



Selective search, sectoral patterns, and the impact on product innovation performance

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ABSTRACT

The shift toward more open and interconnected innovation activities has been a major topic in recent academic and practitioner discussions. Firms must connect their in-house R&D activities with external partners, such as leading customers or universities, to increase the effectiveness of their innovation activities. Hence, management needs to define where to search for valuable knowledge in its environment. In this paper we argue that knowledge search has to reflect the heterogeneity of various knowledge sources with regard to the knowledge they can provide and how these sources can be activated. We hypothesize that search strategies driven by science, suppliers and the product market will contribute differently to innovation success with new-to-market versus imitated products. Moreover, we explore the effect of these types of knowledge search within different sectoral patterns of innovation. Our empirical analysis rests on a sample of almost 5000 firms from five Western European countries. The results support our hypotheses and highlight the potentials and shortcomings of different types of knowledge search.

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1. Introduction

Research has frequently shown that firm success in technology-driven industries critically depends on the ability to invent and commercialize innovative technology embodied in new products (e.g., Katila, 2002; Katila and Ahuja, 2002). In this respect, firms with the ability to create new technological knowledge have been praised for generating knowledge internally and combining it with external knowledge sources (Rosenkopf and Nerkar, 2001). However, the process of identifying knowledge to be integrated into the organization's own knowledge base requires that firms deliberately search for and reach out to promising knowledge sources. Search has been characterized as the fundamental mechanism enabling firms to learn, evolve and refocus the organizational knowledge base. This goes beyond "local search", which assumes that research and development (R&D) activities are connected to the firm's previous R&D (Nelson and Winter, 1982). The literature has emphasized the importance for firms of moving beyond local search and reconfiguring the existing knowledge base (Kogut and Zander, 1992; Teece et al., 1997). In fact, the type of knowledge search and

the defining direction and priority of boundary-spanning search activities have been found to substantially impact innovation performance (Katila, 2002; Katila and Ahuja, 2002; Laursen and Salter, 2006; Grimpe and Sofka, 2009).

In this paper, we shed new light on the relationship between the type of knowledge search of a firm and its innovation performance. We propose that innovation management requires a more nuanced understanding of the nature and effects of knowledge search to implement them successfully. Prior research has largely focused on the dimensions of overall breadth and depth (e.g., Laursen and Salter, 2006). We argue that the description of knowledge search along its breadth and depth underestimates the degree of heterogeneity among the various knowledge sources they encompass. Instead, we suggest that the choice of a type of knowledge search is a selective process. Management will choose certain directions for the firms' knowledge search that target particular knowledge sources (e.g., product market, science, suppliers).

Based on this conceptualization of selectivity in the knowledge sources that firms target through their particular search, we focus on the implications for a firm's success with new product introductions, thereby leaving out potential effects on other types of innovation like process or organizational innovations. In this respect, we suggest that these targeted types of knowledge search differ with regard to whether they generate new-to-market innovations or imitations, i.e., new-to-firm only. Imitated

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product innovations are distinctively different from new-to-market innovations in their degree of novelty. Imitations refer to existing products, services or processes that are adapted by the focal firm, for example through observing or reverse-engineering competitors' innovations. They could be refined to reinforce their ability to create value for the firm (Ettlie, 1983) or to improve and exploit existing technological trajectories (Gatignon et al., 2004). Contrary to imitations, new-to-market innovations are novel in the sense that they initially do not have a directly competing innovation. Distinguishing between both types of innovation output is important for at least two reasons. First, many studies on innovation focus on patents as output measures that reflect new-to-market innovations because the patent office requires a certain "innovative step" in the novelty of an innovation for it to qualify for a patent application. Nevertheless, a significant amount of business R&D is directed toward imitations. Second, the role of search for external knowledge may be substantially different depending on the type of innovation output the firm seeks to achieve.

Moreover, existing research has mostly focused on the manufacturing sector and, more specifically, on high-technology industries. Identifying how firms learn and how their knowledge evolves, though, should not be limited to manufacturing industries, particularly given the increasing importance of service sectors for most modern economies. Therefore, we adopt a novel typology of sectoral patterns of innovation developed by Castellacci (2008, 2010), which provides an integrated view of innovation characteristics in both manufacturing and services industries. The idea of a sectoral taxonomy is based on Pavitt's (1984) seminal contribution to highlight major features of the innovation processes and the distinct trajectories followed by industrial sectors. It is therefore fitting to integrate the role of search into particular sectoral patterns of innovation. Both the distinction between imitation and new-to-market innovation output and the sectoral pattern of innovation have been largely neglected in the extant discussion of knowledge search (e.g., Katila and Ahuja, 2002; Laursen and Salter, 2006; Rosenkopf and Nerkar, 2001), which is why they warrant further investigation.

While we derive hypotheses for the effects of particular types of knowledge search on the two types of innovation output, we choose an exploratory approach, i.e., no ex-ante hypotheses, for differences of these effects within certain sectoral patterns of innovation. Our empirical study is based on a comprehensive dataset of 4933 manufacturing and service firms from five Western European countries. The data include measures on commercialized innovations, which can be considered superior to patents, an intermediary innovation output and typically only relevant in certain industries (Griliches, 1990). Moreover, the sample from five European countries provides close to representative information on manufacturing and service firms in major Western European economies.

The remainder of the paper is organized as follows. The next section details our theoretical framework to develop our hypotheses. Section 3 describes our empirical methods. Results are presented and discussed in the subsequent two sections. Section 6 concludes with limitations of our study and implications for further research.

2. Theoretical framework

2.1. The role of search for innovation performance

It is widely accepted that a firm's ability to innovate is tied to the pool of knowledge available within the organization (e.g., Subramaniam and Venkatraman, 2001). The generation of new knowledge has traditionally been connected to a firm's in-house research and development (R&D) activities. Recent literature, however, points to the advantages of combining internal investments with external resources (e.g., Cassiman and Veugelers, 2006) to

benefit from complementarities. In other words, firms have begun to open up their innovation processes to external knowledge. This trend of so-called "Open Innovation" allows firms to access and exploit external knowledge while internal resources are focused on core activities (Chesbrough, 2003). Both supply and demand oriented aspects put firms in a position to acquire knowledge externally. On the one hand, there is an increasing availability of external knowledge, e.g., from universities, customers and specialized suppliers (e.g., von Hippel, 1988; Link and Scott, 2005; Perkmann and Walsh, 2007; van Echtelt et al., 2008). On the other hand, firms are pushed to find new sources for external innovation impulses because of increasing competitive pressures, shorter product life cycles as well as technological opportunities beyond their traditional fields of expertise (e.g., Calantone et al., 1997; Chatterji, 1996; Kleinschmidt and Cooper, 1988; Ojah and Monplaisir, 2003). Several studies have identified positive performance effects of incorporating external knowledge (e.g., Gemünden et al., 1992; Laursen and Salter, 2006; Love and Roper, 2004).

A crucial element in the open innovation activities of firms is a firm's search for external knowledge. A firm's external knowledge search encompasses an "organization's problem-solving activities that involve the creation and recombination of technological ideas" (Katila and Ahuja, 2002, p. 1184). Consequently, investments in problem-solving activities should result in favorable combinations and linkages of users, suppliers and other relevant actors in the innovation system. Laursen and Salter (2006) discuss the concepts of breadth and depth as important factors in a firm's search. Leiponen and Helfat (2011) complement this view by extending the concept of breadth to innovation objectives. They find that the breadth of knowledge sources and of innovation objectives positively influence innovation success at the firm level. Although a broader set of external sources and innovation objectives reduces the risk of unexpected developments, it has to be taken into account that a firm is constrained in terms of the capacity to absorb external knowledge (Cohen and Levinthal, 1989, 1990). These limitations include the level of overall attention a firm's management can dedicate to these activities (Ocasio, 1997). A proper search for external knowledge should therefore concentrate on certain external sources as a vast number of information sources would hamper selection and in-depth exploration processes (Koput, 1997). Contrary to search breadth, search depth can be described as the extent to which firms draw deeply from various external sources for innovation impulses (Laursen and Salter, 2006). Both breadth and depth depict a firm's openness to external innovation impulses (Chesbrough, 2003). Studying the UK manufacturing sector, Laursen and Salter (2006) find that the relationship between search breadth and depth and innovation performance has an inverted U-shape. This means that while search efforts initially increase a firm's performance, there is a trade-off from "over-searching" the environment. At a certain threshold it requires too much management attention (Ocasio, 1997) and has a negative effect on innovation performance.

In a similar vein, Katila and Ahuja (2002) focus on search depth and search scope in the search and problem-solving activities of firms in the robotics industry. Contrary to Laursen and Salter (2006), they define search depth as the extent to which a firm reuses existing internal knowledge, while search scope indicates how widely a firm explores externally available knowledge. The latter largely corresponds to search breadth as defined by Laursen and Salter (2006). However, Katila and Ahuja's (2002) definition of search depth puts greater emphasis on exploiting the established knowledge base within the firm. Consistent with the results of Laursen and Salter (2006), Katila and Ahuja (2002) observe an inverted U-shaped relationship between the search effort and innovation performance, which again points to the negative consequences of too extensive search activities. They also present evidence that the

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