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External knowledge search, absorptive capacity and radical innovation in high-technology firms

M. Luisa Flor^{a, *}, Sarah Y. Cooper^b, María J. Oltra^a

^a Universitat Jaume I, Av. de Vicent Sos Baynat, s/n 12071 Castellón, Spain

^b University of Edinburgh Business School, University of Edinburgh, Edinburgh, UK

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ABSTRACT

Open innovation and absorptive capacity are two concepts based on the idea that companies can leverage the knowledge generated externally to improve their innovation performance. The aim of this paper is to analyse the joint effect of open innovation and absorptive capacity on a firm's radical innovation. Open innovation is expressed in terms of external search breadth and depth strategies and absorptive capacity is described by distinguishing between potential and realized absorptive capacity. In order to test our hypotheses, we carried out empirical research in firms operating in high-technology industries. The results indicate that internal routines and processes for absorbing external knowledge help explain radical innovation as they show a significant effect of potential and realized absorptive capacity. Also, there is a moderating effect of absorptive capacity on open innovation. Specifically, potential absorptive capacity exerts a positive effect on the relationship between external search breadth and depth and radical innovation. Realized absorptive capacity moderates the influence of external search breadth. These findings confirm the complementary nature of absorptive capacity and open innovation search strategies on radical innovation.

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1. Introduction

The concept of open innovation (OI) stresses the notion of leveraging external knowledge and has become increasingly popular both in academic research and industry practice (Chesbrough & Bogers, 2014). The basic premise of OI is opening up the innovation process (Huizingh, 2011). Nevertheless, the presence of valuable external sources of knowledge does not imply that the flow of external new ideas and knowledge into firms is an automatic or easy process (Vanhaverbeke & Cloodt, 2014). Implicitly, external knowledge is considered to be 'out there' ready to be harnessed by firms, but we have a limited understanding of the process of sourcing and bringing this into corporations (Dahlander & Gann, 2010). The ability to exploit external knowledge is, thus, a critical component of innovative capabilities (Cohen & Levinthal, 1990).

Despite its popularity, many firms still struggle to manage OI properly, and the internal organization challenges perceived are the

most difficult to manage (Vanhaverbeke, Chesbrough, & West, 2014). For instance, results of a survey among large firms in Europe and the United States suggest that it is not easy to implement an OI program and there are a range of challenges and constraints that limit firms' ability to make use of OI, the management of external relationships being an important challenge (Chesbrough & Brunswicker, 2014). In this work, we suggest that the fact that the firm possesses absorptive capacity (AC) facilitates external knowledge identification and exploitation and can be helpful to attenuate some of the challenges posed by OI. AC has been defined as the capacity to learn and solve problems, allowing a firm to assimilate external knowledge and create new knowledge (Kim, 1998; Lane, Koka, & Pathak, 2006; Zahra & George, 2002). It is not only a matter of searching and accessing external ideas and knowledge, but also of being able to generate internally innovative outputs by combining external insights with the firm's internal capabilities. Accordingly, external knowledge does not equally benefit all firms, as the firm's own resources and actions determine the extent to which it will be able to take advantage of it (Fabrizio, 2009). As with OI, the notion of AC is based on the idea that companies can leverage the knowledge generated externally. More particularly, since AC focuses on acquiring and utilizing external knowledge

* Corresponding author.

E-mail addresses: mflor@uji.es (M.L. Flor), Sarah.Cooper@ed.ac.uk (S.Y. Cooper), oltra@uji.es (M.J. Oltra).

inside the firm, it is a concept at the heart of the outside-in dimension of OI (Vanhaverbeke & Cloudt, 2014).

Radical innovations incorporate a large amount of new knowledge since they encompass revolutionary changes in technology and clear departures from existing practice (Dewar & Dutton, 1986) and also may involve new knowledge about existing or emerging markets (Zhou, Yim, & Tse, 2005). Hence, radical innovations require new insight that is distant from a firm's existing competences and practices and, even, its own internal processes, since there is a gap between the firm's knowledge and the knowledge needed to innovate. In doing so, the firm must bring external knowledge inside, or develop the required knowledge in order to innovate successfully (Green, Gavin, & Aiman-Smith, 1995). Thus, external knowledge may complement internal efforts to develop radical innovations. In this context, radical innovation can be fostered in companies with highly developed OI processes and increased AC, since these firms span larger technological distances and are better equipped to explore new technological areas that are not directly related to their core technology (Nooteboom, Vanhaverbeke, Duysters, Gilsing, & van den Oord, 2007; Vanhaverbeke & Cloudt, 2014).

In addition to their direct effects on radical innovation, we propose that there is a complementary positive effect of OI and AC on it. Previous research has explored the relationship between OI and AC by adopting different approaches. Referring to literature on AC and learning, some works rely on the notion that AC is determined primarily by prior related knowledge, suggesting that OI represents an antecedent of a firm's AC (e.g. Ferreras-Méndez, Newell, Fernández-Mesa, & Alegre, 2015; Ferreras-Méndez, Fernández-Mesa, & Alegre, 2016; Fosfuri & Tribó, 2008; Sun & Anderson, 2010). Their reasoning is that firms connect with their external environments in pursuing diverse knowledge across organizational boundaries to increase their AC, this being one of their reasons to propose that AC has a mediation role in the firm's openness-innovation performance relationship. A moderating approach is followed by a second group of scholars who draw on Cohen and Levinthal's (1990) model of sources of a firm's technical knowledge, the central feature of which is that the firm's AC determines the extent to which extramural knowledge is utilized, examining the moderating role of AC in the relationship between OI and innovation performance (e.g. Clausen, 2013; Escribano, Fosfuri, & Tribó, 2009; Fabrizio, 2009; Ghisetti, Marzucchi, & Montresor, 2015; Huang & Rice, 2012; Laursen & Salter, 2006; Rothaermel & Alexandre, 2009). This view can be especially relevant for explaining radical innovation, as "to integrate certain classes of complex and sophisticated technological knowledge successfully into the firm's activities, the firm requires an existing internal staff of technologists and scientists who are both competent in their fields and familiar with (...) extramural relationships" (Cohen & Levinthal, 1990, p. 135). Although Cohen and Levinthal (1990) focused on the role of R&D in enhancing the firm's ability to assimilate and exploit external knowledge, it fits with the idea that AC creates opportunities for interorganizational combinations of knowledge within an OI model (Vanhaverbeke & Cloudt, 2014). Finally, drawing on arguments from both approaches, recent contributions propose conceptual frameworks that embrace relationships between the two concepts by focusing on different types of OI and the components of AC (e.g., Kim, Kim, & Foss, 2016; Xia & Roper, 2016).

This paper adopts a moderating approach to study the influence of both OI and AC on a firm's radical innovation and examine their complementarity by analysing the effect of AC on the relationship between OI and radical innovation. In order to do so, we describe OI in terms of external search breadth and depth strategies (Laursen & Salter, 2006) and focus on both components of AC, potential and

realized AC (Zahra & George, 2002). Our research links to the literature on OI that examines the influence of external knowledge search strategies and the presence of moderators (e.g., Chen, Chen, & Vanhaverbeke, 2011; Chiang & Hung, 2010; Clausen, 2013; Cruz-Gonzalez, López-Sáez, Navas-López, & Delgado-Verde, 2015; Huang & Rice, 2012; Laursen & Salter, 2006; Sofka & Grimpe, 2010). While previous studies examined the moderating effect of AC on external search strategies, most research on the relationship between external search and AC has considered AC as a whole and relied on R&D-related proxies to represent it (e.g., Laursen & Salter, 2006; Rothaermel & Alexandre, 2009). To represent AC, we follow Zahra and George's (2002) reconceptualization of AC and focus on the routines and processes that form potential and realized AC, which organizations use to acquire, assimilate, transform and exploit knowledge. The theoretical distinction between potential and realized AC helps us identify which abilities matter more to the external linkages and radical innovation of firms (Xia & Roper, 2016). Although firms' OI activities need both, the link between two components of AC in the context of various types of OI has not received much attention (Kim et al., 2016). Hence, this research contributes to recent literature examining the specific relationship between OI types and potential and realized AC.

Our study is developed on high-technology firms, since, as they need a great deal of relevant knowledge in their innovation processes, they frequently try to find it outside their boundaries. Firms in high-tech industries have the highest levels of external search breadth and depth, with high levels of R&D and rates of innovation (Laursen & Salter, 2006). Thus, external knowledge flows become important and the ability to benefit from these flows plays a crucial role in securing competitive advantage (Escribano et al., 2009). In addition, one of the most widely cited motives for explorative external collaborations is the acquisition of new technical skills or capabilities from partner firms (Xia & Roper, 2016).

This work both contributes to OI research on the external search for innovation by considering that OI strategies' effectiveness can be enhanced through a firm's internal AC processes in shaping the ability to leverage external knowledge sources. Specifically, examining how each AC component can interact with external search breadth and depth is a distinctive contribution that can enhance understanding about how both concepts relate to radical innovation.

This paper proceeds as follows: in the next section, we provide the theoretical background of this study and formulate the research hypotheses. Section 3 presents the data and the methodology. Section 4 shows the results of the data analysis and Section 5 discusses the results. Section 6 summarizes key conclusions, implications and limitations of the work.

2. Literature review and hypotheses development

2.1. Radical innovation

Radical innovation has been conceptualized in terms of substantial changes in technology that advance the price/performance frontier by much more than the existing rate of progress (e.g., Dewar & Dutton, 1986; Gatignon, Tushman, Smith, & Anderson, 2002). Thus, radical innovations have often been conceived as (Green et al., 1995): 1) incorporation of an embryonic technology rapidly developing in the general scientific community; 2) incorporation of a technology that is new to a firm, but may be well understood by others; 3) departure from the firm's existing management or business practices; 4) requirement of a sizable financial risk. Hence, technology can be new to the adopting firm and to the referent group of organizations, or require important transformations in an organization since it introduces such throughput

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