturing requires extensive experience (such as watches and clocks).

Our study adds nuance to existing research that has identified a variety of benefits associated with combining internal and external exploration and exploitation (Hoang and Rothaermel, 2010; Jansen et al., 2012; Stettner and Lavie, 2014).[5] Past research has theorized several inherent conditions that influence the effectiveness of internal and external combinations of exploration and exploitation, including structure (Lavie et al., 2011), non-redundant technology type (Hess and Rothaermel, 2011) and experience (Hoang and Rothaermel, 2010). We argue that claims about the performance of internalization, externalization or boundary-spanning arrangements of exploration and exploitation should also take account of environmental appropriability conditions (Laursen, 2012). Resource scarcity and dynamism are only a part of the puzzle, however. For example, Windrum (2004) describes the way in which Microsoft incorporated several established technological features of Netscape's Navigator internet browser in the 90s in its own products (a form of external exploitation). This resulted in a version of Internet Explorer (IE) that was not considered to be technologically superior. However, Microsoft was the first to treat an internet browser as part of a wider ecosystem (a form of internal exploration) and make a significant effort to realize cross-product integration within their operating system and other products such as Office. This resonated with end-users, web-developers and computer (re-)sellers who were all interested in integrated software solutions. This example shows how firms may take specific isolating actions to create barriers to imitation by leveraging technological externalities. It also shows that the decision to source exploration or exploitation is influenced by factors that extend beyond either inherent or environmental features. Future research could address this puzzle further by incorporating new dimensions that influence sourcing decisions in an analysis.

Our results indicate that firms dealing with scarcity should, in part at the very least, conduct exploratory or exploitative search internally. At the firm level, this means that a firm in a resource-scarce environment should avoid sourcing all its knowledge development externally. In fact, if we synthesize this with the results of our post-hoc analysis, it appears that it is never a good idea to source all knowledge development externally. From a resource-based perspective, this makes sense. Based on the assumption that firms can compete in the area of knowledge (Zahra and George, 2002; Grant, 1996), it appears that it would be difficult for firms to develop firm-specific knowledge through external sourcing of both exploitative and exploratory search.[6] The knowledge base of such a firm would consist of exploratory and exploitative knowledge that has been developed elsewhere, which, by definition, is more imitable. This would decrease the chances of establishing a competitive advantage and is, therefore, unlikely to improve performance (Barney, 1991). In particular, when resources are scarce, barriers to imitation become all the more important, as they allow firms to extend their competitive advantage in an environment in which one is difficult to attain in the first place.

Furthermore, our results indicate that the interplay between dynamism and resource scarcity has a non-trivial effect on the impact of exploratory and exploitative search and the in- or externalization of these search efforts. When we compare our initial findings with our post-hoc results (in which resources are abundant), it becomes strikingly clear that the availability of resources is an important arbiter of the impact of search. We found none of the combinations of search in the context of a highly munificent environment to be associated with increased performance. There are ample opportunities for firms to grow when they are relatively sheltered from competition. We argue that this extends so far that it diminishes the urgent need to adapt to changes in the environment. Whereas other competitive environments may force firms to react to change, firms that find themselves in munificent conditions can afford to actively develop their own paths. For instance, in an environment typified by low dynamism and high munificence, firms can foresee the future with relative ease and there are enough resources available to allow firms to respond quickly to potential changes in the environment. As such, firms appear to be better off cycling through exploratory and exploitative search over time (Simsek, 2009) with the caveat that it is likely that exploratory phases are relatively rare, barring a significant environmental shock that changes the rules completely (Sirmon et al., 2010). We do not, however, have any evidence of this, so the claim requires further investigation.

[5] It should also be noted however, that many of the studies cited above (partially) focus on how exploration and exploitation should be organized. We make no such claims. For instance, the fact that our study does not find positive performance effects for exclusive external search does not disqualify earlier positive outcomes yielded by ambidexterity through alliances (Lavie and Rosenkopf, 2006; Tiwana, 2008). Alliances can build on internal knowledge, external knowledge and combinations of the two.

[6] We use patent citations as indicators of a firm's knowledge development trajectory. However, this does not rule out alternative explanations for knowledge-based performance across firms that are not captured by their patenting behavior.

Managerial implications

Some managerial implications emerge from our study that relate to the development of technological trajectories and new products. When firms find themselves in a hyper-competitive environment with few opportunities for growth and high dynamism, their aim should be to develop idiosyncratic knowledge that is hard to imitate. Firms may invest heavily in the internal development of innovative knowledge, as well as in the refinement of existing knowledge. A sound, efficient new-product development process that combines both exploratory and exploitative knowledge domains is crucial here. The interface between exploratory knowledge and exploitative knowledge determines how successfully firms will be able to compete in these circumstances. Therefore, it would be sensible to invest in internal knowledge-sharing efforts that span both exploratory and exploitative knowledge, such as the creation of cross-functional teams (Jansen et al., 2009).

In an environment with limited available resources, but stable conditions, firms need to decide as to how they approach their technological development trajectories. They may strive to be game changers. Firms that do so should invest in disruptive technologies and refine existing technologies in response to external prompts. In any case, these firms should aim for quality over quantity, as resources are scarce. The goal is to be selective with regard to the technologies the firm seeks to bring to market: only build on knowledge that has the potential to elicit major change. Firms may also opt to play the game better than the competition. These firms should invest in the refinement of existing technologies. Of course, they should only do so when they are on a sound technological trajectory with high rent-earning potential. Managers of these firms should guard their core knowledge development processes carefully. The aim here is to rely on external ground-breaking exploratory developments to complement a focus on refinement.

Limitations and suggestions for future research

Despite the novel insights into firm-level exploratory and exploitative search strategies that are offered by this study, there are also some limitations of our study that provide interesting avenues for future investigation.

First, while we find several interesting contingent effects of environmental factors on the search-performance relationship, we omit firm-level contingencies from our analysis. In doing so, we build on past research that has indicated that the environment is a sufficient explanation of firm behavior and performance (Edelman and Yli-Renko, 2010). However, others have examined the importance of fit between firm and industry (Helfat et al., 2007). For instance, research on industry clock speed has identified an interplay with within-firm clock speed as a driver of performance (Nadkarni and Narayanan, 2007). In light of this research stream, it would be interesting to examine the moderating effects of internal stability and financial slack on the effectiveness of exploratory and exploitative search activities. Past research on exploration and exploitation has highlighted the importance of slack (Jansen et al., 2012; O'Reilly and Tushman, 2008), but has not done so in conjunction with environmental factors such as dynamism and resource scarcity. As related research finds significant interactions between slack, dynamism and resource availability (Bradley et al., 2011), this interplay could have some interesting implications. For instance, if a firm in a chess-game environment (resource scarcity, low dynamism) combines internal exploitative search with external exploratory search, should it build a stable or fluid organization around it? Likewise, if this firm has sufficient slack, perhaps it can outsource parts of its exploitative activities to optimize effectiveness.

On a related note, we assume that certain abilities and behavior allow firms to make appropriate sourcing decisions. While our objective dataset allows us to uncover long-term effects of search, it lacks richness in terms of the examination of actual firm behavior. Some of our results hint at specific behavior within environmental typologies. While further investigation of these behavioral differences is, no doubt, worthwhile, we also see merit in the examination of differences within environmental typologies. In reality, firms are far from equal when it comes to behaving appropriately in response to environmental factors (Goll and Rasheed, 1997). In part, it is information asymmetry that allows firms to sustain a competitive advantage and the ability to overcome or protect this asymmetry is key (Barney, 1991). As such, future research should explore the interplay between the ability of firms to assess the environment and some of the exploration-exploitation sourcing typologies dealt with in this study. Research on competitive acumen (Tsai et al., 2011), market knowledge (Danneels, 2002) and sensemaking (Weick, 1979) may provide a foundation for inquiry into the ability of firms to read the environment and, in response, identify the appropriate search solution. This implies a cycle between environmental scanning and sourcing of exploitative and exploratory search, which, from a research standpoint, would require a longitudinal perspective. Environments change over time and, as such, the sourcing of search should also change over time. Future research might investigate the ability of firms to change their exploratory and exploitative search-sourcing based on their ability to read the environment and vice versa. This would require an analysis of in-depth industry data, over time, with which a rich narrative may be constructed detailing waves of change and firm reactions to those changes.

Finally, this research project is not about organizing and structuring search activities, so insights from this study do not directly answer the question of whether search should be organized in the intra-organizational domain or through inter-organizational solutions. As argued in prior studies, inter-organizational relationships can be organized in a number of ways and different types of governance provide different learning opportunities (Keil et al., 2008; Schildt et al., 2005; Van de Vrande et al., 2011). Combining the insights from this study with the literature on external knowledge sourcing highlights an interesting avenue for future research, which may contribute to answering questions related to the management of organizational boundary-spanning exploratory and exploitative search activities.

To summarize, we have shown that there is more to firm search and exploration and exploitation than has previously been asserted. We highlight the moderating effect of the environment on the relationship between search and performance. The inclusion of environmental resource scarcity into our analysis has led to novel insight into the role of the environment in value creation and appropriation from exploratory and exploitative search. In fact, scarcity appears to be decisive in determining the impact of combining

exploratory and exploitative search. In highly munificent environments, no combination of search types yields positive results, even when dynamism is high. Firms seeking to maximize their search potential appear to adapt to both industry dynamism, as well as to the available resources within their industry. Even when the environment is not dynamic, but resources are low and conditions are tight, firms may still create value on the basis of their exploratory and exploitative search activities.

CRediT authorship contribution statement

Michiel P. Tempelaar: Conceptualization, Writing - original draft, Writing - review & editing, Project administration, Methodology, Investigation, Visualization, Resources. **Vareska van de Vrande:** Conceptualization, Writing - original draft, Writing - review & editing, Methodology, Formal analysis, Investigation, Data curation, Visualization, Resources.

References

Ahuja, G., Katila, R., 2004. Where do resources come from? The role of idiosyncratic situations. Strat. Manag. J. 25, 887–907.
Aldrich, H.E., 2008. Organizations and Environments. Prentice-Hall, Englewood Cliffs, N. J.
Aldrich, H.E., Mindlin, S., 1978. Uncertainty and dependence: two perspectives on environment. In: Karpit, L. (Ed.), Organization and Environment. Sage, Beverly Hills, CA, pp. 149–170.
Anderson, P., Tushman, M., 2001. Organizational environments and industry exit: the effects of uncertainty, munificence and complexity. Ind. Corp. Change 10, 675–711.
Aragon-Correa, J.A., Sharma, S., 2003. A contingent resource-based view of proactive corporate environmental strategy. Acad. Manag. Rev. 28 (1), 71–88.
Avery, G.C., 2004. Understanding Leadership: Paradigms and Cases. Sage.
Bakker, R.M., Shepherd, D.A., 2017. Pull the plug or take the plunge: multiple opportunities and the speed of venturing decisions in the Australian mining industry. Acad. Manag. J. 60 (1), 130–155.
Barney, J.B., 1991. Firm resources and sustained competitive advantage. J. Manag. 17 (1), 99–120.
Baum, R.J., Wally, S., 2003. Strategic decision speed and firm performance. Strat. Manag. J. 24 (11), 1107–1129.
Belderbos, R., Faems, D., Leten, B., Van Looy, B.V., 2010. Technological activities and their impact on the financial performance of the firm: exploitation and exploration within and between firms. J. Prod. Innovat. Manag. 27 (6), 869–882.
Belderbos, R., Cassiman, B., Faems, D., Leten, B., Van Looy, B.V., 2013. Co-ownership of intellectual property: exploring the value-appropriation and value-creation implications of co-patenting with different partners. Res. Pol. 43 (5), 841–852.
Benner, M.J., Tushman, M., 2002. Process management and technological innovation: a longitudinal study of the photography and paint industries. Adm. Sci. Q. 47, 676–706.
Bharadwaj, A.S., Bharadwaj, S.G., Konsynski, B.R., 1999. Information technology effects on firm performance as measured by Tobin's q. Manag. Sci. 45 (7), 1008–1024.
Billinger, S., Stieglitz, N., Schumacher, T.R., 2013. Search on rugged landscapes: an experimental study. Organ. Sci. 25 (1), 93–108.
Boyd, B., 1990. Corporate linkages and organizational environment: a test of the resource dependence model. Strat. Manag. J. 11 (6), 419–430.
Boyd, B.K., 1995. CEO duality and firm performance: a contingency model. Strat. Manag. J. 16, 301–312.
Bradley, S.W., Shepherd, D.A., Wiklund, J., 2011. The importance of slack for new organizations facing "tough" environments. J. Manag. Stud. 48, 1071–1097.
Breton-Miller, L., Miller, D., 2015. The paradox of resource vulnerability: considerations for organizational curatorship. Strat. Manag. J. 36 (3), 397–415.
Cao, Q., Gedajlovic, E., Zhang, H., 2009. Unpacking organizational ambidexterity: dimensions, contingencies, and synergistic effects. Organ. Sci. 20, 781–796.
Castrogiovanni, G.J., 1991. Environmental munificence: a theoretical assessment. Acad. Manag. Rev. 16, 542–565.
Child, J., 1972. Organizational structure, environment, and performance-the role of strategic choice. Sociology 6, 1–22.
Choi, S., McNamara, G., 2018. Repeating a familiar pattern in a new way: the effect of exploitation and exploration on knowledge leverage behaviors in technology acquisitions. Strat. Manag. J. 39 (2), 356–378.
Cohen, W.M., Levinthal, D.A., 1990. Absorptive capacity: a new perspective on learning and innovation. Adm. Sci. Q. 35 (1), 128–152.
Courtney, H., Kirkland, J., Viguerie, P., 1997. Strategy under uncertainty. Harv. Bus. Rev. 75 (6), 67–79.
Cyert, R., March, J.G., 1963. A Behavioral Theory of the Firm. Prentice-Hall, Englewood Cliffs, N.J.
D'Aveni, R.A., 1994. Hypercompetition: Managing the Dynamics of Strategic Management. The Free Press, New York.
Danneels, E., 2002. The dynamics of product innovation and firm competencies. Strat. Manag. J. 23, 1095–2021.
Dess, G.D., Beard, D.W., 1984. Dimensions of organizational task environments. Adm. Sci. Q. 29 (1), 52–73.
Dierickx, I., Cool, K., 1989. Asset stock accumulation and sustainability of competitive advantage. Manag. Sci. 35 (12), 1504–1511.
Edelman, L., Yli-Renko, H., 2010. The impact of environment and entrepreneurial perceptions on venture-creation efforts: bridging the discovery and creation views of entrepreneurship. Enterpren. Theor. Pract. 34 (5), 833–856.
Eklund, J.C., Mannor, M.J., 2020. Keep your eye on the ball or on the field? Exploring the performance implications of executive strategic attention. Acad. Manag. J. (in press).
Ezzamel, M., Bourn, M., 1995. Budget allocation in a UK university: contrasting periods of resource availability with resource scarcity. J. Manag. Stud. 32, 313–335.
Fleming, L., 2001. Recombinant uncertainty in technological search. Manag. Sci. 47, 117–132.
Ghemawat, P., Del Sol, P., 1998. Commitment versus flexibility? Calif. Manag. Rev. 40 (4), 26–42.
Gibson, C.B., Birkinshaw, J., 2004. The antecedents, consequences, and mediating role of organizational ambidexterity. Acad. Manag. J. 47, 209–226.
Girod, S.J., Whittington, R., 2017. Reconfiguration, restructuring and firm performance: dynamic capabilities and environmental dynamism. Strat. Manag. J. 38 (5), 1121–1133.
Goll, I., Rasheed, M., 1997. Rational decision-making and firm performance: the moderating role of environment. Strat. Manag. J. 18, 583–591.
Grant, R.M., 1996. Prospering in dynamically-competitive environments: organizational capability as knowledge integration. Organ. Sci. 7 (4), 375–387.
Grant, R.M., Baden-Fuller, C., 2004. A knowledge accessing theory of strategic alliances. J. Manag. Stud. 41 (1).
Greve, H.R., 2003. A behavioral theory of R&D expenditures and innovations: evidence from shipbuilding. Acad. Manag. J. 46 (6), 685–702.
Griliches, Z., 1981. Market value, R & D and patents. Econ. Lett. 7, 183–187.
Hagedoorn, J., Cloodt, M.M.A.H., 2003. Measuring innovative performance: is there an advantage in using multiple indicators? Res. Pol. 32, 1365–1379.
Hall, B., Jaffe, A., Trajtenberg, M., 2005. Market value and patent citations. Rand J. Econ. 36 (1), 16–38.
Hambrick, D.C., D'Aveni, R.A., 1988. Large corporate failures as downward spirals. Adm. Sci. Q. 1–23.
Hannan, M.T., Freeman, J., 1977. The population ecology of organizations. Am. J. Sociol. 83, 929–984.
Hanssen-Bauer, J., Snow, C.C., 1996. Responding to hypercompetition: the structure and processes of a regional learning network organization. Organ. Sci. 7, 413–427.
Harhoff, D., Narin, F., Scherer, F.M., Vopel, K., 1999. Citation frequency and the value of patented inventions. Rev. Econ. Stat. 81 (3), 511–515.
Hawawini, G., Subramanian, V., Verdin, P., 2003. Is performance driven by industry-or firm-specific factors? A new look at the evidence. Strat. Manag. J. 24 (1), 1–16.
He, Z., Wong, P., 2004. Exploration vs. Exploitation: an empirical test of the ambidexterity hypothesis. Organ. Sci. 15, 481–494.
Helfat, C.E., Finkelstein, S., Mitchell, W., Peteraf, M.A., Singh, H., Teece, D.J., Winter, S.G., 2007. Dynamic Capabilities: Understanding Strategic Change in Organizations. Blackwell Publishing, Oxford, U.K.

Hess, A.M., Rothaermel, F.T., 2011. When are assets complementary? Star scientists, strategic alliances, and innovation in the pharmaceutical industry. Strat. Manag. J. 32 (8), 895–909.
Hoang, H., Rothaermel, F.T., 2010. Leveraging internal and external experience: exploration, exploitation, and R&D project performance. Strat. Manag. J. 31 (7), 734–775.
Holmqvist, M., 2004. Experiential learning processes of exploitation and exploration within and between organizations: an empirical study of product development. Organ. Sci. 15 (1), 70–81.
Jaffe, A.B., Trajtenberg, M., Fogarty, M.S., 2000. Knowledge spillovers and patent citations: evidence from a Survey of inventors. Am. Econ. Rev. 90, 215–218.
Jansen, J.J.P., Van den Bosch, F.A.J., Volberda, H.W., 2006. Exploratory innovation, exploitative innovation, and performance: effects of organizational antecedents and environmental moderators. Manag. Sci. 52, 1661–1674.
Jansen, J.J.P., Simsek, Z., Cao, Q., 2012. Ambidexterity and performance in multi-unit contexts: cross-level moderating effects of structural and resource attributes. Strat. Manag. J. 33 (11), 1286–1303.
Jansen, J.J.P., Tempelaar, M.P., Van den Bosch, F.A.J., Volberda, H.W., 2009. Structural differentiation and ambidexterity: the mediating role of integration mechanisms. Organ. Sci. 20 (4), 797–811.
Kaplan, S., 2011. Research in cognition and strategy: reflections on two decades of progress and a look to the future. J. Manag. Stud. 48 (3), 665–695.
Katila, R., 2002. New product search over time: past ideas in their prime? Acad. Manag. J. 45, 995–1010.
Katila, R., Ahuja, G., 2002. Something old, something new: a longitudinal study of search behavior and new product introduction. Acad. Manag. J. 45, 1183–1194.
Kauffman, S.A., 1995. Technology and evolution: escaping the Red Queen effect. McKinsey Q. 1, 118–129.
Keil, T., 2004. Building external corporate venturing capability: initial conditions, learning processes, and knowledge management. J. Manag. Stud. 41, 799–825.
Keil, T., Maula, M., Schildt, H., Zahra, S., 2008. The effect of governance modes and relatedness of external business development activities on innovative performance. Strat. Manag. J. 29, 895–907.
Kim, T., Rhee, M., 2009. Exploration and exploitation: internal variety and environmental dynamism. Strat. Organ. 7 (1), 11–41.
Koberg, C.S., 1987. Resource scarcity, environmental uncertainty, and adaptive organizational behavior. Acad. Manag. J. 30, 798–807.
Kogut, B., Zander, U., 1992. Knowledge of the firm, combinative capabilities, and the replication of technology. Organ. Sci. 3 (3), 383–397.
Koka, B.R., Madhavan, R., Prescott, J.E., 2006. The evolution of interfirm networks: environmental effects on patterns of network change. Acad. Manag. Rev. 31 (3), 721–737.
Kotha, S., Nair, A., 1995. Strategy and environment as determinants of performance: evidence from the Japanese machine tool industry. Strat. Manag. J. 16 (7), 497–518.
Lane, P.J., Lubatkin, M., 1998. Relative absorptive capacity and interorganizational learning. Strat. Manag. J. 19 (5), 46–63.
Lane, P.J., Koka, B.R., Pathak, S., 2006. The reification of absorptive capacity: a critical review and rejuvenation of the construct. Acad. Manag. Rev. 31 (4), 833–863.
Laursen, K., 2012. Keep searching and you'll find: what do we know about variety creation through firms' search activities for innovation? Ind. Corp. Change 21 (5), 1181–1220.
Laursen, K., Salter, A., 2006. Open for innovation: the role of openness in explaining innovation performance among UK manufacturing firms. Strat. Manag. J. 2, 131–150.
Lavie, D., 2006. The competitive advantage of interconnected firms: an extension of the resource-based view. Acad. Manag. Rev. 31 (3), 638–658.
Lavie, D., 2007. Alliance portfolios and firm performance: a study of value creation and appropriation in the US software industry. Strat. Manag. J. 28 (12), 1187–1212.
Lavie, D., Kang, J., Rosenkopf, L., 2011. Balance within and across domains: the performance implications of exploration and exploitation in alliances. Organ. Sci. 22 (6), 1517–1538.
Lavie, D., Rosenkopf, L., 2006. Balancing exploration and exploitation in alliance formation. Acad. Manag. J. 49 (4), 797–818.
Lavie, D., Stettner, U., Tushman, M.L., 2010. Exploration and exploitation within and across organizations. Acad. Manag. Ann. 4 (1), 109–155.
Lawrence, P.R., Lorsch, J.W., 1967. Differentiation and integration in complex organizations. Adm. Sci. Q. 12, 1–47.
Levinthal, D.A., March, J.G., 1993. The myopia of learning. Strat. Manag. J. 14, 95–112.
Levinthal, D.A., Posen, H.E., 2007. Myopia of selection: does organizational adaptation limit the efficacy of population selection? Adm. Sci. Q. 52 (4), 586–620.
Levinthal, D.A., Warglien, M., 1999. Landscape design: designing for local action in complex worlds. Organ. Sci. 10 (3), 342–357.
Lieberman, M.B., Montgomery, D.B., 1988. First mover advantages. Strat. Manag. J. 9, 41–58.
Liebeskind, J.P., 1996. Knowledge, strategy, and the theory of the firm. Strat. Manag. J. Spec. Issue 17, 93–107.
Lubatkin, M.H., Shrieves, R.E., 1986. Toward reconciliation of market performance measures to strategic management research. Acad. Manag. Rev. 11 (3), 497–512.
Mauri, A.J., Michaels, M.P., 1998. Firm and industry effects within strategic management: an empirical examination. Strat. Manag. J. 19 (3), 211–219.
McEvily, B., Zaheer, A., 1999. Bridging ties: a source of firm heterogeneity in competitive capabilities. Strat. Manag. J. 20 (12), 1133–1156.
McGrath, R.G., 1997. A real options logic for initiating technology positioning investments. Acad. Manag. Rev. 22 (4), 974–996.
Miller, D.J., Fern, M.J., Cardinal, L.B., 2007. The use of knowledge for technological innovation within diversified firms. Acad. Manag. J. 50 (2), 307–326.
Miller, D., Friesen, P.H., 1982. Innovation in conservative and entrepreneurial firms: two models of strategic momentum. Strat. Manag. J. 3 (1), 1–25.
Miller, D., Friesen, P.H., 1983. Strategy-making and environment: the third link. Strat. Manag. J. 4, 221–235.
Milliken, F.J., 1987. Three types of perceived uncertainty about the environment: state, effect, and response uncertainty. Acad. Manag. Rev. 12 (1), 133–143.
Nadkarni, S., Narayanan, V.K., 2007. Strategic schemas, strategic flexibility, and firm performance: the moderating role of industry clockspeed. Strat. Manag. J. 28, 243–270.
Nadkarni, S., Chen, J., 2014. Bridging yesterday, today, and tomorrow: CEO temporal focus, environmental dynamism, and rate of new product introduction. Acad. Manag. J. 57 (6), 1810–1833.
O'Reilly, C.A., Tushman, M.L., 2008. Ambidexterity as a dynamic capability: resolving the innovator's dilemma. Res. Organ. Behav. 28, 185–206.
Oxenfeldt, A.R., Kelly, A.O., 1968. Will successful franchise systems ultimately become wholly owned chains? J. Retailing 44, 69–83.
Pacheco-de-Almeida, G., Zemsky, P.B., 2012. Some like it free: innovators' strategic use of disclosure to slow down competition. Strat. Manag. J. 33 (7), 773–793.
Pakes, A., 1985. On patents, R&D and the stock market rate of return. J. Polit. Econ. 93, 390–409.
Pfeffer, J., Salancik, G.R., 1978. The External Control of Organizations: A Resource Dependence Perspective. Harper and Row, New York.
Phelps, C.C., 2010. A longitudinal study of the influence of alliance network structure and composition on firm exploratory innovation. Acad. Manag. J. 53 (4), 890–913.
Posen, H.E., Levinthal, D.A., 2012. Chasing a moving target: exploitation and exploration in dynamic environments. Manag. Sci. 58 (3), 587–601.
Postrel, S., 2002. Islands of shared knowledge: specialization and mutual understanding in problem-solving teams. Organ. Sci. 13 (3), 303–320.
Raisch, S., Birkinshaw, J., 2008. Organizational ambidexterity: antecedents, outcomes, and moderators. J. Manag. 34 (3), 375–409.
Reed, R., DeFillippi, R.J., 1990. Causal ambiguity, barriers to imitation, and sustainable competitive advantage. Acad. Manag. Rev. 15 (1), 88–102.
Rosenkopf, L., Nerkar, A., 2001. Beyond local search: boundary-spanning, exploration, and impact in the optical disc industry. Strat. Manag. J. 22, 287–307.
Rosenkopf, L., McGrath, P., 2011. Advancing the conceptualization and operationalization of novelty in organizational research. Organ. Sci. 22 (5), 1297–1311.
Rowley, T., Behrens, D., Krackhardt, D., 2000. Redundant governance structures: an analysis of structural and relational embeddedness in the steel and semiconductor industries. Strat. Manag. J. 21 (3), 369–386.
Schildt, H.A., Maula, M.V.J., Keil, T., 2005. Explorative and exploitative learning from external corporate ventures. Enterpren. Theor. Pract. 29 (4), 493–515.
Schilke, O., 2014. On the contingent value of dynamic capabilities for competitive advantage: the nonlinear moderating effect of environmental dynamism. Strat. Manag. J. 35 (2), 179–203.
Sidhu, J.S., Commandeur, H.R., Volberda, H.W., 2007. The multifaceted nature of exploration and exploitation: value of supply, demand, and spatial search for innovation. Organ. Sci. 18, 20–38.
Simsek, Z., 2009. Organizational ambidexterity: towards a multilevel understanding. J. Manag. Stud. 46, 597–624.

Sirmon, D.G., Hitt, M.A., Arregle, J.L., Campbell, J.T., 2010. Capability strengths and weaknesses in dynamic markets: investigating the bases of temporary competitive advantage. Strat. Manag. J. 31, 1386–1409.
Sirmon, D.G., Hitt, M.A., Ireland, R.D., 2007. Managing firm resources in dynamic environments to create value: looking inside the black box. Acad. Manag. Rev. 32, 273–292.
Soh, P.H., 2010. Network patterns and competitive advantage before the emergence of a dominant design. Strat. Manag. J. 31 (4), 438–461.
Sorensen, J.B., Stuart, T.E., 2000. Aging, obsolescence, and organizational innovation. Adm. Sci. Q. 45, 81–112.
Staw, B.M., Szwajkowski, E., 1975. The scarcity-munificence component of organizational environments and the commission of illegal acts. Adm. Sci. Q. 345–354.
Stettner, U., Lavie, D., 2014. Ambidexterity under scrutiny: exploration and exploitation via internal organization, alliances, and acquisitions. Strat. Manag. J. 35 (13), 1903–1929.
Stuart, T.E., Podolny, J.M., 1996. Local search and the evolution of technological capabilities. Strat. Manag. J. 17 (S1), 21–38.
Taylor, W., 1993. Message and muscle: an interview with Swatch titan Nicolas Hayek. Harv. Bus. Rev. 71 (2), 98–110.
Tiwana, A., 2008. Do bridging ties complement strong ties? An empirical examination of alliance ambidexterity. Strat. Manag. J. 29, 251–272.
Tsai, W., Su, K.H., Chen, M.J., 2011. Seeing through the eyes of a rival: competitor acumen based on rival-centric perceptions. Acad. Manag. J. 54, 761–778.
Tushman, M.L., Anderson, P., 1986. Technological discontinuities and organizational environments. Adm. Sci. Q. 31, 439–465.
Tushman, M.L., O'Reilly III, C.A., 1996. Ambidextrous organizations: managing evolutionary and revolutionary change. Calif. Manag. Rev. 38 (4), 8–29.
Uotila, J., Maula, M., Keil, T., Zahra, S.A., 2009. Exploration, exploitation, and financial performance: analysis of S&P 500 corporations. Strat. Manag. J. 30 (2), 221–231.
Van de Vrande, V., Vanhaverbeke, W., Duysters, G., 2011. Technology in-sourcing and the creation of pioneering technologies. J. Prod. Innovat. Manag. 28, 974–987.
Wan, W.P., Hoskisson, R.E., 2003. Home country environments, corporate diversification strategies, and firm performance. Acad. Manag. J. 46 (1), 27–45.
Wang, H., Chen, W.R., 2010. Is firm-specific innovation associated with greater value appropriation? The roles of environmental dynamism and technological diversity. Res. Pol. 39 (1), 141–154.
Weick, K.E., 1979. The Social Psychology of Organizing. McGraw-Hill, New York.
Wiklund, J., Shepherd, D., 2005. Entrepreneurial orientation and small business performance: a configurational approach. J. Bus. Ventur. 20 (1), 71–91.
Windrum, P., 2004. Leveraging technological externalities in complex technologies: Microsoft's exploitation of standards in the browser wars. Res. Pol. 33 (3), 385–394.
Williamson, O.E., 1975. Markets and Hierarchies, p. 2630. New York.
Yin, X., Shanley, M., 2008. Industry determinants of the "merger versus alliance" decision. Acad. Manag. Rev. 33 (2), 473–491.
Zahra, S.A., George, G., 2002. Absorptive capacity: a review, reconceptualization, and extension. Acad. Manag. Rev. 27 (2), 185–203.

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