THE ORGANIZATION OF THE FIRM'S SEARCH STRATEGIES AND THEIR PERFORMANCE IMPLICATIONS

ABEL LUCENA
Business Administration Department
University of the Balearic Islands
Campus UIB, Palma (Spain) 07122

INTRODUCTION

The literature on organizational search has examined tensions arising from the joint adoption of "exploration" and "exploitation", as well as courses of action to mitigate such tensions (e.g., March, 1991; Lavie & Rosenkopf, 2006; Chen & Katila, 2008). Recently, few works have begun to study how ambidextrous models of exploration and exploitation produce complementarities that balance these tensions (Tushman, & O'Reilly, 1996; Rothaermel & Alexandre, 2008). However, the study about: i) different ways to ambidextrous models for organizing search activities across firms' boundaries, and ii) the performance consequences of these ways of organization remain relatively unexplored in previous literature. Here, I study these issues, proposing that firms organize their search activities by using the following models: the *ambidextrous*, *specialized*, and *diversified* implementation. Then, I assess the performance consequences derived from applying these models, considering that firms' organizational choices are endogenous variables. I explore thus the drivers leading these choices. The empirical design of the study uses new data for manufacturing firms in Spain, surveyed between 2003 and 2006.

MODELS OF ORGANIZATIONAL SEARCH

In this study, I assume that firms implement exploration and exploitation of technological opportunities by choosing the following options: i) not to implement any search strategy, ii) to adopt a "single" implementation, or iii) to adopt a "simultaneous" implementation of exploration and exploitation. Since the previous choice has to be made inside and outside the firms' boundaries, the combination of the internal and external choices generates three generic models of organizational search: the ambidextrous, specialized and the diversified model.

Ambidextrous models

These models stem from the joint adoption of exploration and exploitation search (He & Wong, 2004). Here, I suggest three scenarios of ambidexterity. First, **internal ambidexterity** takes place when the firms choose a simultaneous implementation internally without an external search strategy. This occurs at the firm level, so that a number of technological subunits within firms specialize in exploration while others in exploitation. Internal ambidexterity appears, for instance, when a firm innovates before its competitors, achieving a "first-mover advantage" that allows it to perform the research and development of the emerging opportunities by themselves (Katila & Chen, 2008). Second, **external ambidexterity** involves the adoption of a simultaneous implementation externally without an internal search strategy. This model appears at the level of the firm's alliance portfolio, whereby some alliances are concerned with exploration while others focus on exploitation. Some studies show that firms facing disruptive changes in technologies and/or customer needs overcome obsolesce opening their search activities extensively

(Rosenkopf & Nerkar, 2001). Finally, **radical ambidexterity** arises when firms adopt both an internal and external simultaneous implementation of exploration and exploitation search. Thus, boundary-spanning mechanisms for the organization of firms' search strategies are adopted, so that they widely integrate the search process rooted in their explorative and exploitative alliances with that occurring in their corporate units with both a business (exploitation) and science (exploration) orientation.

Specialized models

Specialization refers to models of organizational search where firms follow a single implementation; just one search type strategy at a time, be it exploration or exploitation. As in the case of ambidextrous models, specialization can occur in three ways. **Internal specialization** characterize models where firms implement either exploration or exploitation search strategies internally. In this instance, tangible and/or intangible resources for search activities are allocated to firms' technological subunits that focus on a given type of search. Examples of these models are found in the case of "dedicated biotech companies" that tend to specialized either in early-research stages targeted to product development, or in the creation of general-purposes platform technologies targeted to the drug discovery (Riccaboni & Moliterni 2009). **External specialization** means the adoption of organizational boundary-spanning mechanisms for the firms' search strategies, where only one type of search is implemented externally. Compared with external ambidexterity, external specialization may be regarded as an incremental way of opening the firm's search process to reach a technological reposition. Finally, **radical specialization** occurs when firms combine internal and external specialization. Here, I distinguish two possible arrangements: i) "inter-organizational specialization" in which firms use the same type of strategy internally and externally and ii) "inter-organizational ambidexterity" in which firms adopt a different strategy internally from that adopted externally.

Diversified models

Diversification involves a situation in which firms combine a "simultaneous" with a "single" implementation of strategies across their organizational boundaries. Diversification can arise in two situations. **Type I diversification** comes about when firms combine an internal single with an external simultaneous implementation. With this model, search activities are conducted by specialized technological subunits within firms along with a portfolio comprising exploration and exploitation alliances. **Type II diversification** occurs when firms choose an internal simultaneous together with an external single implementation. In this setting, the search performed by ambidextrous technological sub-units within firms is combined with an alliance portfolio centered on either exploration or exploitation search. Small companies, with a strong portfolio of external venturing, probably lean toward a model of type I diversification, while large companies, with a remarkable tendency to internalize their R&D, lean toward a model of type II diversification (Almeida, Dokko & Rosenkopf, 2003).

PERFORMANCE IMPLICATIONS OF ORGANIZATIONAL SEARCH

The use of previously-described models of organizational search differ in that each one generates different tensions, which are associated with the joint adoption of explorative and exploitative search, and/or with the integration of internal and external search activities (March,

1991; Rothaermel & Alexandre, 2008). However, the right combination of search activities may also produce complementarities in the sense that adopting one of them raises the returns of adopting the others (Milgrom & Roberts, 1990). The existence of complementarities implies that the combination of internal and external search activities may reduce tensions involved in their joint implementation. This holds true as the exposure of the firm's internal search activities to those developed externally can provide fresh knowledge that helps firms to articulate better their search activities. Participation in external search enhances the sources of alternative knowledge available to firms, leading them to discover new forms of R&D organization and new links to put their solving-problem capabilities together. Collaboration in exploration and/or exploitation with other organizations creates access to information about i) new systems for solving conflicts emerging between research and development units, ii) new communication systems for improving the interaction between research and development divisions, and iii) new technical solutions to turn "inventions" into "innovations" (Rosenkopf & Nerkar, 2001; Katila & Ahuja, 2002; Rothaermel & Alexandre, 2008).

Since firms may adopt alternative models of organizational search (ambidextrous, specialized or diversified), two questions deserve our attention: i) how can best firms organize their search activities to reach the maximum leverage among them in innovative performance, and ii) which are the drivers determining organizational search choices. To answer the first question, I compare complementarities derived from the use of radical ambidexterity, radical specialization, and diversification of both types in terms of a given performance measure. Thus, I point to the problem of how firms should balance their exploration and exploitation search activities along the innovation process. To answer the second question, I assume that firms self-select the search model that represents the best fit with their learning and environmental conditions. Here, I suggest that these choices are particularly affected by factors, such as the firms' absorptive capacity (ACAP) and the level of diversity in their technological opportunities. The first factor is viewed as a combinative capability that enables firms not only to integrate internal and external search activities, but also to articulate explorative and exploitative search. The second factor is regarded as a pull-force driver that induces firms to combine their search activities across organizational boundaries, in attempt to harness knowledge diversity.

EMPIRICAL ANALYSIS

The empirical design of the study contains two parts: one for analyzing the performance consequences and a second for examining the drivers for the organizational search. The former contains an outcome equation, in which a measure of innovative performance depends on both the firms' organizational search choices and on a set of control variables. The latter includes a set of choice equations, in which search choices depend on a set of explanatory and control variables.

Data

In this study, data are provided by the *Technological Innovation Panel* (henceforth, PITEC) conducted by the Spanish National Statistic Institute (INE), in collaboration with the Spanish Science and Technology Foundation (FECYT) and the Foundation for Technological Innovation (COTEC). The PITEC includes information on technological innovation activities of all the main sectors in the Spanish economy, including services and manufacturing. The focus here is on Spanish manufacturing firms in the PITEC for which complete information is available on their innovative activities for two periods, 2002-2004 and 2004-2006. Resultant sample

contains 3566 observations for each period. These data include companies whose principal economic activity appears in one of the two-digit manufacturing industries of the "Classification of Economic Activities in the European Community".

Statistical methods

I implemented the Deb and Trivedi model (2006) in the subsequent empirical analysis. This is a model of treatment (firms' organizational search choices) and outcome (performance) with selection, in which the treatment is endogenous. Although the attention of this model is specifically focused on the effect of an endogenous treatment variable on outcome, I can harness the fact that this model also provides a characterization of the generating process of the treatment. This is informative about the role of factors in determining firms' organizational search choices.

In the outcome equation, innovative performance is measured as the number of times that innovations are perceived as having a strongly positive effect on aspects, such as expansion of their market share, improvement in the quality of their products, increase in their product range. In the choice equations, I created four dummies that adopt the value of one when i) firms declare expenditures on basic research (internal exploration), ii) on development (internal exploitation), and when firms declare that they use iii) R&D alliances (external exploration) and iv) contract R&D services and/or technologies in the market (external exploitation). From these dummies, I formed exclusive combinations for characterizing models of organizational search previously described. Independent variables in the outcome and choice equations include indicators for measuring the firm's ACAP and the level of diversified technological opportunities. Controls variables include firm's size, a measure for the perceived cost of innovation activities, and dummies indicating whether firms operate in high-tech sectors, have patent applications, or belong to a multinational group. Finally, exclusive restrictions were added to choice equations in order to improve identification. Particularly, the number of public financing programs available to firms and the scope of firms' markets are used for this purpose.

Finally, to test for complementarities associated with alternative models of organizational search, I used the characterization proposed by Athey and Stern (1998), in which the supermodularity of a performance function indicates the existence of complementarities. In the context of this study, I tested for supermodulatity of the outcome equation for the case of the combinations where firms implement radical ambidexterity, radical specialization and diversification models.

RESULTS

As regards the outcome equation, the findings indicate that, although radical ambidexterity is the model with the most significant impact on innovative performance, the joint adoption of an internal and external simultaneous implementation does not produce complementarities. Conversely, the data support the hypothesis of complementarities in the case of a radical specialization. This shows that the use of internal and external single implementation leverage from each other in terms of innovative performance. No complementarities are observed in the case of diversification models. Comparing diversification models reveals that type I diversification has a statistically greater effect on performance than that observed in the case of type II diversification. This result supports the idea that firms more open to external search activities reach a better performance than those with a tendency to internalize their R&D activities.

In terms of the choice equations, I found that the ACAP tends to be positively associated with those models in which firms combine exploration and exploitation search activities. In three instances, the ACAP relates to models involving combinations across the firms' boundaries (diversification of type II and I and radical ambidexterity). In the remaining cases, the ACAP is associated with internal search models, be they ambidextrous or specialized. These results lend partial support to the hypothesis that the firm's ACAP contributes to enhancing its possibilities of combining search activities. In the case of diversified technological opportunities, it seems that this variable is strongly associated with models centered on radical ambidexterity and diversification (types II and I). To a lesser degree, this variable is also associated with models in which firms combine external search activities (external ambidexterity) and with those in which firms combine specialized search activities (radical specialization). These results indicate that the diversity of technological opportunities can account for the tendency of firms to combine exploration and exploitation search activities across their boundaries.

DISCUSSION AND CONCLUSIONS

As firms pursue knowledge inside and outside their organizational boundaries, I have examined how they go about selecting their search strategies, based on March's (1991) dichotomy of exploration and exploitation. I extended the arrays of models of organizational search by proposing that firms choose among three generic arrangements: ambidextrous, specialized, and diversified implementation models. I have then analyzed the respective performances of these models and examined the drivers of firms' search choices.

The findings regarding the performance of these knowledge search models contribute to our understanding of how firms mitigate tensions from joining alternative search strategies. An empirical comparison of the capacity of the proposed models to generate complementarities shows that the synchronized implementation of specialized search strategies across firms' organizational boundaries produces synergies in innovative performance. By contrast, the data do not support the hypothesis identifying the presence of complementarities in the case of other models. In line with Rothaermel and Alexandre (2008), this reflects the fact that the cost of implementing ambidextrous search models outweighs any associated benefits. While any comparison of this nature should be treated with caution, the results do suggest that differences in the generation of complementarities may well correspond to differences in the way firms strike a balance in their adoption of search strategies that differ in their technological profiles (exploration vs. exploitation) and/or in their organizational forms (internal vs. external).

This paper also provides new evidence concerning the role of firms' ACAP, and their diversity in technological opportunities as drivers of their decisions to adopt particular models of organizational search. The findings show that these factors result in firms self-selecting models of organizational search that combine several search strategies (particularly, models based upon radical ambidexterity, and types II and I diversification).

The results of the current research are subject to several limitations. The PITEC essentially present a cross-sectional design, which prevents us from undertaking a dynamic analysis of the evolution in the elements comprising the firms' organizational search. This imposes clear limitations on the scope of the current research. For instance, panel data analysis would allow us to examine the influence of path-dependent decisions on current firm's search choices. Likewise, more research could reveal whether firms adopt the same search models over time or rather sequentially switch to alternative models.

REFERENCES

Almeida, P., & Dokko, G., & Rosenkopf, L. 2003. Startup size and the mechanisms of external learning: increasing opportunity and decreasing ability? **Research Policy,** 32: 301-315.

Athey, S., & Stern, S. 1998. An empirical framework for testing theories about complementarity in organizational design. **NBER Working Paper,** Nº 6600.

Chen, E., & Katila, R. 2008. Rival interpretations of balancing exploration and exploitation; simultaneous or sequential. In Shane, S. (Eds.). **Handbook of Technology and Innovation Mangement,** John Willey & Sons, Ltd: 197-214.

Deb, P., & Trivedi, P. 2006. Specification and simulated likelihood estimation of a non-normal treatment-outcome model with selection: Application to health care utilization. **Econometrics Journal,** 9: 307-331.

Katila, R., & Chen, E. 2008. Effects of search timing on innovation: The value of not being in sync with rivals. **Administrative Science Quarterly**, 53: 593-625.

Katila, R., & Ahuja, G. 2002. Something old, something new: A longitudinal study of search behavior and new product introduction. **Academy of Management Journal** 45: 1183-1194.

He, Z., & Wong, P. 2004. Exploration vs. exploitation: An empirical test of the ambidexterity hypothesis. **Organization Science,** 15: 481-494.

Lavie, D., & Rosenkopf, L. 2006. Balancing exploration and exploitation in alliance formation. **Academy of Management Journal,** 49: 797-818.

March, J. 1991. Exploration and exploitation in organizational learning. **Organization Science,** 2: 71-87.

Milgrom, P., & Roberts, J. 1990. The economics of modern manufacturing: technology, strategy, and organization. **The American Economic Review,** 3: 511-528.

Riccaboni, M., & Moliterni, R. 2009. Managing technological transitions through R&D alliances. **R&D Management,** 39: 124-134.

Rosenkopf, L., Nerkar, A. (2001) Beyond Local Search: Boundary-spanning, Exploration, and Impact in the Optical Disk Industry. *Strategic Management Journal* 22: 287-306.

Rothaermel, F., & Alexandre, M. 2008. Ambidexterity in technology sourcing: the moderating role of absorptive capacity. **Organization Science,** articles in advance: 1-22.

Tushman, M., & O'Reilly, C. 1996. Ambidextrous organizations: Managing evolutionary and revolutionary change. **California Management Review,** 38: 8-30.