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Solving Environmental Problems: Knowledge and Coordination in Collaborative Search

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Recent innovation and strategy research emphasizes the importance of firm's search for external knowledge to improve innovation performance. We focus on such search strategies within the domain of sustainable innovation in which problems are inherently complex and the relevant knowledge is widely dispersed. Hence, firms need to collaborate. We shed new light on collaborative search strategies led by firms in general and for solving environmental problems in particular. Both topics are largely absent in the extant open innovation literature. Using data from the European Seventh Framework Program for Research and Technological Development (FP7), our results indicate that the problem-solving potential of a search strategy increases with the diversity of existing knowledge of the partners in a consortium and with the experience of the partners involved. Moreover, we identify a substantial negative effect from involving partners in a search consortium who collaborate for the first time. Our findings have implications for both the literature on firms' search and the creation of sustainable innovation.

Introduction

Firms are increasingly challenged to generate sustainable innovations that provide economic returns and simultaneously have positive effects by solving environmental or societal problems (Ketata et al., 2015). Such challenges are often beyond the expertise of individual firms and require collaboration with outside partners to jointly develop promising solutions. Prior research has frequently documented the benefits of integrating external knowledge into firms' innovation processes (e.g., Garriga et al., 2013; Laursen and Salter, 2006; Leiponen and Helfat, 2010). Connecting with external sources of knowledge, such as universities, customers, or suppliers, allows firms to access contextually different knowledge that they can recombine with internal knowledge to improve their innovation outcomes (Chesbrough, 2003).

Firms develop search strategies that target external knowledge sources in order to find solutions to a problem they are facing (Katila and Ahuja, 2002). When problems are complex, a search strategy is likely to involve relationships with several external partners at the same time in order to collaboratively solve a problem. However, the particularities of collaborative search strategies have received little attention so far in extant research (exceptions include the simulation studies of Knudsen and Srikanth, 2014). We develop a theoretical understanding of problemistic search that takes into account the fact that the search is collaborative in nature. We argue that each partner in a consortium contributes knowledge to potential solutions from its particular domain, while the problem-solving potential of the overall search strategy depends on how well these contributions can be integrated (Knudsen and Srikanth, 2014). In that sense, search strategies do not only differ with respect to the diversity of knowledge provided by external sources but also how well these sources and their contributions can be coordinated.

We predict that both the prior knowledge of partners involved in a search strategy and their experience with coordination in collaborative search will positively influence the problem-solving potential of the search strategy. Moreover, we argue that the problem-solving potential of a search consortium decreases if it includes partners who participate for the first time.

The empirical context of our paper is the domain of sustainable innovation. More specifically, we focus on solving environmental problems — one of the core elements of the sustainability agenda (Ketata et al., 2015; Siegel, 2009). Innovation activities that target environmental problems are different from solving other innovation related problems for two main reasons. First, environmental problems are typically complex and the knowledge to solve them is dispersed. In fact, many sustainable innovations are systemic in nature and they originate from complex sets of knowledge that require the involvement of diverse groups of actors (Hall and Vredenburg, 2003). Second, environmental problems are rarely formulated by the firm devising a search strategy but rather by the external setting the firm is operating in. This includes stakeholders,

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NGOs, and society more generally, which demand solutions to the problems they have defined in a discursive way (Devinney, 2009). Both complexity and the limited ability to define the problem at hand make coordination within a search strategy a particularly salient issue (Felin and Zenger, 2014).

Testing our hypotheses requires a research design in which many firms search for comparable solutions to environmental problems by assembling search consortia of different partners. We have the unique opportunity to study such a setting by accessing all 731 firm-led project applications submitted to 25 different collaborative topic calls in the environmental area of the European Commission's Seventh Framework Program for Research and Technological Development (FP7), a research funding program that ran during the period of 2007–2013 with a total budget of more than 50 billion Euros, of which 1.89 billion Euros were allocated to the environmental area. Individual project grants can reach budgets of several million Euros and the grant application process requires significant investments by the applicants. Hence, the effort is significant and there is a potentially high payoff in terms of funding obtained to execute the proposed solution. Grant applications are submitted through consortia of partners and receive a quality score based on standardized criteria from multiple independent experts. This provides us with a unique dependent variable to measure the problem-solving potential of a search strategy, which is exogenous to the firm and comparable across applications within the same topic area.

Our research contributes to the literature in three ways. First, by emphasizing the coordination effort required in search consortia, we look both theoretically and empirically at an understudied area in the literature on external knowledge search (e.g., Laursen and Salter, 2006, Leiponen and Helfat, 2010). On the one hand, prior literature treats external search, at least implicitly, as independent, bilateral arrangements, controlled by a focal firm that seeks to solve a problem. We suggest that this assumption is too narrow and biases the results. Instead, search strategies are oftentimes multilateral in nature. As a consequence, coordination among the partners involved becomes a crucial factor, currently absent in most models of knowledge search. Research that focuses on collaborative search is often limited to simulation studies (Knudsen and Srikanth, 2014). On the other hand, prior literature largely ignores the fact that the partners involved in a search consortium differ with regard to not only the knowledge they can provide but also the collaborative experience they bring into the consortium. We suggest that the distribution of both knowledge and experience among the partners matters for the problem-solving potential of a search strategy.

Second, by focusing on the problem-solving potential of a search strategy we are able to observe the likelihood with which a search strategy will be successful. Prior research has typically looked at the outcomes of a firm's search strategy, for example, the number of patents or innovative products generated subsequently or the sales achieved with such new products (Katila and Ahuja, 2002; Laursen and Salter, 2006; Rosenkopf and Nerkar, 2001). These outcomes, however, are hard to trace back to a firm's original search strategy since they easily confound searching with finding. The latter is likely to be only a narrow snapshot of the search strategies that were originally developed. Instead, the problem-solving potential isolates the likely effectiveness of a search strategy. What is more, it reflects the more likely scenario within firms in which different search strategies compete for resources to be enacted. We have the unique opportunity to also observe the less successful strategies while previous studies fail to distinguish innovative firms which have searched but not found.

Third, our research provides direct implications for management practice in the area of sustainable innovation. While the problems in this area are typically formulated outside the firm's boundaries and are thus beyond the firm's control, management does have the opportunity to configure and manage a search consortium that is likely to solve the formulated problem. In that regard, our research suggests that coordination experience is important and that a consortium benefits from the accumulated experience of the partners in order to tackle the complexities of sustainable innovation.

The remainder of this paper is structured as follows. The following section describes the theoretical background and derives a set of hypotheses. Data, measures, and the empirical model are outlined in the subsequent section followed by the results. Subsequently, we discuss these results and draw conclusions. The final section addresses the limitations of our research and implications for future research.

Theory and hypotheses

Problemistic search for sustainable innovation

Within the model of problemistic search firms develop search strategies to find solutions for a problem they are facing (Katila and Ahuja, 2002). Accordingly, we investigate search strategies at the problem level rather than at the aggregated firm level. This allows us to develop theory to match the nature of sustainable innovation, which often requires search strategies that differ from the overall search strategy formulated at the firm level (Ketata et al., 2015). We will develop theoretical predictions for why certain search strategies have a higher potential to solve sustainable innovation problems than others. We will explain these differences in the problem-solving potential of different search strategies based on both the accumulated knowledge of a search consortium and how well the consortium partners and their knowledge can be coordinated. The latter factor is largely ignored in existing search theory but is especially relevant for sustainable innovation because of its inherent complexities and the dispersion of relevant knowledge. We start out by defining central constructs and mechanisms.

Firms develop search strategies by defining a set of technologies or technological areas (Katila and Ahuja, 2002) and/or knowledge sources (Laursen and Salter, 2006) that can provide a solution to a problem. Firms have been found to benefit

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