Keep searching and you'll find: What do we know about variety creation through firms' search activities for innovation?

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Abstract. The paper reviews contributions found in theoretical and empirical studies of innovation search processes at the firm-level. The advantages for local and non-local search are discussed and potential triggers for local and non-local search are specified. It is argued that the initial focus in the literature on local search was, in part, a consequence of the fact that the literature departed from evolutionary economics that, from the birth, centered on path-dependent behavior. However, later, as localized behavior became increasingly accepted as the standard mode of behavior in the innovation literature — and more broadly in strategic management — contributions began to question the univocal virtues of local search as the best solution in all cases. More recently, the literature has focused on the trade-offs created by firms having to balance local and non-local search. In the conclusion an attempt is made to reconcile the "stylized fact" that organizations within the same industry tend to follow different search strategies, but end up having very similar technological profiles. The paper ends by suggesting new avenues for research on search for variety to foster innovation.

Keywords. Variety creation, innovation, search

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Long ago, Alfred Marshall pointed to the importance of diverse business approaches for economic progress: “Every locality has incidents of its own which affect in various ways the methods of arrangement of every class of business that is carried on in it: and even in the same place and the same trade no two persons pursuing the same aims will adopt exactly the same routes. *The tendency to variation is a chief cause of progress; and the abler are the undertakers in any trade the greater will this tendency be.*” (Marshall 1890/1949: 295, italics added). Later, evolutionary economics and the strategic management of innovation literature both stressed the importance of firms having access to a variety of inputs to be able to produce successful innovations, that in turn affect firms’ competitive advantage (e.g., Nelson and Winter 1982, Metcalfe 1994, Cohen and Malerba 2001, Fleming and Sorenson 2001, Rosenkopf and Nerkar 2001, Katila and Ahuja 2002, Laursen and Salter 2006).

However, given that firms and their decision-makers have only limited attention available to them (Simon 1947, Ocasio 1997), searching for, and managing such variety is not an easy task, as it often involves searching for solutions in alien technological domains (Cyert and March 1963, Katila and Ahuja 2002), and typically demands firms to work with a variety of non-local individuals (such as scientists) or organizations (such as supplier firms) that may each have different norms, habits and rules; often requiring different organizational practices in order to make the search processes successful (Laursen and Salter 2006). In addition, empirical research has shown that firms tend to search predominantly locally (Stuart and Podolny 1996, Tripsas and Gavetti 2000) and that firm’s observed (*ex post* search) technological profiles — within the same industry — display remarkably small signs of technological variety (Patel and Pavitt 1997). In other words, there seems to be en in-built trade-off between the advantages firms can gain from variety and the amount of variety they are effectively able to manage.[1]

The paper draws on — and reviews — contributions found in theoretical and empirical studies of innovation processes at the firm-level. The advantages for local and non-local search are discussed and potential triggers for local and non-local search are specified, including firm-specific triggers ("problemistic", slack search, and search based on idiosyncratic situations), and new technological opportunities that is seen as an expansion of the overall potential search space of available to firms. Subsequently, the paper critically review the available empirical evidence on firms' search for a variety of knowledge inputs, arguing that the initial focus in the literature on local search was, in part, a consequence of the fact that the literature, by and large, departed from evolutionary economics that from the outset centered on path-dependent behavior. However, later, as localized behavior became increasingly accepted as the standard mode of behavior in the innovation literature — and more broadly in strategic management — contributions started to question the some of the virtues of local search. More recently, the literature has focused on the trade-offs triggered by firms having to balance local and non-local search. This discussion is followed by a portrayal of the mechanisms — all involving a division of labor — that can be used to alleviate part of the trade-off (a diverse set of employees, formal collaboration, informal knowledge exchange, markets for technology, user networks, broadcast search, ect.). In the conclusion, an attempt is made to reconcile the empirical finding that organizations within the same industry tend to follow different search strategies, but end up having very similar technological profiles. The paper ends by suggesting new issues for research on search for innovation.

[1] Phrased in terms of evolutionary economics this could be called a firm-level trade-off between the mechanisms of preservation and transmission (trough organizational routines) and the mechanisms of variety-creation (see Andersen 1994: 14-15).

The role of a variety of inputs in the innovation process

Following earlier research (Schumpeter 1912/1934, Nelson and Winter 1982, Kogut and Zander 1992, Fleming and Sorenson 2004), in this paper, innovation is seen as a result of the novel integration of previously separate bodies of knowledge with a commercial application. With this definition of innovation, variety becomes a central. Evolutionary economists highlight the role of search in helping organizations to find sources of variety, allowing them to create new combinations of technologies and other knowledge (Nelson and Winter 1982). Accordingly, a variety of knowledge inputs provides opportunities for firms to choose among different technological paths (Metcalfe 1994). And the more approaches there are to a given technological objective, the greater the possibilities for improvements in products' quality and performance, or in manufacturing costs (Nelson 1961, Evenson and Kislev 1976, Nelson 1982, Cohen and Malerba 2001).

Why it is (most) often advantageous to conduct local search?

Based on earlier behavioralistic insights (in particular, Cyert and March 1963), evolutionary economists such as Dosi (1982) and Nelson and Winter (1982) argued that search processes are almost always highly localized, in that firms search along established trajectories created by past experiences, routines and heuristics (see also, Nelson 1991, Malerba 1992). Sorenson and Fleming (2004) define "local" (search) as referring to activities that relate quite closely to prior activities, "…by definition implying some experience with the technologies being developed." Two fundamental reasons may be given for the dominant tendency to conduct local search (Helfat 1994). First, humans' limited cognitive abilities gives rise to boundedly rational behavior (Simon 1982) so that managers and other problem solvers are unable to consider all possible options for solutions to problems, and are also unable to accurately evaluate the potential option's future prospects for performance. Second, the accumulated knowledge base facilitates learning that is related to that knowledge. For that reason it may often — as a starting point — be wise for a firm to search for innovative solutions for new processes, products and services in areas where it already has expertise. In the words of Nelson and Winter, organizations are "…typically much better at the tasks of self-maintenance in a constant environment than they are at major change, and much better at doing "more of the same" than they are at any other kind of change." (Nelson and Winter 1982: 9-10). In other words, learning is easier, when it is restricted to familiar and proximate neighborhoods (Cohen and Levinthal 1990). Although local search has a lower potential for knowledge recombination of a more radical nature, the search costs for local solutions are most often much lower within a familiar domain (Rosenkopf and Almeida 2003), one of the reasons being resistance to communication across knowledge boundaries (Carlile 2002). In addition, since agents develop an understanding of the "local" elements that can potentially be combined, they are better able to invent with greater reliability by avoiding elements that did not work in the past (Fleming and Sorenson 2004). In sum, there are clear advantages for organizations in conducting local search their problem-solving activity, including problem-solving related to innovation.

The need for variety creation through boundary-spanning search

While empirical evidence suggests that evolutionary economics is right in observing that firms are constrained in the range of choices they have, and that most often, local search is the most efficient mode of search due to its relatively low costs (Helfat 1994, Stuart and Podolny 1996, Tripsas and Gavetti 2000), recent contributions have paid a substantial amount of attention to the disadvantageous sides of local search — sides that can be potentially damaging and eventually lethal to organizations when they become too reliant on local search (Levinthal and March 1993, Gavetti and Levinthal 2000, Tripsas and Gavetti 2000, Levinthal and Rerup 2006). The setback with local search is that in recurrent cases, the knowledge input required to solve a given problem will likely not coincide with one's current knowledge base and therefore the need to go beyond the boundaries of an organization or community for complementary knowledge may be quite prevalent (Postrel 2002) — local sources of inputs may often offer too little inspiration and variety for problem solution. In other words, the local environment may not offer enough opportunities for knowledge combination and recombination (Rosenkopf and Nerkar 2001, Fleming and Sorenson 2004). If taken too far, local search can lead to myopic behavior (March 1991, Levinthal and March 1993) due to cognitive biases where superior solutions from more distant knowledge domains — often nested in communities beyond the immediate boundary of the focal organization — are systematically overlooked. The widely "not invented here" syndrome in part reflects these myopic tendencies among teams and managers (Katz and Allen 1982).

Triggers of search for variety

"Problemistic", slack search and search based on idiosyncratic situations

The behavioral theory of the firm (Cyert and March 1963) posit that one of the central types of search firms perform is "problemistic search" (i.e., search triggered by a problem). Such search is initiated when managers find that organizational performance is below their perceived aspiration level — a level that is in part a function of prior performance. Consequently, if an organization is under competitive pressure (in particular through pressure from price competition or rival innovation), it may increase its search for innovation when managers decide that upgrading processes and products can solve the performance problems (Greve and Taylor 2000, Greve 2003). For instance, organizations with declining profits may enter R&D races in an attempt to restore profitability (Kamien and Schwarz 1982, Antonelli 1989). Building on Bolton's (1993) work, Greve (2003) argues and empirically demonstrate that performance below the aspiration level not only makes managers search for solutions but also makes them more likely to accept inherently risky solutions, by for instance, spending more on research and development activities.

However, not only the level of search activities may be affected by problemistic search, also the type of search may affect the search for variety and the outcome in terms of the degree of radicalness in innovations. Firms that are facing innovations from their rivals or increased price competition from competitors have incentives to change their internal routines and hence unlock innovation potential that may have been previously held up by risk aversion or everyday business practices (McDermott and O'Connor 2002).

The selection of a strategy to meet the immediate threat to companies' sustained profits is, however, not random and short-term incentives are not the only drivers of radical innovation. Substantial resources are required too — resources that may not be available to firms under external pressure. Cost efficiency considerations and commitment to certain types of existing products, processes or business practices will induce companies to choose not to engage in making radical changes. In other words, there may be widespread inertia in firms' reactions to these competitive circumstances (Tripsas and Gavetti 2000, Gilbert 2005). Accordingly, to meet an immediate decline in a company's profits, managers may typically not be able to conduct large scale R&D to develop radical combinations and recombinations of technologies and other kinds of knowledge. Rather, many companies will search for the less challenging path out of the competitive situation by attempting to innovate incrementally; that is, to recombine existing knowledge moderately. Put differently, when under extreme competitive pressure, firms should be expected to focus on updating exiting products in an incremental way based on the exploitation of existing ideas, rather than focusing on the exploration associated with radical innovation (March 1991), when such innovation may require long-term investments in order to become successful in the market.

This outlook is consistent with the view that competitive pressures may substantially reduce or remove the organizational slack of firms that is otherwise needed to produce more radical recombinations (Cyert and March 1963). While looking at declining organizations, Wiseman and Bromily (1996: 524) assert that the relationship between risk taking behavior and performance can be expressed as "…a cyclical process with positive feedback in which decline and the loss of certain slack resources increases risk which in turn reduces performance and results in further organizational shrinkage. Thus firms facing decline fall into a trap of taking unprofitable risks that ultimately exacerbates the decline." Regarding innovation, unprofitable risk may often encompasses a focus on producing incremental innovation rather than radical innovation, as radical innovation requires slack to allow for the more broad and explorative search needed to produce this type of innovation (Knight 1967, Özcan 2005). In the innovation context, Nohria and Gulati (1996) demonstrate that there is a curvilinear relationship (taking an inverted U-shape) between functional departments' level of slack and their perceived innovativeness. This may especially be the case for radical innovation as an organization needs a certain amount of slack to be able to pursue more radically new combinations of knowledge (Cyert and March 1963, Greve 2003) by searching broadly among a variety of possible inputs, as these innovations remain unpredictable — given high levels of uncertainty — in their technological and market outcomes (Pavitt 2005).

Ahuja and Katila (2004) posit that "idiosyncratic situations" may also trigger path breaking search. These situations include in particular, technological exhaustion and expansion beyond national markets. The authors show that US-based chemical firms conduct more search drawing on science, when they face a high degree of technological exhaustion. The authors also show that changes in firms' product market presence triggers changes in the international research presence of the firm.

New technological and scientific opportunities

Technological opportunities comprise the set of possibilities for technological advance and may be measured as the returns to R&D, given demand conditions, the current level of technology, and the appropriability regime (Klevorick et al. 1995: 188). Arguably, new technological opportunities gives more variety in the possibilities for combining and recombining knowledge elements through technological search. As resources are devoted to R&D and projects are completed, the pool of opportunities can be depleted and the possibilities for combining and recombining knowledge become limited. However, the pool of opportunities are refilled through the sources of opportunity, including the advance of scientific understanding; technological advance originating outside of the industry; and through new possibilities opened up by feedbacks resulting from current innovations (ibid, 1995: 189). Accordingly, whenever the pool of opportunities is replenished, it is implied that a period of incremental change is replaced by a period of ferment — a period in which radical innovations materialize (Tushman and Anderson 1986), possibly to the extent that a new technological paradigm emerges (Dosi 1982). The theory of recombinant invention (Utterback 1994, Hargadon and Sutton 1997, Fleming 2001) provides another related argument for why new technological opportunities may lead to recombinations of a variety of inputs of more radical nature. According to this theory, inventors' experimentation with the combination of new components and configurations of previously combined components leads to less technological success on average, but it increases the variability that can lead to technological breakthroughs associated with radical innovation (Fleming 2001). However as technologies mature, the likelihood that high-utility combinations of the technology's elements have not been tried or exploited already must eventually decline (Ahuja and Lampert 2001). As a result, new technological opportunities offer the possibility of radical combinations and re-combinations. In other words, new technological opportunities may allow technologies that hitherto were separate to be combined in a new, complex and valuable fashion.

In many cases advances in basic scientific research has led to new combinations of a more radical nature — in particular in science-based industries (Nelson 1959, Klevorick et al. 1995). Although basic scientific research may eventually lead to a technological breakthrough, it is fundamentally uncertain when and where the results of basic research may be applied (Nelson 1959, Pavitt 1993). In the words of Nelson (1959: 300): “Moving from the applied-science end of the spectrum to the basic-science end, the degree of uncertainty about the result of specific research projects increases, and the goals become less clearly defined and less closely tied to the solution of a specific practical problem or the creation of a practical object.” The reason why basic science has often led to radical breakthroughs can, thus, be connected to the observation that basic research addresses fundamental questions that are not necessarily constrained by the solution to a practical problem. The results of the research are, moreover, fully and freely disseminated to a large community, so that the sources of new ideas are numerous and varied (Dasgupta and David 1994, Fleming and Sorenson 2004).

Why organizations often don’t get it right

Although there are several inducement mechanisms for firms to conduct variety generating search for innovation, many firms apply dysfunctional search strategies, implying that firms search too much or too little, or conduct too much of one type of search at the expense of other types of search (see for instance, Katila 2002, Rosenkopf and Almeida 2003, He and Wong 2004, Laursen and Salter 2006). In particular, in industries of rapid change, search is often conducted under extreme time pressure and this pressure may lead firms to adopt too narrow or too broad search routines (Levinthal and March 1993). The literature has a number of explanations for these inabilities. As mentioned above, many firms are subject to cognitive bias against external sources and may be myopic in their search processes (March 1991, Levinthal and March 1993). The search processes of firms are severely constrained by time and resources (Koput 1997). In the case of too narrow, or myopic search processes, the search process itself may be hampered by a lack of resources in terms of the lack of funds and skilled personnel to explore different potential combinations. Models of innovative search also highlight limited cognitive abilities of agents and the need for agents to concentrate their attention or mindfulness on a limited range of potential alternatives rather than searching the broad environment or following many different paths simultaneously (Simon 1947, Ocasio 1997, Gavetti and Levinthal 2000). Given that search strategies are rooted in the past experiences and future expectations of managers, such experience and expectations may in contrast, also lead firms to over-search the external environment with an equal detrimental outcome as the result.

Empirical evidence on firms' search for a variety of knowledge inputs: From local to boundary spanning search

Local versus non-local search

Table 1 below presents an overview of the some of the literature on variety generating search for innovation — in particular the subset of contributions that are based on quantitative empirical research. One important thing to note from the table is the shift in balance in the literature from a focus on local search, to a focus on how firms can balance the necessity of local search with the less pressing — but nonetheless essential — requirement for boundary-spanning or non-local search. Another trend has to do with an increased attention to the fact that there are important costs associated with search (in particular non-local search has high costs) — and that given cognitive limitations of the mangers, organizations may not only conduct too little search — they may also in some cases conducts too much search. These shifts in the emphasis in the literature may reflect an increasing understanding of the multifaceted reality firms and their managers face. However, it may also reflect the evolution of the literature itself that has to with the fact that most of the search for innovation literature took evolutionary economics (often together with the resource based view of the firm and/or behavioralistic theory) as the point of departure. A central aim of evolutionary economics was to construct a theory with more "realistic" assumptions that broke with the standard behavioral assumptions made in orthodox economics (Nelson and Winter 1982, Dosi 2000). One of the most central assumptions in evolutionary economics is that organizations and their managers are unable to maximize globally. Instead, firms are assumed to base their decisions on past experiences and based on that, display "satisficing behavior." As a starting point, such assumptions quite easily gives rise to local search behavior. Accordingly, some of the seminal early contributions (e.g. Sahal 1985, Burgelman 1994, Helfat 1994, Stuart and Podolny 1996) in the search literature were understandably focused on examining the assumptions and predictions made in evolutionary economics and in the related field of strategic management.

[Insert Table 1, just about here]

Later, however, as localized behavior became increasingly accepted in the innovation literature — and more broadly in strategic management — contributions started to question the unambiguous virtues of local search, both theoretically (e.g., Levinthal and March 1993, e.g., Gavetti and Levinthal 2000, Levinthal and Rerup 2006), as well as empirically (e.g., Tripsas and Gavetti 2000, Rosenkopf and Nerkar 2001, Katila and Ahuja 2002, Rosenkopf and Almeida 2003, Fleming and Sorenson 2004, He and Wong 2004). These more recent contributions have worked from the assumption that search continues to be predominantly local, but have tried to analyze how organizations can respond to avoid ending up in a "local search trap" and how organizations can somehow balance local and non-local search.

Organizational responses to the local search problem

Variety among organizational members. Organizations may employ people with varied backgrounds in the attempt to avoid to fall into the local search trap. Research emphasizing the advantages of diversity in human resources, stresses flexible adaptation to a changing environment (Priem 1990, Lyles and Schwenk 1992, O'Reilly 1993, Sutton and Hargadon 1997, Galunic and Rjordan 1998). As Lyles and Schwenk (1992) assert, "diversity may influence a firm's repertoire of the definitions and understandings of how to handle different situations and events." (p.168). It may also lead to more comprehensive problem solving and conflict resolution in the face of novel contexts (Priem 1990, O'Reilly 1993). Educational diversity among knowledge workers may be especially important. The reason is that educational categories can be said to represent different bodies of knowledge within firms (Jacobsson and Oskarsson 1995, Carlile 2002), as different types of education may provide people with different basic concepts and models for problem solving and may be seen as the road for individuals to join particular communities of practice, encompassing different institutional norms, habits and rules (Brown and Duguid 1991, Brown and Duguid 2001). In this context, Brown and Duguid (2001: 202) describe how the striking differences in the outlooks of different types of professions, with apparently closely related job functions, may be explained by the existence of such communities of practice. While other types of diversity, such as gender, race and geographical origin may provide different perspectives on problem solving, educational diversity may in addition do something more fundamental, since such diversity brings about the possibility of (re)combining different bodies of knowledge (Sutton and Hargadon 1997, Galunic and Rjordan 1998).

However, educational variety — and other types of variety in firms' human capital — may also carry costs. As Grant (1996: 116) asserts: "…if two people have identical knowledge there is no gain from integration, yet, if the individuals have entirely separate knowledge bases, then integration cannot occur beyond the most primitive level." In other words, increasing educational diversity can carry a performance penalty when costs outweigh the benefits of diversity. For example, a highly diverse human resource pool can undermine organizational capabilities if individuals involved in them do not share enough common knowledge (Buckley and Carter 2004). This can lead to uncoordinated action, delayed decisions, and high communication costs (Hambrick et al. 1996, Casson 1998). Diversity in perspectives might also create a basis for harmful conflict and misunderstanding. In particular when time pressure exists, conflicting views result in haggling and unconstructive bargaining. Another harmful impact of diversity of employee's educational background might be information overload, which alongside decision delays can prevent the integration of individual skills in the pursuit of organizational efficiency (March 1991).

External sources of variety for innovation. A number of possibilities — all involving an increased inter-organizational division of labor — for dealing with the trade-off are also available choices to organizations, although any of the possible ways out of the problem raise their own managerial challenges. Rosenkoph and Almeida (2003) pinpoints two mechanisms that may help overcoming the local search problem — inter-firm collaboration through alliances and inter-firm labor mobility. They argue and empirically substantiate that alliances and the mobility of inventors can serve as bridges to distant contexts and, thus, enable firms to overcome the constraints of contextually localized search.

Katila and Ahuja (2002) investigate the impact of search depth and scope along a technological trajectory on innovative performance, and find that firms often "under search". The authors, however, also pays attention to the costs of search and find that many firms "over search" (especially when they perform local search), and that this has negative performance implications. Laursen and Salter (2006) find that external search breadth and depth using external sources of innovation — such as competitors, costumers, suppliers and universities — lead to higher sales of innovative products, but that some firms "over search" the external environment, given the substantial costs associated with working with many types of external partners. In other words, it pays off to conduct boundary spanning search, but given the associated costs, too much of such search may be harmful.

Fleming and Sorenson (2004) points to the helpful role of scientific thinking when performing "difficult" search and show that patents drawing from science are likely to increase the likelihood of new combinations when technologies a closely coupled. Stated differently, when problems are hard to solve (closely coupled technologies are inherently difficult to recombine), scientific knowledge may serve as a "map" that helps decouple important knowledge elements to allow for new knowledge recombination. Another solution to difficult innovation-related problems (that seem unsolvable through local search), utilizes boundary spanning search, and has been labeled "broadcast search" (Lakhani and Jeppesen 2007). The idea is that if technological problems can be codified precisely, then problems can be broadcast — typically trough electronic media — to a large amount of people with varied backgrounds. Provided incentives to solve the problem by the large solver base, there is a high probability that among the many potential solvers, one of them will have a solution that comes at a relatively low cost.

Concluding remarks and possibilities for future research

The theoretical and empirical literature on variety generation through search for knowledge components for innovation has demonstrated that firms vary in the way and intensity in which they search for new combinations and, moreover, that the resulting resource heterogeneity can lead to variations in organizational performance. Nevertheless, it has been found that firm's observed technological profiles — within the same industry — display remarkably small signs of technological diversity (Patel and Pavitt 1997). In other words, firms within the same industry tend to have very similar technological profiles as expressed in their patenting activities. Two related factors may account for these apparently contradictory finding. First, technological profiles, across patent classes of firms are observed *ex post* the search process. So while firms *ex ante* search for knowledge components with different intensities and in different ways, they are often looking for solutions to similar problems, given their shared industrial context and technological imperatives (Teece 1988, Patel and Pavitt 1997) — these solutions to similar problems are likely to be classified in the same patent classes. Second, advanced organizations do not only rely on their own research in the development of innovations, but also use the innovations of competing organizations as an input to their own innovation processes through various forms of imitation mediated by industrial intelligence activities (Mansfield et al. 1981, Levin et al. 1987, Cassiman and Veugelers 2002, Ziedonis 2004). In that sense, organizations' directions of search are to some extent interdependent. This also would tend to create more similar technological profiles for firms in the same industry.

While the innovation-search literature has answered a number of important questions and has deepened our understanding of the innovative process greatly, some important puzzles for future research remain. One set of questions relate to the role of appropriability when conducting search for innovation. For instance, how do firms engage in knowledge search in the external environment without loosing too much essential knowledge? What is the role of appropriability conditions in this context? Another set of questions relate to how firms prioritize their search-for-new-combinations efforts, given the opportunity costs in terms of other alternative investments. Yet another issue that needs to be addressed, pertains to what kind of search problemistic or slack search give rise to. Prior empirical research has focused on the search intensity (Greve 2003, Chen and Miller 2007), but not on the direction of search. For instance, under which conditions will organizations search for incremental or radical solutions? We still know little about how managers make priorities to allocate their scarce resources for search and other essential activities in a bid to achieve the best performance outcomes.

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Table 1: Overview of some key contributions in the search for innovation literature

Authors	Search variable	Dependent variable	Cost of search	Data type, technology variables	Industry	Main results
Helfat (1994)	R&D intensity	R&D intensity lagged	-	R&D data	US Petroleum industry	Firms tend both to persist and to differ in the amount of effort they devote to various R&D applications
Stuart and Poldony (1996)	Technological position in comparison to other firms	-	-	Patent data	Japanese semiconductor industry	Firms conduct local search. Firms technological position also depends on the R&D of its competitors
Rosenkopf and Nerkar (2001)	Four types of exploration	The search variable is the dept. variable	-	Patent data	Optical dick industry	Exploration that does not span organizations generates lower impact on subsequent technological evolution.
Katila and Ahuja (2002)	Search depth and scope (patent citations)	Number of new product introductions	Through squared terms	Patent data	Robotics industry	Search depth and scope affect the ability to introduce new products, but some firms “over search”
Katila (2002)	Competitor search age and external search age (age of cited patents)	Number of new product introductions	Through squared terms	Patent data	Robotics industry	Old competitor knowledge hurts, but old extra-industry knowledge promotes innovation.
Rosenkopf and Almeida (2003)	Strategic alliances and labor mobility	Knowledge flows (patent citations)	Technological and geographical distance	Patent data	Semiconductor industry	Labor mobility is associated with interfirm knowledge flows regardless of geographical proximity and the usefulness of alliances improve with geographical distance.
Greve (2003)	R&D intensity (+ innovation launches)	The search variable is the dept. variable	-	R&D and product announcement data	Japanese shipbuilding	Problemistic and slack search increase firms’ R&D intensity
Nerkar (2003)	Temporal exploitation and exploration (“recency” and spread measures over time, based on patent citations)	Technological impact and performance measured as patent citations	Through a squared term	Patent data	US pharmaceutical market	A balance in combining current knowledge with the knowledge available across large time spans explains the impact of new knowledge
He and Wong (2004)	Explorative and exploitative innovation strategies	Percentage of sales from new products	-	Survey data	Manufacturing firms from Singapore and the State of Penang in Malaysia	The interaction between explorative and exploitative innovation strategies is positively related to sales growth rate.
Fleming and Sorenson (2004)	“Coupling” among components and cites to science	Citation counts to given patents	-	Patent data	US patents, May and June 1990	Patents drawing from science are likely to increase the likelihood of new combinations when technologies a closely coupled
Nerkar and Roberts (2004)	Proximal and distal technological experience (patent classes)	Sales of new products in the 1st year in the market	-	Patent data	US pharmaceutical market	New products are more successful when a firm possesses the appropriate stocks of technological and product market experience
Laursen and Salter (2006)	Search breadth and dept among external sources of innovation	Percentage of sales from new products	Through a squared term	Survey data	The UK manufacturing sector	External search breadth and depth leads to higher sales of innovative products, but some firms “over search”.
Cassiman and Veugelers (2006)	Internal and externally acquired R&D	Percentage of sales from new products	-	Survey data	The Belgian manufacturing sector	Internal and external search processes are “Edgeworth” complementary
Chen and Miller (2007)	R&D intensity	The search variable is the dept. variable	-	R&D data	The US manufacturing sector	Most of the explained variance in R&D intensity is due to firm effects. Slack is a determinant of search investment decisions for outperforming firms with high accumulated slack, but not for outperforming firms with less slack.