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# **INBOUND OPEN INNOVATION, ABSORPTIVE CAPACITY AND INNOVATION PERFORMANCE: AN EMPIRICAL RESEARCH ON SPANISH FIRMS**

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## **Abstract**

The aim of this paper is to show the influence of both open innovation and absorptive capacity in the innovative performance of the firm and explore the complementarity of both concepts. Specifically, it explores the effect that depth and breadth search open innovation practices and the potential and realised dimensions of absorptive capacity exert on a firm's output innovation. The empirical research was conducted on a sample of 174 Spanish medium-sized and large industrial firms belonging to high technology industries. Hypotheses were tested using multiple linear regression analysis. Results show the positive effects of potential absorptive capacity and open innovation sources breadth and

radical innovation. Also, the complementary effect of absorptive capacity and open innovation is shown.

# **INBOUND OPEN INNOVATION, ABSORPTIVE CAPACITY AND INNOVATION PERFORMANCE: AN EMPIRICAL RESEARCH ON SPANISH FIRMS**

## **1 Introduction**

The absorptive capacity (AC) and open innovation (OI) are two concepts of growing acceptance in the field of innovation management. They are based on the idea that companies can leverage the knowledge generated externally to improve their innovation performance. Despite its obvious connections, both concepts have only recently begun to be addressed jointly in the literature.

The presence of valuable external sources of knowledge does not imply that the flow of new ideas and external knowledge into firms is an automatic or easy process (Clausen, 2013). External knowledge can only be integrated and assimilated with the firm's (internal) knowledge base when the firm has internal competencies that facilitate OI processes (Dahlander and Gann 2010). An improved understanding of OI therefore requires a better understanding of this sourcing mechanism (Vanhaverbeke, Cloudt, and Van de Vrande 2008). Insofar as the firm owns abilities to explore, retain and exploit external knowledge it will complement open innovation efforts.

The aim of this paper is to show the influence of both OI and AC in the innovative performance of the firm and explore the complementarity of both concepts. In order to do so, we are carrying out an empirical research in firms operating in high technology industries. The findings permit to enrich the literature of both OI and AC concepts.

This paper is divided into four additional sections. The next one deploys the hypotheses to be analyzed in the empirical research. Section 3 describes the scope of the empirical research and data collection. Next, it is shown the measurement of variables. Section 5 describes the findings and, finally, we summarize the conclusions.

## **2 Literature review and hypotheses development**

### **2.1 Absorptive capacity and innovation outcome**

AC constitutes one of the fundamental learning processes in a firm and can be a source of competitive advantage, as it represents its ability to identify, adapt and incorporate external knowledge within its routines (Cohen and Levinthal, 1990; Lane et al, 2006). In spite of relying on external partners, firms need to create the capacity to track and evaluate developments outside firm boundaries and benefit from ‘spill-overs’. They will vary in the extent to which they can screen, evaluate and assimilate external inputs to the innovation process (Dalander and Gann, 2010). In this way, developing a firm’s absorptive capacity can be seen as a necessary complement to openness for ideas and resources from external actors.

As Lane et al. (2006) have indicated, AC is one of a firm’s fundamental learning processes as it reflects its ability to identify, assimilate and exploit knowledge from its environment. In this vein, AC facilitates the creation of radical innovations by enabling the exchange of existing knowledge and learning, and combining it with new sources of knowledge (Ritala and Hurmelinna-Laukkanen, 2013).

Amongst the proposals made to further explore and extend the definition of AC and identify its most important dimensions, the study by Zahra and George (2002) has had the greatest impact. These authors view AC as a dynamic capability formed by a set of organizational routines and processes by which firms acquire, assimilate, transform and exploit knowledge, and distinguish between potential and realized absorptive capacity. Whereas potential absorptive capacity represents the knowledge-seeking capacities a firm has developed, but which may or may not be used to produce innovations, realized absorptive capacity represents its ability to develop products and services based on this stock of knowledge.

Potential absorptive capacity consists of the processes of external knowledge acquisition and assimilation of externally acquired knowledge. Whereas acquisition includes the efforts made to identify and acquire new external knowledge, assimilation refers to the firm’s routines and processes that allow it to analyze process, interpret and understand the information obtained from external sources. A developed potential AC helps firms track changes in their industries more effectively and therefore facilitates the timely deployment of necessary capabilities, such as production and technological competencies (Zahra and George, 2002). In addition, firms with well-developed acquisition and assimilation capabilities are

likely to be more adept at continually renewing their knowledge stock by detecting trends in their external environment and internalizing this knowledge. For example, these opportunities can help firms to maintain and sustain better performance through strategic advantages such as first-mover advantages and receptiveness towards customers.

A firm's AC, however, is not merely directed outward through a focus on the acquisition and assimilation of external knowledge, but also encompasses a firm's ability to process knowledge internally (Rothaermel and Alexandre, 2009). That is it, although potential AC is necessary to identify and filter relevant external knowledge and brings it into the firm, a competitive advantage in innovation only materializes if the firm also possesses realized AC (Fosfuri and Tribó, 2008). Indeed, once the knowledge is inside the organization, it must be shared across the firm's members, and transformed and integrated with internally generated knowledge. Realized absorptive capacity results from processes of transformation and exploitation. Transformation refers to a firm's ability to develop and improve the routines that facilitate the combination of existing knowledge and new acquired and assimilated knowledge; this transformation is achieved by adding or eliminating knowledge or simply interpreting the same knowledge differently. Exploitation as an organizational capability is based on routines that allow firms to refine, extend and leverage competences or create new ones by incorporating acquired and transformed knowledge into their operations. Whereas transformation helps firms to develop new perceptual schema or changes to existing processes, exploitation converts knowledge into new products (Kogut and Zander, 1992). The transformation and exploitation capabilities that make up AC are therefore likely to influence firm performance through product and process innovation (Zahra and George, 2002). Thus, we propose the following hypotheses:

*Hypothesis 1. Potential absorptive capacity will exert a positive effect on a firm's innovation output.*

*Hypothesis 2. Realized absorptive capacity will exert a positive effect on a firm's innovation output.*

## **2.2. Open innovation and innovation output**

The open innovation paradigm has caught immense interest, not only from researchers who have unraveled a number of relevant managerial questions pertaining to open innovation, but also from the business community (Knudsen and Mortensen, 2011).

The practices of traditional innovation, in environments where product life cycles are increasingly short and technologies continuously change do not represent a suitable response. Therefore, new ways of innovation must be looked for, in which open innovation represents a viable alternative for companies. Henry W. Chesbrough defined open innovation as “the purposive use of inflows and outflows of knowledge to, respectively, accelerate internal innovation, and expand the markets for external use of innovation process” (Chesbrough, 2006, p.2). Since then, open innovation has emerged as a paradigm to which scholars and practitioners paid significant attention. Though, as being a recent concept, there is still an ongoing debate about the usefulness of this concept. For example, among others, Groen and Linton (2010) discuss if the term open innovation should be modified or even abandoned in favour of the term supply chain management. On the other hand, Van de Vrande and De Man (2011) explain that both terms have different research domains, but emphasize that open innovation is a paradigm whose development may integrate different streams, such as supply chain management, strategic alliances, networks, ambidexterity or exploitative and explorative learning.

There is mixed evidence on the relationship between open innovation practices and innovation performance. Knudsen and Mortensen (2011) analyzes the relationship between the degree of openness and the NPD performance. Inter-organizational relationships in new product development lay the foundation for operationalizing openness because these represent important sources of ideas and knowledge in purposive inbound open innovation. This research finds that the use of internal and external relationships is highly correlated and that these interact with each other, although firms that implement open innovation practices do not show a better performance in NPD performance. Other papers also study the influence of OI over NPD: Huang and Rice (2012) assess the impact of openness on innovation in products and shows that open innovation approaches positively affect innovation performance. Salge et al. (2012), drawing on longitudinal and cross-sectorial data from German firms, finds search openness to be related to firms' revenue share from really new products.

The concepts of breadth and depth are especially interesting to analyze the effect of OI in innovation performance. Laursen and Salter (2006), based on the UK Innovation survey and using a large-scale sample of industrial firms and found that, with regard to open innovation, searching widely and deeply is curvilinearly (taking an inverted U-shape) related to performance. Bahemia and Squire (2010) develop a conceptual framework of inbound open innovation at the NPD project level to assess factors that help determine the degree of openness along three dimensions. They argue that the margin of managerial action is not only constrained to the decision to open up the NPD project to a wide range of different types of external parties (breadth dimension), but that it is equally important to consider the depth of the relationships with different types of external parties (depth dimension) and the balance between the development of new and longstanding relationships (ambidexterity dimension). Chiang and Hung (2010) finds that open search depth is positively related to the innovating firm's incremental innovation performance, and that open search breadth is positively related to radical innovation performance. Keupp and Gassmann (2009) develop hypotheses on how impediments to innovation influence the breadth and depth of OI. Results provide support to identify four 'archetypes' of firms that differ significantly regarding the breadth and depth of OI and the importance of impediments. Garriga et al. (2013) extends Laursen and Salter (2006) model hypothesizing that the search strategy itself is impacted by firm context. That is, both "constraints on the application of firm resources" and the "abundance of external knowledge" have a direct impact on innovative performance and a firm's search strategy in terms of breadth and depth. In this sense, Vahter et al. (2012) examine the role of breadth of external linkages and its link to innovation performance. They show in an empirical research in Irish firms that larger firms are able to continue benefitting from increased linkage breadth beyond the limit at which increased breadth has started to have negative effects for small firms.

Thus, we propose the following hypotheses:

*H3: Open innovation practices related to breadth of innovation sources will exert a positive effect on a firm's innovation output.*

*H4: Open innovation practices related to depth of innovation sources will exert a positive effect on a firm's innovation output.*

## 2. Scope of the empirical research and data collection

The empirical research was conducted in Spanish medium-sized and large industrial firms (with 50 or more employees) belonging to high technology industries as defined by the OECD classification on technology intensity. The sample was obtained by stratifying according to sector and size and the final sample consisted of 174 firms. The sample firms came from the following sectors: aircrafts and spacecraft; office, accounting and computing machinery; radio, TV and communications equipment; and medical, precision and optical instruments. Table 1 shows the distribution of firms by sector. Data were gathered between December 2009 and April 2010 by means of telephone interviews. To limit common method bias, we interviewed two respondents from each firm using two different questionnaires. Data on absorptive capacity dimensions were provided by the R&D manager, while data on open innovation sources and innovation output came from the general manager or marketing manager, depending on the firm's structure. R&D managers were also asked about innovation output and this information was used to further assess the scales' validity.

**Table 1.** Sample composition by sector

<i>Sectors</i>	<i>Sample size</i>
Pharmaceuticals	63
Office, accounting and computing machinery	6
Radio, TV and communications equipment	38
Medical, precision and optical instruments	48
Aircraft and spacecraft	19
Total sample	174

## 3. Measurement of variables

### 4.1. Innovation output

To represent firms' innovation, we used items from the scale proposed by Gatignon et al. (2002) to assess innovation radicalness. These items were answered by the second respondent in each firm, i.e., either the general manager or the head of marketing, depending on the firm's



structure. Respondents were asked to assess, on a 7-point scale, how far they agreed with statements on aspects of innovations the firm had introduced during the 2006-2008 period. The statements on *innovation radicalness* were the following: (1) the innovation was a minor improvement on the previous technology; (2) the innovation was based on a revolutionary change in technology (breakthrough innovation); (3) the innovation led to products that were difficult to replace using older technology; (4) the innovation represented a major technological advance in a subsystem, part or product component. Cronbach's alpha was used to test the reliability of the resulting scale (from which the first item was subsequently deleted), resulting in a value of 0.730.

#### *4.2. Open innovation*

We relied on Laursen and Salter (2006) measures to represent OI practices. Breadth was constructed by considering either or not the firm has formal collaboration links with different external partners, including suppliers, clients or customers, competitors, consultants, universities or other higher education institutes, commercial laboratories/R&D institutes, government research institutes, private research institutes. Each of the 7 sources are coded as a binary variable, 0 being no collaborating and 1 being collaboration with the given partner. Subsequently, the 7 sources are simply added up so that each firm gets a 0 when no partners are used, while the firm gets the value of 7 when all the potential collaboration partners are used.

External search depth, defined as the extent to which firms draw intensively from different search channels or sources of innovative ideas, was constructed using 10 sources of external knowledge for innovation. Each of the 10 sources are coded with 1 when the firm in question reports that it uses the source to a high degree and 0 in the case of no, low, or medium use of the given source. The 10 sources are subsequently added up so that each firm gets a score of 0 when no knowledge sources are used to a high degree, while the firm gets the value of 10 when all knowledge sources are used to a high degree.

#### *Absorptive capacity*

To reflect potential and realised AC, we essentially adapted the items used by Jansen et al. (2005), which, in turn, were based on Zahra and George (2002) and Szulanski (1996). The

items were assessed by each R&D manager on a 7-point disagree-agree scale.

*Potential absorptive capacity*, comprising the processes of acquisition and assimilation, was measured by the following items: (1) new opportunities to serve our clients are understood rapidly; (2) we analyze and interpret changing market demands promptly; (3) employees record and store newly acquired knowledge for future reference; (4) we quickly recognize the usefulness of new external knowledge to existing knowledge. Cronbach's alpha for this variable was 0.751.

*Realized absorptive capacity* was measured with the following items: (1) we incorporate external technological knowledge into our firm; (2) we thoroughly grasp the opportunities new external knowledge offers our company; (3) we periodically meet to discuss consequences of market trends and new product development; (4) employees are clearly aware of how the firm's activities should be performed; (5) we are constantly reviewing how to better exploit external knowledge; (6) employees share a common language to refer to our products and services. The reliability of the scale was verified with a Cronbach's alpha of 0.707.

#### *Control variable*

Also we included firm size, measured by the number of employees, as a control variable.

## 5. Analysis and results

Table 2 presents descriptive statistics and correlations for the study variables.

Table 2. Means, standard deviations and correlations

	<b>Mean</b>	<b>S.D.</b>	<b>1</b>	<b>2</b>	<b>3</b>	<b>4</b>	<b>5</b>
1. Radical innovation	4,5153	,82788					
2. Size	259,52	353,758	,081				
3. Potential AC	4,4741	,90641	,377**	-,048			
4. Realized AC	4,8498	,61971	,208**	-,009	,540**		
5. Breadth	2,80	1,583	,280**	,185*	,045	,151*	
6. Depth	2,61	1,772	,260**	,130	,200**	,172*	,459**

\*Correlation significant at the 0.1 level

\*\*Correlation significant at the 0.05 level.

Hypotheses were tested using multiple linear regression analysis. Following a hierarchical procedure, we estimated two models where the dependent variable was innovation radicalness (Table 3). Firstly, we analysed the impacts of potential AC and realized AC on innovation radicalness (Model 1) and then we added the variables representing open innovation practices related to depth and breadth of innovation sources (Model 2).

**Table 3.** Results of regression analyses: effects of absorptive capacity and open innovation on innovation radicalness. Standardised coefficients ( $\beta$ )

	Model 1		Model 2	
	Beta	<i>t</i>	Beta	<i>t</i>
Size	,099	1,406	,047	,673
Potential AC	,379***	4,514	,375***	4,560
Realized AC	,004	,046	-,042	-,518
Breadth			,223**	2,849
Depth			,083	1,062
R <sup>2</sup>	,152		,220	
Adj. R <sup>2</sup>	,137		,197	
$\Delta$ R <sup>2</sup>			,069**	

\*\* The relationship is significant at the 0.05 level

\*\*\* The relationship is significant at the 0.001 level

Examination of the effect of absorptive capacity on output innovation confirms that internal routines and processes for absorbing external knowledge help explain innovation radicalness, since Model 1 shows the positive significant effect of potential absorptive capacity. On the other side, Model 2 shows the additional positive effect explained by the incorporation of variables related to open innovation practices, as denoted by the significant increase in explained variance of radicalness. Specifically, it is confirmed that breadth of innovation sources exerts a positive effect on radicalness. In addition, the fact that potential absorptive

capacity is still significant suggests the complementary nature of potential AC and this open innovation practice.

## **6. Discussion and conclusion**

This study has confirmed that absorptive capacity and open innovation influence firms' innovation performance in firms belonging to high technology industries. However, the partial nature of the confirmation of the proposed relationships leads us to further explore this initial claim. The results emphasise the importance to innovation performance of abilities related to the absorption of external knowledge for obtaining new products and processes. Likewise, the way AC is represented should be highlighted. In contrast to the traditional view that only associates absorptive capacity with R&D activities, we base our approach on Zahra and George's (2002) distinction between potential and realised AC. In this respect, our results demonstrate the role of potential absorptive capacity, i.e. search-based capabilities related to knowledge acquisition and assimilation, in innovation radicalness. Realised absorptive capacity does not appear to have a significant effect on a firm's innovation output. A possible explanation may lie in the correlation between the two types of AC. Further research efforts should be devoted to examine this result.

Regarding the relationship between open innovation breadth and depth practices, our findings corroborate previous research where a positive relationship between innovation sources breadth and radical innovation has been found.

Specially revealing is the finding about the complementary effect of potential absorptive capacity and breadth, which gives support to previous research on the complementarity of absorptive capacity and inbound open innovation (e.g. Clausen, 2013).

On the whole, the results of this study point to the importance of external sources of knowledge and firms' internal efforts to absorb it to their innovation results. However, it should be stressed that any evaluation of our conclusions must take into account the characteristics of the analysed industries, since relevance of open innovation practices and AC abilities on innovation may differ in industries with other technological accumulation patterns.

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