DO WE TEACH WHAT WE RESEARCH?

UNFOLDING ABSORPTIVE CAPACITY, OPEN INNOVATION, MANAGEMENT INNOVATION AND CLUSTERS

Valencia, 24-25 de Enero de 2012
UNIVERSITAT POLITÈCNICA DE VALÈNCIA

Dirección del Taller:
Dr. José Luis Hervás Oliver

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UNIVERSITAT POLITÈCNICA DE VALÈNCIA

EDITORIAL
UNIVERSITAT POLITÈCNICA DE VALÈNCIA

TALLER DE ESTRATEGIA EMPRESARIAL, ACEDE

Valencia, 24-25 de Enero de 2012—

UNIVERSIDAD POLITÉCNICA DE VALENCIA

FACULTAD DE ADMINISTRACIÓN DE EMPRESAS Y DEPARTAMENTO DE ORGANIZACIÓN DE EMPRESAS

DIRECCIÓN: Dr. JOSE LUIS HERVAS OLIVER

CONTEMPORARY CONCEPTS IN STRATEGIC MANAGEMENT:

DO WE TEACH WHAT WE RESEARCH? UNFOLDING OPEN INNOVATION, ABSORPTIVE CAPACITY, MANAGEMENT INNOVATION AND CLUSTERS

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EDITADO POR

JOSE LUIS HERVÁS OLIVER

CÉSAR CAMISÓN ZORNOZA

Citar como: Hervas y Camisón (2012) CONTEMPORARY ISSUES IN STRATEGIC MANAGEMENT: *DO WE TEACH WHAT WE RESEARCH? UNFOLDING OPEN INNOVATION, ABSORPTIVE CAPACITY, MANAGEMENT INNOVATION and CLUSTERS, Taller de Estrategia Empresarial de ACEDE, Sección de Estrategia Empresarial, Valencia, Enero de 2012.*

El presente Taller de Estrategia Empresarial, es un *workshop* internacional organizado por la Sección de Estrategia Empresarial de la asociación ACEDE, que se celebrará en Valencia en enero de 2012. El objetivo general del mismo se base en tomar el pulso a la comunidad científica sobre unos de los conceptos más actuales y relevantes en la literatura de la Estrategia Empresarial, como son los conceptos de: *Capacidad de Absorción, Innovación Abierta, Innovación en Gestión y los Clusters* empresariales. En general, y pese a ser conceptos relevantes y actuales en el campo de la investigación en Dirección de Empresas, dichos constructos no están del todo acotados, necesitan más precisión conceptual y evidencia empírica, al tiempo que necesitan ser trasladados al ámbito docente y así formar parte de nuestros programas educativos y formativos.

La **Capacidad de Absorción** es un constructo versado en la capacidad de las empresas de identificar, absorber, asimilar, transformar y explotar comercialmente conocimiento obtenido de fuentes externas a la organización (Cohen y Levinthal, 1989, 1990; Lane et al., 2006; Todorova y Durisin, 2007; Lichtenthaler, 2009, entre otros). El constructo original de Cohen y Levinthal ha sido reconceptualizado (Zahra y George, 2002; Todorova y Durisin, 2007) en diversas ocasiones, sobre todo debido a la falta de unidad en cuanto a su medición y concreción del término (Lane et al., 2006). ¿Qué retos presenta la medición del concepto? ¿Cómo podemos aplicar dicho concepto a las *pymes*? ¿Cómo enseñamos dicho constructo en las aulas?

El término de ***Open Innovation*** (Vareska et al., 2009; entre otros) ha tomado fuerza en la comunidad científica desde el lanzamiento de la idea por parte de Chesbrough (2003), si bien recientes estudios como el de la Comisión Europea (Ebersberger et al., 2011), tras ligar el proceso de *open innovation* con la capacidad de absorción, se muestran críticos ante el impacto de dichas estrategias de adquisición de conocimiento y el seguimiento que esta teniendo en las empresas. Sin embargo, ¿qué evidencia tenemos sobre esta práctica en España? ¿Hemos incorporado dicho concepto en nuestros programas docentes?

La ***Innovación en Management*** (Birkinshaw, Hamel and Mol, 2008; Damanpour, et al., 2009; Vaccaro, Jansen, Van Den Bosch, and Volberda, 2010; Walker et al., 2010), si se me permite la traducción, ha estado relativamente poco investigada por la comunidad científica, desarrollándose a la sombra de la todopoderosa innovación tecnológica. Sin embargo, aun contando con la difícil separación de la innovación tecnológica en proceso (como en el caso del *lean manufacturing,* en el que procesos y nuevas formas de gestión van solapadas), resulta vital para acompañar las innovación tecnológicas y sobre todo, independientemente, como acción revitalizadora y amplificadora de la capacidad innovadora de la empresa en la búsqueda y sostenimiento de la ventaja competitiva. ¿Cómo impacta en la ventaja competitiva de la empresa?

Por último, el tema de los ***Clusters*** ha sido estudiado profundamente en la literatura regional, más que en el ámbito empresarial, pese a la gran relevancia de la aportación *porteriana* (Porter, 1998). Sin embargo, no ha tenido tanto seguimiento en el caso concreto de la literatura en Dirección de Empresas, aun considerándolos cómo una fuente de ventaja competitiva para la empresa debido a que los clusters son una fuente continua de innovación y, sobre todo, un catalizador de recursos externos que sustentan y mejoran la performance de la empresa *co-localizada* (Becattini, 1990). En la actualidad, se reconoce la heterogeneidad de las empresas en los clusters y, sobre todo, la necesidad de tener un umbral mínimo de recursos para poder absorber los recursos externos disponibles en el territorio (Hervas-Oliver and Albors-Garrigos, 2009). Sin embargo, quedan temas pendientes como el ciclo de vida de los clusters y su incidencia en la empresa (Staber and Sauter, 2011) o la importancia cada vez mayor de los clusters creativos (Hervas-Oliver et al., 2011, 2012).

En general, el Taller espera recibir contribuciones teóricas, casos de estudio concretos y, en especial, contribuciones empíricas sobre la temática expuesta, y así como cualquiera de sus posibles extensiones a otras temáticas relacionadas. Todo tipo de metodologías son bienvenidas, siempre que de forma coherente representen un encaje entre la teoría y el diseño empírico. El presente Taller trata de contribuir a la conversación en la comunidad científica y, por ello, se esperan aportaciones de calidad y relevancia.

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PROGRAMA

Día 24 de Enero, 2012

Reunión del Comité Científico

Discusión de los *papers* presentados

Pautas científicas del Taller

Día 25 de Enero, 2012

-8.30 Inscripción y registro asistentes

-9.00-9.30 –Presentación e inaguración del Taller.
-9,30-10.30 Key note speaker: Dr. **Bruno Cassiman (IESE)**: "***What is Open Innovation, really?***"

-10.30 Debate sobre la temática

-11:00-11.30 Coffee Break

-11.30 hasta 12.30 Presentación de papers sobre Absorptive Capacity (AC) y Open Innovation

12.30-13.300 Debate: Enseñamos lo que investigamos? (AC y Open Innovation)

13.30 –14.30 Comida
14: 30 -15.30 Papers sobre *Management Innovation*

15.30—16.30 DEBATE SOBRE MANAGEMENT INNOVATION: Enseñamos lo que investigamos? (Management Innovation)

16:30—17:00 Resumen de los puntos relevantes y conclusiones del Taller

17.00-17.15 CLAUSURA

PROGRAMA ACADÉMICO:

8:30	Registro
9:00—9:15	Presentación y Sesión de Apertura.

Temática: Open Innovation

9:15-10.00	Dr. Bruno Cassiman "*What is Open Innovation, really?*" Key Note Speaker

		IESE, University of Navarra.
10.00—10.15	Paper 1. Open Innovation and technology disruption in firm's agglomerations: Inkjet technological paradigm entrance in the global ceramic value chain.	José Albors-Garrigos, Jose-Luis Hervas-Oliver U. Politécnica de Valencia
10.15—10.30	Paper 2. Innovación Abierta En Sectores Tradicionales. El Caso De La Multinacional *Lactalis Forlasa*.	Laura Avellaneda, Universidad de Castilla la Mancha.
10.30—10.45	Paper 3. Saliendo de la torre de marfil: capital social, grupos de investigación universitarios y transferencia de conocimiento en la innovación abierta	Padilla Meléndez, Garrido Moreno Universidad de Málaga
10.45—11.10	Debate abierto sobre Open Innovation: traducción de las conclusiones a la docencia en los diferentes niveles de la Dirección Estratégica	¿Cómo incorporar el concepto a la docencia? -¿Cómo influye el sector? -¿Empresas abiertas o actividades abiertas? ¿Qué actividades? ¿Cuestión de grado?
11.10—11.30	Coffee break	

Temática: Capacidad de Absorción

11.35—11.50	Paper 4. Modelos y constructos de medida de la capacidad de absorción: ¿existe un consenso en su desarrollo?	José Luis Ferreras Méndez Joaquín Alegre Vidal Ana Isabel Fernández Mesa CSIC_Ingenio, U. Politécnica de Valencia Universitat de València
11.50—12.05	Paper 5. The Use Of Information Technology In Interdependent Tasks: Effects On Absorptive Capacity And Organizational Performance	María Teresa Bolívar-Ramos, Víctor Jesús García-Morales, Rodrigo Martín-Rojas, Encarnación García-Sánchez

		Universidad de Granada
12:05-- 12.20	Paper 6. Shared Competences, Learning Capabilites And Innovation Performance: An Interplay Of Complementary Effects	César Camisón, Beatriz Forés and Alba Puig Universitat de València, U. Jaume I.
12:20— 12.35	Paper 7. Análisis Del Constructo Capacidad De Absorción: Hacia Un Marco De Integración	Rocío González-Sánchez • Fernando E. García-Muiña U. Rey Juan Carlos.
12.35— 12.50	Paper 8. Delocalisation patterns in University-Industry interaction: Evidence from the 6th R&D Framework Programme	Joaquín M. Azagra-Caro, Dimitrios Pontikakis & Attila Varga CSIC-Ingenio UPV, JRC-IPTS, Newcastle Business School, Northumbria University, UK
12.50— 13.05	Paper 9. Capital social cognitivo, adquisición de conocimiento y Resultado de la innovación en los distritos industriales: El papel moderador de la capacidad de absorción	Gloria Parra-Requena María José Ruiz-Ortega Pedro Manuel García-Villaverde U. De Castilla La Mancha
13.05— 13.20	Paper 10. How exploitative and explorative alliances between familiar partners succeed? Real options reasoning and knowledge-sharing routines redeployment	Isabel estrada vaquero Natalia martín cruz Pilar pérez santana Universidad De Valladolid
13.20- 14.00	Debate abierto Capacidad de Absorción: -Retos y barreras en la conceptualización del constructo -Implicaciones útiles para la docencia -¿Capacidad de absorción e innovación abierta: cómo encadenamos la complementariedad de los dos constructos?	
14.00- 15.00	Comida y Posters	

Temática	Management Innovation	
15.00-15.20	Paper 11. Benchmarking sobre Lean Manufacturing en empresas del sector del automóvil	Maria Valero-Herrero, Juan A. Marín-García, Julio J. García-Sabater U. Politécnica de Valencia.
15.20—15.40	Paper 12. Combining technical and management innovation: understanding their antecedents and effects on performance	Francisca Sempere, Jose-Luis Hervas-Oliver, Universidad Politécnica de Valencia.
15.40-16.00	Paper 13. Management innovation as a determinant of exporting behaviour	Francisco J. Sáez-Martínez Cristina Díaz-García Ángela González-Moreno Universidad de Castilla La Mancha
16.00—16.20	Paper 14. ¿Es posible hablar de Management Innovation en la Administración Pública?	María de Miguel, Universidad Politécnica de Valencia.
16.20-17.00	Debate Abierto sobre Management Innovation: -¿Qué falta por hacer en el campo del Management Innovation? -¿Cómo lo articulamos dentro de la Dirección Estratégica en sus diferentes niveles (grado, master, PhD.)? ¿Qué otros campos organizativos complementan dicho constructo, a saber, diseño organizativo, teoría de costes de transacción, etc.?	
17.00—17.30	Resumen e integración de las sesiones del Taller: Conclusiones, retos e implicaciones docentes	Gestión de Iniciativas e ideas para generar propuestas de integración de los conceptos debatidos en los programas y temarios como contenidos importantes.
17.30-17.45	Sesión de Clausura.	

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Doctor por la Universitat Politécnica de Valencia (Dr. En Organización de Empresas, obtenido en 2004 en la Escuela Superior de Ingenieros Industriales, Universidad Politécnica de Valencia, UPV). Economista de formación, el profesor Hervas-Oliver, ha sido tres veces Premio Extraordinario de Titulación (CC. Empresariales, Económicas y Doctorado). Actualmente es profesor Titular de Universidad y tiene también afiliación en Florida State University, International Programmes (USA). Investigador Principal y director del grupo MIN (Management and Innovation Network) y del Proyecto ECO2010:17318 Innoclusters del Plan Nacional del Ministerio de Economia y Competitividad; imparte Dirección Estratégica en la Facultad de ADE de la UPV. Sus trabajos han sido publicados en diversas revistas de alto impacto (por ejemplo) *Technovation, Journal of Economic Geography, Technological Forecasting and Social Change, Entrepreneurship and Regional Development, International Journal of Technology Management, European Planning Studies, Service Business, Asian Journal of Technology Management, Technology Transfer, International Journal of Information Management, Economics of Innovation and New Technology*, así como en diversos libros de editoriales de prestigio, (*Edward Elgar, Springer*, et c.); también en medios nacionales (CEDE, Economía Industrial, etc.). Su campo de especialización es la innovación, con especial relevancia a los clusters industriales y la innovación tecnológica y en gestión (management innovation). Actualmente forma parte de un Proyecto Europeo en la temática de Industrias Creativas y su impacto en las regiones Europeas. Ha estado de estancias en el extranjero en la London School of Economics, Maastricht University (MERIT Innovation Institute), University of Edinburgh, University of Southampton, INHOLLAND University, etc.

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London School of Economics and Political Science, Université Montpellier I, Montpellier, Viena University, Universitá degli Studi di Modena, Modena, University of Surrey, Universitá Commerciale Luigi Bocconi y University of Texas. Investigador Principal de *GRECO Research Group on Strategy, Competitiveness and Innovation and Knowledge Management.* Sus intereses de investigación se encuentran en las cuestiones relacionadas con la competitividad y la estrategia empresarial, la prospectiva empresarial, regional y sectorial, inteligencia competitiva y gestión del conocimiento. Ha publicado casi 90 libros o capítulos de libros (con editoriales como Prentice-Hall, Elsevier Science Publishers o John Wiley & Sons) y más de un centenar de artículos en revistas académicas, y ha contribuido con ponencias y comunicaciones a más de 120 congresos en todo el mundo.

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THE RELATIONSHIP BETWEEN DEGREE OF EXPLORATION OR EXPLOITATION PURSUED BY AN ORGANIZATION AND ITS PERFORMANCE: A LONGITUDINAL ANALYSIS OF ENVIRONMENTAL INNOVATIONS.

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ABSTRACT

In this paper we study the effects over firm performance when an organization decides to generate exploitative or explorative innovations. Whereas previous scholars have analyzed the advantages and drawbacks of each approach in the context of technology-based alliances or acquisitions, we focus on firm's internal technological outputs to assess which choice leads to higher firm market-based performance, measured by Tobin's Q. Given the growing importance of environmental innovations in most industries, we employ a longitudinal analysis comprising of 3,966 environmental patents from 68 companies of the Electrical Components & Equipment Industry during the period 2005-2007. The results show a positive relationship between the degree of exploration pursued and firm performance.

Keywords: Environmental innovation, exploration, exploitation, firm market-based performance.

1. INTRODUCTION

Since organizations are constrained by a limited budget, several studies have analyzed how technological alliances between different firms (Nooteboom et al., 2007; Petruzelli, 2011) increase financial resources and reduces costs and global risk, but at the expense of a spread of benefits and the threat of an opportunistic behavior from any of the counterparts (Williamson, 1981). In order to avoid these constraints, other scholars have preferred to focus on examining the opportunities of a single firm to expand its technological innovative outputs and consequences. Some of these studies have specifically examined the duality between focusing on a single specific technology (exploitation) and developing non-related R&D activities (exploration) carried out by a sole organization (Miller, Fern, and Cardinal, 2007; Shin, and Jalajas, 2010; Tanriverdi and Venkatraman, 2005).

Miller, Fern, and Cardinal's (2007) study relates interdivisional, intradivisional and extraorganizational knowledge with the invention's impact, measured by the number of times a patent is cited. These authors suggest that knowledge transfer from other divisions has a positive effect if it is not too different, although they do not explicitly suggest the consequences of that relation. Shin, & Jalajas' empirical work over United States Patent and Trademark Office (USPTO) patents compared the existent technological relatedness among organization's subunits and the boundary-spanning combination of knowledge, but not the firm performance. Similarly, Carnabucci and Bruggeman (2009) also discuss about the exploitation-exploration continuum analyzing implications on knowledge growth.

Although the importance of these previous literature, it is still remaining analyzing one of the main reasons to choose if exploitation or exploration works better for a specific firm: the relationship between its innovative strategy and the firm market-based performance. To date we do not acknowledge any studies analyzing the relationship between the degree of innovative specialization and firm market-based performance measured by Tobin's Q.

Thus, in this paper we try to bridge this gap. We want to examine if an exploitation approach yields to a greater firm performance or if on the contrary it is a more diversified pattern of innovative strategy (exploration) what has more positive impact. Different works have analyzed the strengths and drawbacks of each approach in the context of technological acquisitions and alliances (Ahuja and Katila, 2001; Mowery et al., 1998; Nooteboom et al., 2007; Petruzelli, 2011). Previous results suggest that neither too much exploitation nor exploration yield the higher performance rates, being an intermediary approach what maximize firm performance. We consider that those finding might be applied in the context of a single organization and hypothesize that a non-linear inverted U-shaped relationship between firm performance and knowledge relatedness.

Due to the changing environment faced by the organization, a continuously effort in innovation has become a common practice, since by investing in R&D, the firm may build "rare, valuable, and inimitable sources of competitive advantage for firms" (Phene et al., 370: 2006) that help it to obtain sustained profitability (Roberts, 1999).

In a more general context, a continuously effort in innovation has become a common practice, since by investing in R&D, the firm may build "rare, valuable, and inimitable sources of competitive advantage for firms" (Phene et al., 370: 2006) that help it to obtain sustained profitability (Roberts, 1999). Although the dilemma between exploitation and exploration is our main interest in this paper, we also analyze the direct (positive) relationship between innovation and firm performance. This relationship is the general background of our interest regarding the kind of innovation approach. Therefore, we also expect a positive relationship between the number of innovations, measured by patents, and firm performance, measured by Tobin's Q.

After this first section of introduction, the paper includes some theoretical background and discussion of our hypotheses. In the third part we expose our methodology, sample of 1,368 environmental patents from 50 companies of the Electrical Components & Equipment industry, and selection of variables. Next we show the results of our empirical analysis, and finally we discuss these results and propose new avenues of research.

2. THEORETICAL BACKGROUND AND HYPOTHESES

The importance of the environmental innovations

Innovation has become an important activity for the survival and development of organizations in a wide variety of industries (Brown and Eisenhardt, 2007) as it stands as a key process to gain and maintain competitive advantage. It represents new, rare and valuable sources of knowledge that are linked to greater returns (Ahuja and Katila, 2001). In this paper we examine our hypotheses in the context of environmental innovations.

Rushton (1993) estimated that in 1993 US$ 10 billion out of US$ 103 billion spending in R&D was already allocated to environmental innovation. Similarly, Namerof et al. (2004: 961) point out that " the European Industrial Research Management Association found that for most companies, nearly half of all R&D projects have a significant environmental and safety content."

Governments are also a good example of the public interest on the firms' environmental innovations (Marcus, Aragon-Correa, and Pinkse, 2011). Since it has been argued that environmental protection has a positive impact for both the economic system and citizens' wellbeing, governments are strengthening their regulation in order to reduce the levels of pollution (Courvisanos, 2005; Holliday et al., 2002; Schmidheiny, 1992), adopting it unilaterally as well as through international agreements (Chen, 2008).

For instance, in the United States, although there is not a national regulation that enforce companies to calculate or inform about their greenhouse gas emission, some states have agreed on the establishment of certain norms about the greenhouse gas emission from power plants through the formation of the Regional Greenhouse Gas Initiative (RGGI) which includes the states of Connecticut, Delaware, Maine, Massachusetts, Maryland, New Hampshire, New Jersey, New York, Rhode Island, and Vermont (Reid et al., 2009). This regulation is already in use in the whole area of the European Union.

While regulation remains as an obvious element of pressure, there are other market forces that influence over companies' environmental innovations, like suppliers, employees, shareholders, and customers (Neu, Warsame, and Pedwell, 1998). Several actors may illustrate the market and social interest on firms' environmental innovations. Green suppliers may decide to break relationships with high polluter organizations since keep doing business with them may affect their own reputation (Henriques and Sadorsky, 1999); customers and consumers in general may persuade an organization to pursue a more environmentally responsible strategy by sharing a negative opinion about its level of pollution or even boycotting its products (Greeno and Robinson, 1992); media, thanks to the fast development of information technologies like internet as well as the population's massive use of press and television as source of information, can easily expose to the public any environmental irresponsible action carried out by the organization (Buysse and Verbeke, 2003).

Environmental innovations and market-based firm performance

Although there is still a large number of reactive companies, i.e. those whose investments are based on complying with the current environmental regulation, the public pressure over tougher standards may make these organizations drive from investing only in "end-of-pipe pollution abatement" to a more voluntary environmental-friendly technologies (Neu, Warsame, and Pedwell, 1998). Innovations related to the natural environment have gained a growing importance since the past decades, so we can find an increasing number of organizations that take green innovations, whether they are motivated by the strengthens of external pressures or because they see environmental innovation as an strategic opportunity that confers long-term advantages instead of as an unrecoverable cost (Russo and Fouts, 1997).

Proactive companies are those that go beyond legal and societal coercions, as they see environmental strategies as opportunities that may enhance their market performance. In fact, by pursuing a greener production, organizations may push governments to a more stringent regulation, attract consumers, and improve their reputation (Berry and Rondinelli, 1998; Chen et al., 2006; Porter and van der Linde, 1995; Shrivastava, 1995).

For instance, Bird, Swezey, and Aabakken (2004), point out that the number of consumers willing to pay a higher price for electricity generated by greener technologies has quadrupled between 1999 and 2002 to a total of 711,500. Apart from this increase in consumer awareness over natural environment (Byrnes, Jones, and Goodman, 1999) that allows firms raise the final price, organizations that undertake green innovations proactively may benefit from a more efficient production due to the reduction of waste. For instance, Nameroff et al., (2004) mention the technological improvements made by the company Pifzer, which reduced the use of water in processing inputs by 27-45 million m3 per year, obtaining costs savings of 30%.

Finally, some scholars have followed original arguments from Shrivastava (1995) and Porter and van der Linde (1995) and pointed out that organizations that carry out environmental innovations generate competitive advantages and may obtain "first-mover advantages" including: higher prices for their products, develop new markets, and improve their image.

These arguments suggest that the pursue of environmental innovation is not an additional cost that organizations must bear in order to respond to a more stringent regulation, but it has positive effects that may increase its performance. Therefore, we hypothesize that there is a direct relationship between the number of environmental innovations and the performance of the organization.

H1: The more is the number of environmental innovations carried out by the organization, the greater is the market-based firm performance.

The exploration-exploitation choice

We have suggested that organizations might invest in environmental technologies if they want to increase their performance, but at this point we want to go a little further and try to shed some light on the following question: once an organization has decided to invest in environmental technologies, how should it focus its innovative development: extending similar innovations to different developments in the firm or pursuing new innovations?; should it take both to a lesser degree? if so, in which proportion?

R&D investments may be aimed to develop core competences in a specific knowledge or to perform a wider knowledge that can be applied to a larger set of products or services. Following the seminal work developed by March (1991) we refer to exploitation activities as the "refinement and extension of existing competencies, technologies, and paradigms [that lead to returns that] are positive, proximate, and predictable", whereas exploration is the "experimentation with new alternatives [that lead to returns that] are uncertain, distant, and often negative" (March, 1991: 85).

Given the characteristic of uncertainty that experimentation has, one may think that the exploration of new avenues of knowledge is undesirable since after investing generous resources in unknown technologies there is still a possibility that such an effort do not yield in any positive result, hence resulting in a waste of time and money. However, that exploration may also become an important source of competitive advantage because some breakthrough innovations generate high returns for the organizations (Fleming, 2002; Utterback, 1994).

Pharmaceutical companies are a good example of this approach. These companies budget yearly several US$ billions to research and development activities (Parayil et al., 2003), from which a significant part is dedicated to combine knowledge from different technological domains such as physiology, biochemistry or molecular biology (Henderson and Cockburn, 1994). Firms that have broader knowledge can apply it to a greater number of products, benefiting from their higher technological scope (Miller, 2004).

In a similar vein, Miller's (2006) work over diversified firms with at least $50 million in total assets shows that organizations with a greater technological diversification, i.e. the ones adopting an exploratory strategy, have greater performance than single-segment firms, i.e. those with a very specific technology. Thus, by exploring new forms of knowledge firms may build new capabilities that create value (Cohen and Levinthal, 1990), can develop and introduce new products, create new markets and benefiting from first-mover advantages as the absence of competitors in the short-run (Prahalad and Hamel, 1990). This newness may lead to competitive advantages in the long-run as well. For instance, Toyota's pioneer production of hybrid cars gave it some monopoly rents due to the novelty of its product, yet nowadays is still positioned as the leader of the industry at world level (Spencer, 2003).

On the other hand, some scholars sustain that exploitation activities produce the most valuable innovations for the organization (Montgomery and Wernerfelt, 1988). The specialization in an specific technology allows organizations to master in that knowledge so they can recombine it more efficiently. That expertise may generate what Rosenkopf and Nerkar (2001) call "first-order competence", which "is considered to be a distinctive competence if it is superior to competition and leads to competitive advantage" (Rosenkopf and Nerkar (2001: 288). That first-order competence may position the organization as a reference in a specific technology within its industry, but in order to achieve that the firm has to invest heavily in developing such a domain. When an organization achieves that privileged position, other companies may avoid the pursue of new technologies and focus on creating product based on that specific knowledge (Rosenkopf and Nerkar, 2001). For instance, in the late 1980 most personal computers were compatible with IBM and in the 1990s most hardware and software companies designed products compatible with Microsoft's Windows operating systems.

Although exploitation generates less radical knowledge than exploration, the know-how created by the former is more secure and easily extracted thanks to the higher prior understanding of the organization (Carnabucci and Bruggeman, 2009). Since exploitation fosters familiarity, the problem-solving of any issue related to the innovation is much easier than when dealing with a newer technology that usually imply high, fixed learning costs, whether in price (Hayes 1989; Simonton 1991) or through time spent in employee training (Weisberg 1993).

The exploitation of a specific knowledge is strictly related to the concept of absorptive capacity proposed by Cohen and Levinthal (1990). The higher is the absorptive capacity of a firm the greater is its organizational learning and the faster is the development of products (Cohen and Levinthal, 1990; Moorman and Slotegraaf, 1999).

In their study over organizations alliances, Lane and Lubatkin (1998) showed that collaboration among firms with related technologies (exploitation) exhibited higher innovative performance than those partnering in non-related technology (exploration). They showed that organizations pursuing exploitative alliances had greater relative absorptive capacity, thus generating economies of scope derived from their common understanding. When an organization focuses on one technology its technical workforce "speak the same language", which eases understanding and sharing of ideas, the firm can coordinate more easily its different departments, and allocate more efficiently its resources.

In addition to this, some scholars argue that firms have a tendency to pursue an exploitative behaviour in detriment of a more explorative one. The better understanding of a given technology and the short-term gains derived from its development may drive the company through an organizational inertia that maximize the efficiency of its current activities at the same time that generates an strong internal resistance against technological change (Nelson and Winter, 1982), i.e. the good results obtained by a well-known technology may cause organizations to overlook new opportunities or exhibit opposition against innovations which gains are uncertain (Zhou and Wu, 2010).

For instance, a firm specialized in coal-generating technologies would hardly change its current activity to renewable technologies since doing so "will threaten [its] long-embedded competences and competitive advantages" (Delmas et al., 2007: 195). Delmas et al., add some evidence to the effect that inertia may have over organizations pointing out that the more efficient is a facility in a high-contaminating technology, the less interest it will have over greener technologies.

Although several authors recognize the positive effect of exploitation on performance, especially in the context of high-return industries (Roberts, 1999) the changing nature of the environment makes necessary for firms to adapt their technologies. By sticking into a specific know-how organizations can turn their core capabilities into core rigidities, thus compromising their long-term performance or even survival (Christensen and Overdorf, 2000; Leonard-Barton, 1992). For instance, Zhou and Wu (2010) point out that Polaroid, the former leader of instant film and cameras, failed to adapt its technology to digital cameras and declared bankruptcy in 2001. Likewise, Kodak's leadership in digital camera sales in 2005 thanks to the introduction of its ‘Kodak Easyshare’ camera has become a huge profit disappointment because of its failure to adapt to new market demands (Hamm and Symonds, 2006).

Given that the adoption of both exploration and exploitation may increase organizational performance and that the refusal of any of them may have negative effect to performance, instead of choosing between an explorative or exploitative practice organizations should pursue both, as exploitation of current technologies grants a superior performance and exploration is needed in order to assure firm's long-term survival, and sometimes may lead to higher performance. Some scholars argue that both ways are not only compatible but also complementary. For instance, Rothaermel and Deeds (2004) state that when organizations start a new project they need exploratory research in order to discover something new and potentially useful, and once they have found it organizations should build on that knowledge (exploration) to create a marketable product. These authors sustain that this is a cyclic process, so when an organization is exploiting a new innovation it should continue searching for new opportunities.

In the case of exploiting a well-known technology, several authors posit that while concentrating on a single technology domain may create synergies among firm's subunits, an excessive overlap may be detrimental for its performance. Ahuja and Katila's (2001) study over acquisitions in the chemical industry showed a non-monotonic relationship between innovation performance and the technological relatedness of the acquiring and acquired company, i.e. there is a positive effect (synergy) as relatedness increase but after reaching some point the innovation output decreases.

Nooteboom et al. (2007) reach to the same conclusion in their study over technology-based alliances, with the difference that instead of studying technological relatedness between organizations they focus on their existing cognitive distance. Their results suggest that there is a parabolic, inverted-U shaped relationship between innovation performance and cognitive distance so that too much familiarity discourage collaboration (there is nothing to learn from each other) while too diverse knowledge hamper mutual understanding.

Likewise, Mowery et al.'s (1998) study over joint ventures as well as Petruzelli's (2011) paper over alliances made between firms and universities also showed an inverted U-shaped relationship between firms' technological overlap (i.e. the degree of knowledge similarity) and their likelihood of establishing an alliance, and between technological relatedness and the probability of collaborating with universities, respectively.

Although in this paper we focus on firm's internal capabilities instead of firms' acquisitions or alliances with external parties (Ahuja and Katila's, 2001; Mowery et al., 1998; Nooteboom et al., 2007; Petruzelli's, 2011), we think that the premises exposed in such collaborations/acquisitions can be applied in the context of a single organization, since as Belderbos et al., (2010:871) state: "a central concern of corporate strategy relates to decisions on how to divide attention and resources between explorative and exploitative activities within firms".

Consequently, we hypothesize that:

H2: There is a non-monotonic, inverted-U relationship between firm performance and the degree of diversity of its environmental innovations.

3. METHOD

Sampling and data collection

We employ patent data as a proxy for firms' R&D expenditures in green technologies.

The use of patents for measuring the innovative performance of the companies has some limitations that have generated a longstanding debate (and still nowadays) over their reliability and strength as a valid indicator (Archibugi, 1992; Cohen and Levin, 1989; Dosi, 1988; Griliches, 1998). Among their weaknesses, scholars argue that firms sometimes rely on secrecy instead of patenting their inventions (Mansfield, 1986; Arundel and Kabla, 1998; Hall et al., 2001), as well as the fact that all patents receive the same weight despite there are some inventions more important than others[1] (Wartburg et al., 2005).

Despite these and others drawbacks, Hagedoorn and Cloodt (2003: 1368) state that " it appears that, certainly in large parts of the economics literature, raw patent counts are generally accepted as one of the most appropriate indicators that enable researchers to compare the inventive or innovative performance of companies in terms of new technologies, new processes and new products." (Hagedoorn and Cloodt , 2003: 1368).

The number of patents presented by a firm in a specific domain indicate the effort made to develop knowledge on that area, hence the greater is the number of patents presented in that technology the greater is the interest in exploiting it. Put it differently, given the fact that a firm is constrained by a limited budget that impedes to invest heavily in all areas, the decision of allocating more resources to a specific domain shows that the organization is interested in deepen that technology. Contrarily, a firm presenting patents in different technological areas means that it follows a more explorative strategy.

We based our search in the European Patent Office (EPO) Global Patent Index (GPI), a worldwide database that contains more than 70 million patent records supplied to the EPO by more than 80 patent offices and over 75 countries (GPI user manual, 2009). We withdraw data only from EPO database for three reasons: (1) using several databases might yield to conflicting results due to the different standards, different systems of granting patents as well as patentability requirements, hence focusing in a single database is " necessary to maintain consistency, reliability, and comparability" (Ahuja and Katila, 2001: 205); (2) the wide scope of the EPO database makes unnecessary to complement the search as it allows us to extract data from most innovative countries like Japan and the US among others (GPI user manual, 2009); and (3), EPO has recently created a new classification for green technologies and applications developed to reduce the impact over climate change (EPO, 2011).

[1] For a comprehensive discussion over strengths and weaknesses of patent data, see Griliches (1990) or Silverman (1996). ---> Technological overlap and interfirm cooperation

Additionally, in our search we filter all patents using a single European Classification System (ECLA), so we make sure that a same patent is not classified differently by two offices, which could affect their comparability. ECLA is divided into eight sections (A-H), each of which is subdivided into classes, sub-classes, groups and sub-groups. In relation to environmental innovations, the EPO has created the above mentioned ECLA codes for green technologies, which contains dozens of subgroups, reaching over 17.000 different patents to date (EPO, 2011). Since a same application can be published several times we searched only one document , the family representative[2], per application.

In relation with the sample selected we decided to focus on the " Electrical Components & Equipment" sector, numbered 6190 by the COMPUSTAT database, which is facing multiple environmental challenges in the last decades, including energy efficiency for production and utilization of its products, intensive use of raw materials, or large amounts of electronic waste. We searched for environmental innovations issued during the years 2005, 2006 and 2007 by any company in the industry with at least $1 Million of net sales during the first year of our analysis, 2005. That resulted in 98 companies out of a sample of 1,396 firms, with a total number of 1,354 environmental patents in 2005.

However, we did not include firms with just one patent since as McGrath and Nerkar (2004:6 and 7) state "one could argue that obtaining a first patent in a new area could arise because of luck [whereas] a second patent in a new area is prime evidence of the initiation of a pattern of investment in that area, indicates a firm-level committnent to that area and is a much stronger indicator of a deliberate choice to focus there than a first patent".

Given that not all companies have issued two or more environmental patents during the period of time analyzed, and the fact that COMPUSTAT had no market info over some companies, the final sample resulted in a balanced panel data of 68 companies comprising a total of 122 observations and 3,966 patents (additional info is displayed on table 1).

[2] According to the GPI user manual a same application can be filed in different countries and thus published by several authorities. These publications have a similar content and all together form a simple patent family. When filtering one representative per family we assure that the same patent does not appear several times.

Measures

We set "Tobin's Q" as our dependent variable since we consider it is a valid measure for assessing market-based firm performance (for a deeper explanation see, for example, Tanriverdi and Venkatraman, 2005). Defined as the ratio of the market value of a firm to the replacement cost of its assets, we calculated Tobin's Q using basic financial and accounting data from COMPUSTAT (Chung and Pruitt, 1994).

As usually in previous literature regarding innovation and patents, we use the number of environmental patents as a proxy of innovative performance (Hagedoorn and Cloodt , 2003).

In order to evaluate the exploration/exploitation situation we have developed an indicator, named Intensity of Exploration (I.E.), that brings together three variables related to the degree of exploration carried out by an organization: the number of different ECLAs codes per patent (a), the degree of exploitation (b), and the widespread of knowledge (c).

$$I.E. = a * (1 + b)^{-1} * (1 + c)$$

The first variable (a) we take into account is the total number of different ECLAs codes divided by the number of patents issued by an organization (#ECLA different/#patents). Note that we do not consider the total number of ECLAs, but how many of them are different. A purely exploitative company may have many ECLAs (in number) but only one different, hence the numerator will be one in this case. According to this definition, the greater is (a) the more explorative is an organization.

The second variable (b) we consider is the degree of exploitation deployed by an organization. This variable is calculated as the standard deviation of all ECLA's codes contained in the patents issued by an organization.

Let's suppose a firm that has issued ten patents and that, when examining them, we found that in total there are ten different ECLA's codes. Since each code relates to a different specific knowledge we may think the firm is pursuing a explorative approach (ten different domains in ten different patents). However, since each patent uses to include several codes, it may occur that one code appears ten times (i.e. in all patents) while the others appear only a few times. In this case the firm is exploiting a well-known knowledge.

Thus, the degree of exploitation (b) distinguishes between an exploitative or explorative approach, where the higher is its value the more frequent is a specific knowledge across the patents issued by a firm. Conversely, if the firm has the same number of each ECLA's code (exploration pattern) the

value of this variable will be zero. Since multiplying a zero value would eliminate the explanative power of the other variables ("a" and "c") in the equation we multiply by (1+b).
We multiply by the inverse of (1+b) because I.E. measures the degree of exploration, which is the opposite of exploitation.

The third variable (c) is the widespread of knowledge. We calculated the distribution of ECLAs codes over the patents issued by an organization. If a given ECLA code appears many times and it is distributed uniformly the value of (c) will be low, whereas a more widespread knowledge will lead to a higher value. Consequently the higher it is the widespread of knowledge (c) the more explorative will be the organization.
Since a purely exploitative organization will have a zero value of widespread of knowledge, we multiply by (1+c).

All three variables exposed above (a, b and c) could separately measure the level of exploration/exploitation carried out by an organization. However, if we take into account one single variable (eg, the #ECLA/#Pat) the values given by different companies might be so similar that impede distinguishing between exploration and exploration practices. By multiplying these variables we make sure that the differences between explorative organizations and exploitative ones will be more noticeable, hence the relation between the firm value, measured by Tobin's Q, and the degree of exploration, measured by I.E., can be estimated more easily.

We have sorted ECLA's codes at 6 digits ("groups", according to EPO classification, GPI user manual, 2009) for the following reason. If, for instance, we sort a code at 3-digit level it may occur that a same patent has many identical codes, so we might overvalue the influence of a code that has appeared many times in just one patent in detriment of the rest of the codes. We decide to sort at 6-digits instead of not having any grouping because the preliminary test we set the later with yielded no significant results, i.e. the maximum level of digits is too wide to reach any significant analysis.

We display descriptive statistics and correlations in Tables 1 and 2 for each of the variables described above.

4. RESULTS

To test our hypothesis we employed the statistic program STATA 12. We adjusted a linear regression model with fixed effects by entering the command xtreg. We entered firm size as control variable and tested the relationship between Tobin's Q and the number of patents (hypothesis 1) and the Intensity of Exploration (hypothesis 2). Table 1 shows the descriptive statistics for, and correlations among, the study variables. Table 2 shows the regression results when Tobin's Q is the dependent variable.

Table 1. Correlations

	1	2	3	4
Number of patents	-			
Firm performance (Tobin's Q)	0,082	-		
Intensity of Exploration (I.E.)	-0,423	0,220	-	
Size (Ln Sales)	0,282	-0,278	-0,202	-

Descriptive statistics

Variable	Obs.	Mean	S.D.	Min	Max
Number of patents	122	31,26	55,40	2	301
Firm performance (Tobin's Q)	122	651,83	1071,37	0,698	5412,33
Intensity of Exploration (I.E.)	122	0,70	0,70	0,01	3,50
Size (Ln Sales)	122	13,38	2,65	8,97	21,39

Table 1 shows no significant correlation between the variables analyzed. The correlation coefficient between the number of patents and Tobin's Q is .082, whereas the coefficient between firm size and Tobin's Q is -.278. Hence, it appears that neither the firm size, measured by the natural logarithm of net sales, nor the number of patents have significant effects over firm performance (Tobin's Q).

Table 2. Summary of the model

Number of obs	122	Obs per group: max	3
Number of groups	49	F(3,70)	2,76
Obs per group: min	1	Prob > F	0,0483
Obs per group: avg	2,5	R-sq: within	0.1059

Coefficients[a]

Firm performance (Tobin's Q)	Coef.	Std. Err.	t	P>|t|	[95% Conf. Interval]	
Number of patents	1,44	2,42	0,59	0,555	-3,39	6,26
Intensity of Exploration (I.E.)	208,23	73,33	2,84	0,006	61,98	354,48
Size (Ln Sales)	17,34	189,95	0,09	0,928	-361,51	396,19
Constant	229,01	2533,57	0,09	0,928	-4824,05	5282,06

F test that all u_i=0: F(48, 70) = 24.88 Prob > F = 0.0000

a. Dependent variable: Tobin's Q.

The results from the regression analysis are displayed in table 2. Given the fact that there are a few number of companies that issued two or more environmental patents during just one year, the minimum number of observations is 1. However most of firms in the panel generated innovations during two or the three years of the model, thus resulting in a total average observations of 2,5.

According to our model, only the variable I.E. is related with firm market-based performance, measured by Tobin's Q.

The degree of exploration carried out by an organization (I.E.) has a positive significant effect over firm performance, with a confidence interval of 95% (t = 2.84). In other words, the greater is the diversity of knowledge accomplished by the organization the higher is its performance.

Interestingly, there is no relationship between the number of patents and firm performance. Several scholars have criticized the predicting power of raw patent counts because they give only a quantitative measure of innovativeness, thus recommending more qualitative measures such as patent citations (Hagedoorn and Cloodt, 2003). Since we do not want to state the relevancy of one patent but the exploitation/exploration approach followed by the organization, instead of using patent citations we formulated the I.E. variable.

5. DISCUSSION

We have tried to shed some light over the exploration-exploitation dilemma, stating the advantages and drawbacks of each one, and proposing an intermediate approach in order to reduce the negative consequences of taking too much exploration in detriment of the exploitation or vice-versa. Thus, we deepen a little in the innovation approach and raise the following question: since a firm is constrained by a limited budget, should it employ its entire R&D interest in developing a specific technology (exploitation) or should it spread to different technologies (exploration)? Should it do something in between? In other words, we aim to determine which approach yields to higher firm performance, measured by Tobin's Q.

To date there is not consistent empirical evidence that an exploitative approach yields to better results that an explorative one, nor vice-versa. Advocates of exploration argue that by focusing on a very concrete knowledge an organization may build a "first-order competence" (Rosenkopf and Nerkar, 2001), i.e. a differentiating competence that leads to a superior performance. Additionally, specializing in a given technology eases understanding among unities and foster absorptive capacity (Carnabucci and Bruggeman, 2009).

On the other hand, defenders of exploration argue that investing in different technologies help develop new products, create new markets and enjoy first-mover advantages that might be sustained in time since the organization can become a world-wide reference (Cohen and Levinthal, 1990; Prahalad and Hamel, 1990). In addition to this, centering on one specific knowledge might overlook new opportunities and create inertia that make impossible to anticipate to market changes, which may endanger organization's survival (Zhou and Wu, 2010)

Thus we hypothesize that there is a non-linear relationship between firm performance and the degree of exploration it pursues. We try to address these questions using a sample of environmental patents since the increasing importance of environmental concern has made that even most reactive companies (i.e. those that consider environmental restriction as a cost to minimize) take into account the so-called "green innovations".

We use the number of patents as a proxy for firm innovativeness, but since it is a quantitative measure that gives the same weigh to important innovations vs. less relevant ones (Hagedoorn and Cloodt , 2003), we develop a specific qualitative variable (the Intensity of Exploration, I.E.) to measure the degree of exploration pursued by the organization.

Our analysis over environmental innovations among firms of the Electrical Components & Equipment Industry during the years 2005, 2006 and 2007 shows that the number of patents has no significant effect over firm performance (thus, rejecting hypothesis 1), whereas the Intensity of Exploration, I.E., has a positive effect over Tobin's Q. It appears that it is not a matter of how many innovations are generated by an organization but the degree of diversification of its technological domains.

Contrary to our expectations the relationship between exploration/exploitation and firm performance is not inverted U-shaped, hence it is not an intermediate approach what yields to better performance. Not only an average level of exploitation appears not to be the best choice but, according to our results, any level of exploitative R&D activity seems to be detrimental. It appears that the disadvantages of focusing on a very specific technology, such as organizational inertia (Zhou and Wu, 2010), hinders the positive effect of a higher absorptive capacity (Cohen and Levinthal, 1990).
On the other hand, the greater is the exploration the greater is the firm value, which is in line with the argument of some scholars (vg. Fleming, 2002; Utterback, 1994) that posit that radical innovations leads to higher returns. It seems that a broader technological scope does not only assure the organizational survival in the long run (Christensen and Overdorf, 2000; Leonard-Barton, 1992), but it pays off in the short run, as the three-year period analysis suggests.

The exploration of new avenues of knowledge may lead to first-mover advantages that confer higher returns in the short-run thanks to the absence of competitors. However this short-run benefit might be extended if the innovator keeps its market leadership thanks to a better corporate image, greater understanding of the techonlogy, etc. (Spencer, 2003).

These unexpected results are very appealing if we keep in mind the cross-sectional nature of our data. In any case, our results have to be taken carefully before more definitive conclusions due to several reasons. First, an increase in the number of firms analyzed as well as a longer longitudinal analysis will yield to more reliable results. Second, the specific characteristics of environmental innovations may make possible for pioneer firms to maintain their leadership in the market thanks to a greener corporate image. As Springer (2007) points out, national and supranational agreements on reducing pollution, along with a greater environmental concerning among customers, may make companies see environmental leadership as a competitive advantage. If an organization heads over green technologies the customers will trust more their products than the competitors', which can be translated into higher returns, given the increasing importance of environment-friendly innovations.

For instance, despite the number of costumers willing to pay an extra price for electricity environmentally generated has quadrupled between 1999 and 2002 to a total of 711,500 (Bird, Swezey, and Aabakken, 2004), "[they are] still relatively small in total number" (Delmas et al., 2007:193). Likewise Delmas et al. (2007) estimated a four-times increase of demand for green power between 2002 and 2010.

Complementarily to our empirical analysis, further longitudinal studies should examine several sectors and compare the results and the differences among them, i.e. which sectors show an inverted U-shaped relationship?, and do some sectors follow a more exploitative approach than others? If that is the case, what other circumstances explain such a behavior? Additionally, further studies could also implement other measures of an exploitation/exploration approach. They can employ different construct and compare their variability or explanation power with the developed in this article.

To conclude, our study sheds some light over the dilemma between exploration and exploitation in the sense that it is based upon organization's internal capabilities, instead of evaluating acquisitions or alliances, which may be less desirable than internal growth (Miller, 2004). We found a positive relationship between the degree of exploration and firm performance, highlighting that investing in unknown technologies yields to higher returns given the ability of generating breakthrough innovations that may confer first-mover advantages that if they are well managed they can be sustained in the long-run (Spencer, 2003).

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THE IMPACT OF INTRAMURAL, CONTRACTED R&D AND IMPORT OF TECHNOLOGY ON THE INNOVATION RETURNS OF SPANISH SMES

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Abstract

The aim of this study is to ascertain the impact of three different innovation strategies –namely, intramural R&D, externally contracted R&D, and import of technology through licenses- upon the returns to R&D (in terms of productivity) attained by small and medium-sized enterprises (SMEs) in the Spanish industry. In order to evaluate these effects we consider robust estimates of total factor productivity (TFP) through a GMM approach and numerically compute the sample distribution of the R&D returns. Using data for Spanish manufacturing SMEs drawn from the *Encuesta de Estrategias Empresariales* (ESEE), over the period 1990-2005, our results suggest that the innovation strategy that combines intramural and external R&D is the one that pays off more in terms of returns to R&D, while the import of technology seems not providing any additional sinergy effect, except for low-tech SMEs.

Key words: intramural R&D, contracted R&D, import of technology, R&D returns, TFP, SMEs.

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1. INTRODUCTION.

It is acknowledged that R&D is an important determinant of firm's productivity, innovation and competitiveness (Griliches, 1980). Since small and medium-sized enterprises (SMEs) play an increasingly important role in the Spanish economy (accounting for over 78% of employment and 68% of value added, Eurostat (2005)), it is desirable that SMEs are stimulated into the adoption and generation of innovations. However, it must be realized that not all innovations employed within a firm are induced by the firm through its own R&D: many innovations are purchased through technological licensing or in the form of externally contracted industrial research, and firms may introduce different combinations of these alternatives in order to shape their own innovation strategy. The aim of our study is to analyse the impact of different innovation strategies –defined as intramural R&D; externally contracted R&D; and, imports of technology - and their combinations upon the private return to R&D (in terms of total factor productivity, TFP). This paper attempts to contribute to the current literature measuring the effects of innovation strategies on SMEs performance, which has yielded mixed and inconclusive results.

More specifically, we seek to analyze the effects of three different innovation strategies and their combinations on the contribution of R&D to firm's productivity in Spanish manufacturing SMEs using recent methodological innovations. In particular, we follow a two-step strategy. In the first step, we use a GMM approach to consistently estimate the input coefficients of a Cobb-Douglas production function under the assumption that firms' expectations on future productivity depend on their current productivity as well as on their current R&D spending (Doraszelski and Jaumandreu, 2009). We also obtain estimates of the firm's (non-observable) productivity, which we use to compute the sample distribution of the private R&D returns using a numerical approximation (Judd, 1998). In the second step, we use a regression analysis approach to make inferences about the role of these strategies and their combinations in shaping the distribution of the R&D returns. Also, we aim to analyse the effects of these technological strategies in relation to the industry where the SME operates. The analysis is performed for an unbalanced panel of Spanish manufacturing SMEs drawn from the "*Encuesta Sobre Estrategias Empresariales*" (ESEE) and observed for the period 1990-2005.

Previous studies analysing the role of innovation strategies on firm's innovation performance have produced mixed findings, and have largely ignored SMEs as a research population. For instance, Cassiman and Veugelers (2006) in a study of Belgian firms found that internal R&D and external knowledge acquisition were complementary with respect to influencing innovation performance. In contrast, Laursen and Salter (2006) found evidence of a substitution effect between internal R&D and external knowledge sourcing strategies. Our study provides new empirical evidence on the effect of internal and external knowledge sourcing strategies adopted by Spanish manufacturing SMEs, on innovation performance. Our study differs from previous studies on several aspects: First, instead of focusing on large firms we explore the role of innovation strategies in SMEs, traditionally characterized by limited R&D investment. Secondly, instead of relying on cross-sectional data (e.g. Cassiman and Veugelers, 2006), we explore a panel data set to examine these effects at firm level (see also Lokshin *et al.*, 2008). Thirddly, instead of looking at the correlation (or adoption) structure between internal and external sources of innovation[3], we examine the performance effect of three kinds of innovation-related strategies: the decision to conduct R&D internally; the decision to contract R&D externally; and the decision to acquire foreign technology through licensing, plus all the combinations between these strategies. Thus, extending previous studies (see Cassiman and Veugelers, 2006; Vega Jurado *et al.*, 2009), we investigate the effects of intramural R&D and two strategies for acquiring external knowledge (contracted external R&D and import of technology).

Our results reveal that the technological strategy that combines *Internal and external R&D* is the one that pays off more in terms or returns to R&D to SMEs; however, combining any strategy with *Imported technology* does not make any improvement in the returns to R&D, except for low-tech SMEs. By technological intensity breakdown we confirm these results although the size of the increase in the returns to R&D for the strategy *Internal and external R&D* vary across sectors. Therefore, it seems that there are complementary effects between undertaking *Internal R&D* and *External R&D* in Spanish manufacturing SMEs.

The remainder of this paper is organized as follows. The next section reviews previous empirical studies on the relationship between internal and external sources of knowledge and their impact on firm's perfomance. In section 3 we present the empirical model and discuss the estimation methodology. Section 4 describes the data and section 5 presents the empirical results. Section 6 concludes.

2. LITERATURE REVIEW.

The distinction between internal and external sources of knowledge and the analysis of its various impacts on the returns to innovation has attracted great interest both theoretically and empirically. This trend of the literature is partly explained by the accelerating process in the use of external sources of knowledge that has been accompanied, in parallel, by a reduction of the presence of internal R&D departments (Narula, 2001; Bönte, 2003). However, the empirical evidence on the

[3] This approach has been shown to suffer from measurement problems and inference difficulties (Arora, 1996; Piga and Vivarelli, 2004).

potential complementarities between these strategies and their differential impact on firm's innovation performance is still inconclusive.

As regards the theoretical literature, there are both studies indicating the importance of external sources of knowledge in the innovation process (Chesbrough, 2003), and studies that argue that, in certain industries, the company's internal resources are the main drivers of the firm's returns to innovation (Freel, 2003). Besides, arguments in line with the transaction costs theory would suggest that the acquisition of external knowledge may substitute for intramural R&D (Williamson, 1985). From a more inclusive perspective, there are studies which point out that internal and external knowledge acquisition may be complementary strategies in the innovation process. These studies argue that the firm's internal sources of knowledge not only generate new knowledge, but at the same time they increase the firm's ability to exploit the external sources in the development of new products and processes. This is evocative of the notion of "absorptive capacity" (Cohen and Levinthal, 1989), which stresses the importance of internal knowledge to effectively absorb external know-how.

While there is an increasing number of empirical evidence on the impact of the internal and external innovation strategies on innovative outcomes (Veugelers and Cassiman, 2006, and later references that have followed this strand), most empirical works devoted to this analysis do not distinguish among different types of external strategies available to the firm[4] – as it is the distinction between externally contracted R&D and acquisition of foreign technology through licensing.[5]

Nevertheless, independently of the external innovation strategy used in the analysis, the empirical evidence on the complementarity in innovation performance between internal and external innovation strategies provides mixed findings. For instance, Cassiman and Veugelers (2006) find that intramural R&D and external knowledge acquisition are complementary in influencing innovation performance in Belgian firms. In the same line, Lokshin *et al.* (2008), using a dynamic panel of Dutch manufacturing firms, find also complementarities between the two strategies, but external R&D has only a positive impact on innovation performance in case of sufficient internal R&D. In contrast,

[4] There are few exceptions, as it is the case of the study on Spanish firms of Vega-Jurado et al. (2009) that distinguish between external knowledge acquisition and cooperation as two different external innovation strategies. See also Laursen and Salter (2006) and Schiemdeberg (2008).

[5] In the literature we can find studies that analyse the complementriety between internal R&D and imports of technology (Lee, 1996; Katrack, 1997). However, these studies tend to focus on developing economies, with rather few studies using data for develop economies (for instance, González Cedeira et al., 1999).

Laursen and Salter (2006), for a sample of UK firms, find evidence of a substitution effect between internal R&D and external knowledge sourcing strategies. Similarly, Kraft (2006), analysing whether firm's R&D intensity and its R&D cooperations are complementary in terms of innovative performance, interpret their findings as a hint towards a rather substitutive relationship. On the other hand, the results by Schiemdeberg (2008) provide evidence for significant complementarities between internal R&D and R&D cooperation in German manufacturing firms, but cast doubt on the complementarity of internal and contracted R&D.

Regarding the empirical evidence for Spanish manufacturing firms there are also mixed results. On one hand, Beneito (2006) finds a positive effect of externally contracted R&D when combined with internal R&D, pointing out the role of absorptive capacity. Based on the distinction between innovation types measured by patents and utility models, Beneito stresses a particular aspect of complementarity concluding that internal R&D produces rather significant innovation whereas contracted R&D seems more orientated towards innovations of incremental nature. In the same line, Cruz-Cázares *et al.* (2010), analysing the different effect of R&D strategies upon innovation outputs, find that internal, external R&D and the combination of both strategies have a different impact on performance, with the combined strategy having the greatest impact (a sign of complementarity) and the external-only strategy having the lowest. The study by Vega-Jurado *et al.* (2009) confirms also the different impact of innovation strategies; in this case upon different innovation types (process and product), but in contrast to the previous studies, they are unable to find complementarities between internal and external sources.

By and large, these various strands of the empirical literature indicate the inconclusive nature on the debate between the different impact of innovation strategies and the complementarity between them in shaping firms' innovative performance.

3. EMPIRICAL STRATEGY.

We assume that firms produce a homogenous good using a Cobb-Douglas technology:

$$y_{it} = \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \beta_a a_{it} + \beta_m m_{it} + \omega_{it} + \eta_{it} \tag{1}$$

where y_{it} is the natural log of production of firm i at time t, l_{it} is the natural log of labour, k_{it} is the natural log of capital, a_{it} is the natural log of age of the firm and, m_{it} is the natural log of intermediate inputs. As for the unobservables, ω_{it} is the productivity (not observed by the econometrician but observable -or predictable by firms) and η_{it} is the productivity news that is neither observed nor predictable by the firm.

It is also assumed that age and capital evolve following a certain law of motion that is not directly related to current productivity shocks (i.e. they are state variables), whereas labour and intermediate materials are inputs that can easily be adjusted whenever the firm faces a productivity shock (i.e. they are variable factors).

Following Wooldridge (2009) GMM estimation approach, both Olley and Pakes (1996)(OP, hereafter) and Levinshon and Petrin (2003) (LP, hereafter) estimation methods can be considered as consisting of two equations: the first equation tackles the problem of endogeneity of the non-dynamic inputs; and the second equation deals with the issue of the law of motion of productivity.

Let us start considering first the problem of endogeneity of the non-dynamic inputs. Correlation between variable inputs and productivity complicates the estimation of equation (1), for it makes the OLS estimator biased and the fixed-effects and instrumental variables methods generally unreliable (Ackerberg et al., 2007). Both OP and LP use a proxy (control) function approach to solve this problem based on using the investments and materials, respectively, to proxy for the "unobserved" firm productivity.

OP assumes that the demand of investment, $i_{it} = i_t\left(k_{it}, a_{it}, \omega_{it}\right)$, is a function of capital, age and productivity. LP to circumvent the problem of firms with zero investments uses the demand of materials ($i_{it} = i_t\left(k_{it}, a_{it}, \omega_{it}\right)$) instead as proxy variable, and this is the approach that we will follow in our analysis. [6]

Therefore, when estimating productivity using these general versions of OP and LP in a sample with R&D performers and non-performers, it is assumed identical demand of investments/demand of intermediate materials for both groups of firms.

However, as it is possible to see in Table 3, R&D performers differ in many aspects from non-performers. Thus, we aim at considering different demands of intermediate inputs for R&D performers and non-performers, i.e. we will allow the intermediate inputs demand to depend on R&D experience. Thus, we write the demand of materials as:

$$m_{it} = m_R\left(k_{it}, a_{it}, \omega_{it}\right) \tag{2}$$

[6] Both the investment demand function and the demand of intermediate inputs are assumed to be strictly increasing in ω_{it} (in the case of investment in the region in which i_{it}>0). That is, conditional on k_{it} and a_{it} a firm with higher ω_{it} optimally invests more (it demands more intermediate inputs).

where we include the subscript R to allow for different demands of intermediate inputs for R&D performers and non-performers. Then, given that the demand of intermediate inputs is assumed to be monotonic in productivity it can be inverted to generate the following inverse demand function of materials:

$$m_{it} = m_R\left(k_{it}, a_{it}, \omega_{it}\right) \tag{3}$$

where h_R is an unknown function of k, a, and m.

Then, substituting (3) into the production function (1) we get:

$$y_{it} = \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \beta_a a_{it} + \beta_m m_{it} + h_R\left(k_{it}, m_{it}, a_{it}\right) + \eta_{it} \tag{4}$$

and after taking into account in (4) both that we cannot identify β_k, β_m and β_a and that we consider to different demands of intermediate inputs for R&D performers and non-performers, our first estimation equation is given by:

$$y_{it} = \beta_l l_{it} + 1\left(non\_perf\right)H_0\left(k_{it}, a_{it}, m_{it}\right) + 1\left(perf\right)H_1\left(k_{it}, a_{it}, m_{it}, R_{it}\right) + \eta_{it} \tag{5}$$

where 1(*non_perf*) and 1(*perf*) are indicator functions that take the value of 1 for non-performers and R&D performers, respectively, while R_{it} represent the firm's expenditure in R&D. Further, the unknown functions H_0 and H_1 are proxied by third degree polynomials in their respective arguments.

The second estimation equation deals with the law of motion of productivity. The standard OP/LP approach neglects the possibility of previous R&D experience to affect productivity as they consider that productivity evolves according to an exogenous Markov process:

$$\omega_{it} = E\left[\omega_{it} \middle| \omega_{it-1}\right] + \xi_{it} = f(\omega_{it-1}) + \xi_{it} \tag{6}$$

where f is an unknown function that relates productivity in t with productivity in t-1 and ξ_{it} is an innovation term uncorrelated by definition with k_{it} and a_{it}.

A solution is to consider a more general process (endogenous Markov process) in which previous R&D experience can influence the dynamics of productivity (see Doraszelski and Jaumandreu, 2009):

$$\omega_{it} = E\left[\omega_{it} \middle| \omega_{it-1}, R_{it-1}\right] + \xi_{it} = f\left(\omega_{it-1}, R_{it-1}\right) + \xi_{it} \tag{7}$$

where $R_{\text{it-1}}$ is a vector of variables summarising a firm R&D experience.

Let us now to rewrite the production function (1) using (7) as:

$$y_{it} = \beta_0 + \beta_l l_{it} + \beta_k k_{it} + \beta_a a_{it} + \beta_m m_{it} + h_R\left(k_{it}, m_{it}, a_{it}\right) + \eta_{it} \tag{8}$$

Further, since $\omega_{it} = h_R\left(k_{it}, a_{it}, m_{it}\right)$ and we consider different demands of intermediate inputs for R&D performers and non-performers, we can rewrite $f(\omega_{it-1}, R_{it-1})$ as:

$$\begin{aligned} &f(\omega_{it-1}, R_{it-1}) = f\left[h_R\left(k_{it-1}, a_{it-1}, m_{it-1}\right), R_{it-1}\right] = F_R\left(k_{it-1}, a_{it-1}, m_{it-1}\right) = \\ &= 1\left(non\_perf\right) F_0\left(k_{it-1}, a_{it-1}, m_{it-1}\right) + 1\left(perf\right) F_1\left(k_{it-1}, a_{it-1}, m_{it-1}, R_{it-1}\right) \end{aligned} \tag{9}$$

Thus, substituting (9) in (8), our second estimation equation is given by:

$$\begin{aligned} &y_{it} = \beta_l l_{it} + \beta_k k_{it} + \beta_a a_{it} + \beta_m m_{it} + 1\left(non\_perf\right) F_0\left(k_{it-1}, a_{it-1}, m_{it-1}\right) + \\ &+ 1\left(perf\right) F_0\left(k_{it-1}, a_{it-1}, m_{it-1}, R_{it-1}\right) + u_{it} \end{aligned} \tag{10}$$

where $u_{it} = \eta_{it} + \xi_{it}$ is a composed error term and the unknown functions F_0 and F_1 are proxied by third degree polynomials in their respective arguments.

Wooldridge (2009) proposes to estimate jointly equations (5) and (10) by GMM using the appropriate instruments for each equation. These joint estimation strategy has several advantages: i) it increases efficiency relative to two step traditional procedures (e.g. OP and LP); ii) it makes unnecessary to bootstrap to calculate standard errors; and iii) it solves the problem of identification of the labour coefficient in the estimation of equation (5) pointed out by Ackerberg *et al* (2006).

The downside is that since R&D does not enter directly in the specification of the production function, we cannot estimate its marginal or partial effect with respect to the firms' output. However, we may compute the sample distribution of the (lagged) R&D returns using a numerical approximation to the derivative and the estimates of the firm's productivity (Judd, 1998). In particular, we use a three-point formula with a bandwidth parameter calculated using lagged R&D as the upper bound of the fourth derivative and trim 2.5% of observations at each tail of the distribution to avoid outliers.

In a second step, we pair-wise compare the returns to R&D of firms that undertake different innovation strategies. In particular, we test whether undertaking internal R&D versus external R&D only (or other strategies, such as external R&D plus imported technology through licenses or internal R&D combined with imported technology), reports significant higher returns to R&D for a firm. Analogously, we test whether undertaking external R&D versus undertaking external R&D combined with importing technology, implies higher returns to R&D. Finally, we also consider the comparison of undertaking both internal and externally contracted R&D versus externally contracted R&D, and the combination of the three strategies (internal R&D, externally contracted R&D and imported technology) versus external R&D combined with imported technology. These pair-wise comparisons will allow establishing a ranking of the best innovation strategy (among the distinct combination of strategies) for SMEs, in terms of the returns to R&D.

To do all these comparisons we relate the estimated returns to R&D to relevant indicators for the different technological strategies and several control variables (log (size), year dummies, fixed effects). Specifically, to investigate the role of the distinct technological strategies on returns to R&D we estimate the following equation:

$$\log rRD_{it} = \beta_0 + \beta_1 s[1,0,0]_{it} + \beta_2 s[1,1,0]_{it} + \beta_3 s[1,0,1]_{it} + \beta_4 s[0,1,1]_{it} + \beta_5 s[1,1,1]_{it} + control_{it} + \alpha_i + e_{it} \tag{11}$$

where the dependent variable, $r\mathrm{RD}_{it}$, is the return to R&D by firm i in period t, $s[1,0,0]_{it}$ is an indicator for firms whose strategy is *Internal R&D only*, $s[1,1,0]_{it}$ indicates that the firm's strategy is a combination of *Internal and external R&D*, $s[1,0,1]_{it}$ indicates that the strategy is *Internal R&D* and *Imported technology,* $s[0,1,1]_{it}$ indicates that the strategy is *Externally contracted R&D* and *Imported technology,* and, finally, $s[1,1,1]_{it}$ indicates the strategy combines *Internal, externally contracted R&D*, plus *Imported technology.*[7] In the *control* variable we account for size and year dummies. We estimate equation (11) using a fixed effects model.

On the basis of the estimated coefficients from equation (11) we will pair-wise test one strategy against another one.

4. THE DATA.

To conduct our research we use a representative sample of Spanish SME manufacturing firms drawn from the *Encuesta sobre Estrategias Empresariales* (ESEE) for the period 1990-2005. This is an annual survey sponsored by the Spanish Ministry of Industry and carried out since 1990 that is representative of Spanish manufacturing firms classified by industrial sectors and size categories. The sampling procedure of the ESEE is the following. Firms with less than 10 employees were excluded from the survey. Firms with 10 to 200 employees were randomly sampled, holding around 5% of the population in 1990. All firms with more than 200 employees were requested to participate, obtaining a participation rate of about 70% in 1990. Important

[7] The reference category is $s[0,1,0]_{it}$ that indicates that the firm's strategy is *External R&D only.*

efforts have been made to minimise attrition and to annually incorporate new firms with the same sampling criteria as in the base year, so that the sample of firms remains representative of the Spanish manufacturing sector over time. Firms in the ESEE correspond to 20 industrial sectors according to the 2-digit NACE classification for manufactures. For this study we have selected SME firms (firms with 10-200 workers).

We consider this survey is quite unique to develop this piece of research, as this is a general survey with very rich and detailed information on firm activities and strategies[8] continuously (real panel data). Further, it covers 15 years of Spanish manufacturing. Among the variables we find in the survey we can outline the following: complete information to construct a firm productivity index (TFP) using any firm level approach, very detailed information about firms' innovation activities (information on patents, utility models, product innovation and process innovation, information on internal and contracted (external) R&D expenditures, information on other informal innovation activities and expenditures (revenues) for paying (selling) licenses.[9] Thus, we can relate firm innovation profiles with a broad range of characteristics of firms (i.e., productivity, performance, returns to R&D, etc.) and their environment.

The sample of SME firms for this period consists of 2512 firms (18124 observations). However, our final sample is an unbalanced panel of 890 SME manufacturing firms (9849 observations) observed at least three consecutive years over the period 1990 to 2005, see Table 1. The panel is unbalanced due to the existence of missing observations in critical variables (see the appendix for definitions and data sources). In particular, to construct the final sample we selected firms that provided information for three or more consecutive periods on output, capital, materials, age and number of workers on one hand and on the expenditures on the three innovation strategies considered (i.e., expenditure on internal R&D, on external R&D and on imported technology through licenses). [See Table 1]

In Table 2 we provide descriptive statistics of the technological strategies followed by the SMEs (internal R&D activities, externally contracted R&D activities or imports of technology through licenses), by technological intensity sector. We observe that 25% of the SMEs in our sample are

[8] For example, innovation or export strategies pursued by firms.

[9] Further information about this survey can be found in the following web page, provided by FUNEP: http://www.funep.es/esee/en/einfo_que_es.asp.

involved in innovative activities (see Table 1).[10] With respect to the combination of R&D strategies, we observe that 36% of the SMEs only undertake internal activities and 33% of them combine internal and external R&D strategies. The combination of the three strategies is done by a 3% of the SMEs. We also have that 15% of the SMEs only undertake external R&D activities. Further, 8% of the SMEs only import technology through licensing, 3% combine internal R&D and import technology, and, finally, only 2% of the SMEs in our sample combine external R&D activities with the imports of technology.

By technological sector breakdown, it is interesting to underline some differences with the general pattern described above. We observe that 39% of the firms operating in the high-tech sector combine internal and external R&D strategies, whereas this figure is 30% and 33% for SMEs operating in the med and low-tech industries. As regards the strategy "only internal R&D", we observe that it is undertaken by 34% and 42% of the SMEs in the high and med-tech industries, and by 33% of SMEs in the low-tech sector. Further, we observe that 7% of SMEs in the high-tech sector combine the three innovation strategies, while 3% firms in the med-tech sector do so and only 1% of SMEs in the low-tech sector combine the 3 strategies. The third different feature we observe is that only 9% of SMEs in the high-tech industries undertake external innovation activities, whereas 15% of SMEs in the med-tech and 21% in the low tech do so.

From the above descriptive statistics, we can conclude that the innovation strategies pursued by SMEs operating in different technological intensity sectors are quite different. In particular, we see that the higher the technological intensity of the sector the lower the probability of implementing an "internal and external" or the "internal and external, plus importing" technologies. Further, the lower the technological intensity of the sector the higher the probability of undertaking the "only external R&D" strategy. [See Table 2]

Next, we identify some stylized facts about SMEs performing innovation activities and SMEs that do not, using a simple regression analysis (see Table 3). The objective is to explore the relationship between performing R&D activities at the firm level and some basic firm characteristics. In particular, output per worker, capital per worker, materials per worker, age and size of the firm are the main characteristics we focus on. To be more specific, we estimate an equation of the form:

[10] We define innovative SMEs those declaring positive R&D expenditures (either in internal or externally contracted R&D activities) plus importers of technology through licensing, during at least one year of the observed period.

$$\log\left(y_{it}\right) = b_0 + b_1 drd_{it} + d\log\left(size_{it}\right) + \sum_{i=2}^{20} g_{it} ind_i + \sum_{i=1994}^{2005} g_{it} year_t + e_{it} \tag{12}$$

where the dependent variable is alternatively output per worker, capital per worker, materials per worker, age and size. The logit transformation of the dependent variable is introduced to deal with the fact that the dependent variables are proportions with values between 0 and 1. The variable drd_{it} is a dummy variable that takes on value 1 if the firm performs any kind of R&D activity (either internal, external or both). We also control for size (number of employees), industrial sector and year. [See Table 3]

The differences (in %) between R&D performers and non-performers, computed from the estimated coefficient β_1 as $100(\exp(\beta) - 1)$, show the average percentage difference in the five firm characteristics considered between R&D performers and non performers, controlling for size, industrial sector and year. In all cases, we obtain that there are significant differences between R&D performers and non-performers: output, capital and materials per worker are significantly bigger for R&D performers. Further, there are also significant and positive differences for age and size between the two groups of firms. These significant differences give support the approach undertaken in this piece of research as regards to endogenously consider the link between R&D and productivity.

5. RESULTS.

Table 4 provides estimates of the production function (1) using alternative estimation methods: OLS, fixed effects, and GMM (with and without R&D in the Markov process that defines productivity, i.e. using the Wooldridge (2009) estimator with an Exogenous Markov Process and the simplified version of the Controlled Markov Process of Doraszelski and Jaumandreu (2009), respectively. Results are similar to those obtained in previous studies —see Hall *et al.* (2009). In particular, figures in Table 4 show that OLS estimates tend to overestimate the effect of labour and underestimate that of capital. [See Table 4]

The main aim in this piece of research is to analyse the returns to R&D in SMEs (or more appropriately the TFP elasticities with respect to R&D). As discussed in the previous section, these are obtained by a numerical approximation method applied to the estimated productivity. However, it is worth noting that since the instruments employed to estimate productivity are two-period lags of some variables, we are able to compute the R&D elasticity distributions only for the last twelve years of the sample (1994-2005).

Prior to formally presenting the pair-wise tests, we present the results for the estimation of the returns to R&D equation (see table 5) obtained after estimating equation (11). In particular, we report the results for the whole sample (column 1) and the breakdown by technological sector (columns 2-4). In the equation estimated, the reference category strategy is *Externally contracted R&D only* (s[0,1,0]). Therefore, the results for the coefficients estimates are in relation to this category. [See Table 5]

From our findings, and focusing in the results for the whole sample (first column), we obtain that SMEs whose technological strategy is *Internal R&D only* (s[1,0,0]) have no significant higher return to R&D than the reference firms (those whose strategy is *Externally contracted R&D only*). However, SMEs whose innovation strategy combines *Internal and external R&D* (s[1,1,0]), enjoy a positive and significant higher return to R&D (about 3%) than the reference firm. This result is maintained for low and med-tech sectors, for which combining in-house and externally contracted R&D provides larger R&D returns (of the order of 5% or more). Moreover, those SMEs whose innovation strategy combines *Internal, external R&D and imported technology* (s[1,1,1]), also enjoy a positive and significant higher return to R&D (about 3.5%). Across technological sectors, we find that SMES in low and med-tech sectors that combine the tree innovation strategies are able to attain higher R&D returns (about 8% and 5% in the case of low and med-tech, respectively) than those firms using only externally contracted R&D.

On the basis of the estimated coefficients, the next step is to formally test whether any of the technological strategies pursued by SMEs dominates any of the other ones (see table 6). In particular, we test: (i) *Internal R&D only* versus *Externally contracted R&D only;* (ii) the combination of *Internal and externally contracted R&D* versus *Externally contracted R&D only;* (iii) the combination of *Internal and external R&D* versus *Internal R&D only;* (iv) the combination *External R&D and imported technology* versus *External R&D* only*;* (v) the combination of *Internal R&D and imported technology* versus *Internal R&D only*; and, (vi) *Internal and external R&D plus imported technology* versus *Internal and external R&D*. As before, we report the results for all firms and by technological intensity sectors. [See Table 6]

From our results, and focusing on the sample of all firms (first column of table 6), we conclude that combining both *Internal and externally contracted R&D* reports a significant increase in the firms' returns to R&D, in terms of productivity, vis-à-vis undertaking *Internal R&D only* or *Externally contracted R&D only*. In particular, when we compare the strategy that combines *Internal and externally contracted R&D* with the strategy *Externally contracted R&D only* the increase in the returns to R&D is 3.3% (and statistically significant); and, when we compare it with the strategy *Internal R&D only*, the increase in the returns to R&D is 3.1% (and statistically significant). These results point out to the existence of complementarities by doing both innovation strategies together. Further, when we conduct the analysis by technological intensity (see columns 3-4), we confirm the above results but we are able to offer some valuable insights. In particular, for low and med-tech sectors, in-house and externally contracted R&D appear complementary, as combining both strategies offers significantly higher returns than conducting each innovation strategy separately. Further, the incremental return to implementing the combined strategy is greater if externally contracted R&D is already implemented, than if internal R&D is implemented. In other words, in the case of low-tech the incremental return of combining both strategies is 5.4% (5.9% in med-tech) if externally contracted was already implemented, while it is 3.8% (4.3% in med-tech) if internal R&D was already implemented. This result provides further light into the important role of intramural R&D in SMEs.

Further, *Imported technology* only appears to have a significant role in low tech sectors, and only if *Externally-contracted R&D* has already been implemented. Particularly, the incremental return of combining *externally contracted R&D* and *Imported technology* if *Externally contracted R&D* is already implemented is 6.7%*, while* the incremental return of combining *internal*, *externally contracted R&D* and *Imported technology* if *In-house* and *Externally contracted R&D* are already implemented is 2.8%.

Therefore, we can conclude that: (i) independently of the sector, the superior strategy in terms of the increase in the returns to R&D is the combination of *Internal and external R&D*, with both strategies showing complentarity effects in the returns to innovate; and, (ii) combining these strategy with *Imported technology* does not make any improvement in the returns to R&D, with the exception of low tech firms where import of technology appears complementary of Externally contracted R&D.

6. CONCLUSIONS.

The latest SBS report (European Commission, 2011) shows that though Spanish SMEs are less likely to introduce innovation, collaborate or innovate in-house, those that innovate are more successful than their EU peers in converting these new products and processes into sales revenues. It is evidence like this that is behind the increasingly commitment of policymakers in Spain to supporting innovation is small and medium sized firms. However, for these policy initiatives to be successful, an understanding of the innovation process in SMEs and the different innovation strategies available to SMEs is required. Therefore, the aim of our study is to analyse the impact of different innovation strategies –defined as intramural R&D; externally contracted R&D; and, imports of technology - and their combinations upon the private return to R&D (in terms of total factor productivity, TFP). This paper attempts to contribute to the current literature measuring the effects of innovation strategies on firm performance, which has yielded mixed and inconclusive results. For that purpose we explore a Spanish panel data for manufacturing (ESEE) for the period 1990-2005.

Our results reveal that the technological strategy that combines *Internal and externally R&D* is the one that pays off more in terms or returns to R&D. Therefore, it seems that there are complementary effects between undertaking *Internal R&D* and *External R&D.* However, combining any strategy with *Imported technology* does not make any improvement in the returns to R&D, with the exception of low tech firms where import of technology appears complementary of Externally contracted R&D. These results suggest that government policies should stimulate both in-house and externally contracted R&D, and focus on the particular synergy effects between these two strategies. Additionally, in the case of low-tech sectors, the role of imported technology should also be taken into consideration.

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Table 1. Number of SME firms by technological intensity breakdown.

Firms	All firms		Low-tech		Med-tech		High-tech	
Total number of firms	1181		570		415		196	53%
Number of innovative firms	291	25%	92	16%	107	26%	92	47%

Notes:

1. Innovative firms are defined as those exhibiting positive R&D plus licensing during at least one year of the observed period.
2. The total sample of 1181 SMEs corresponds to 9849 observations, and the sample of the 291 SME innovative firms corresponds to 2196 observations.

Table 2. Technological strategies for the SME innovative firms.

Observations	**All firms**		**Low-tech**		**Med-tech**		**High-tech**	
Only internal R&D	798	36%	239	33%	331	42%	228	34%
Only external R&D	329	15%	150	21%	120	15%	59	9%
Only imports of technology	173	8%	64	9%	56	7%	53	8%
Internal and external	719	33%	220	30%	236	30%	263	39%
Internal and imports of technology	59	3%	24	3%	18	2%	17	3%
External and imports of technology	45	2%	22	3%	11	1%	12	2%
Internal external and imports of technology	73	3%	8	1%	21	3%	44	7%
Total	2196	100%	727	100%	793	100%	676	100%

Table 3. Differences between SME R&D performers and non performers.

	Difference in % (R&D performers vs. no performers)	Standard error	*p*-value
Output per worker	40.41	0.004	0.000
Capital per worker	47.56	0.059	0.000
Materials per worker	56.20	0.052	0.000
Age	7.6	0.041	0.073
Size	109.28	0.052	0.000

Notes: For the estimation of the differences in size across firms groups we do not include *log*(size) as a regressor.

Table 4. Product function estimates.

	OLS (1)	**FE** (2)	**GMM (exogenous Markov process)** (3)	**GMM (endogenous Markov process)** (4)
Labour	0.265***	0.390***	0.214***	0.214***
	(0.012)	(0.017)	(0.003)	(0.003)
Materials	0.654***	0.484***	0.638***	0.633***
	(0.010)	(0.013)	(0.022)	(0.022)
Capital	0.091***	0.093***	0.082***	0.083***
	(0.005)	(0.008)	(0.015)	(0.015)
Age	0.033***	0.329***	0.073***	0.075***
	(0.005)	(0.013)	(0.059)	(0.060)

Notes:

1. The dependent variable is (log) value added.
2. Standard errors are in brackets.
3. ***, **, * denote level of significance at 1%, 5%, and 10%, respectively.

Table 5. Percentage of increase for the rate of return of R&D in terms of productivity.

	All sample	Low-tech	Med-tech	High-tech
Internal R&D	0.002	0.016	0.016	-0.008
	(0.008)	(0.011)	(0.001)	(0.016)
Internal and external R&D	0.033***	0.054***	0.059***	0.023
	(0.007)	(0.010)	(0.013)	(0.015)
Internal R&D and imported technology	0.011	0.018	0.006	-0.027
	(0.013)	(0.017)	(0.019)	(0.018)
External R&D and imported technology	-0.026	0.067***	0.006	-0.005
	(0.016)	(0.026)	(0.001)	(0.024)
Internal and external R&D and imported technology	0.035***	0.082***	0.054***	0.018
	(0.011)	(0.016)	(0.016)	(0001)
Log employment	0.050***	0.046***	0.001	0.093***
	(0.008)	(0.011)	(0.015)	(0.012)

Notes:

1. We estimate the returns to R&D equation controlling for fixed effects.
2. All estimations control for size and year dummies. Standard errors are in parenthesis.

Table 6. Comparing the increase in the rate of returns of R&D in terms of productivity between different innovation strategies.

	All sample	Low-tech	Med-tech	High-tech
Comparing internal R&D only versus external R&D only				
	0.002	0.016	0.016	-0.008
	(0.008)	(0.011)	(0.014)	(0.016)
Comparing internal and external R&D versus external R&D only				
	0.033***	0.054***	0.059***	0.023
	(0.007)	(0.010)	(0.013)	(0.015)
Comparing internal and external R&D versus internal R&D only				
	0.031***	0.038***	0.043***	0.031***
	(0.004)	(0.006)	(0.007)	(0.007)
Comparing external R&D and imports of technology versus external R&D				
	-0.026	0.067***	0.006	-0.005
	(0.017)	(0.026)	(0.022)	(0.024)
Comparing internal R&D and imports of technology versus internal R&D				
	0.008	0.002	-0.010	-0.019
	(0.012)	(0.014)	(0.015)	(0.012)
Comparing internal and external R&D plus imports of technology versus internal and external R&D				
	0.002	0.028**	-0.005	-0.005
	(0.009)	(0.013)	(0.011)	(0.010)

Notes:

1. *Standard errors* are in parenthesis.
2. ***, **, *denote level of significance at 1%, 5%, and 10%, respectively.

BENCHMARKING SOBRE LEAN MANUFACTURING EN EMPRESAS DEL SECTOR DEL AUTOMÓVIL

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Resumen:

Entre las alternativas que pueden garantizar la supervivencia de las empresas, la innovación es uno de los más relevantes. La innovación puede incluir aspectos como los materiales, el producto, el proceso, el mercado o la forma de gestionar la empresa. Entre las nuevas maneras de gestión destacan las herramientas de producción ajustada. El propósito de este trabajo es mostrar la evolución de las prácticas de Lean Manufacturing en las empresas valencianas del sector del automóvil en los últimos años.

Palabras clave: Lean Manufacturing; Management Innovation; Sector Automoción

(1) INTRODUCCIÓN.

La innovación se ha convertido en los últimos años en un elemento esencial para la supervivencia de las organizaciones. La innovación se puede llevar a cabo en las empresas a través de la introducción de un nuevo producto o un cambio cualitativo en un producto ya existente, la presentación de un nuevo proceso, la apertura de un nuevo mercado, el desarrollo de nuevas fuentes de suministro de materia prima o mediante la realización de cambios en la organización industrial a través de una nueva forma de gestión.

En general la innovación de producto, proceso y mercado puede ser copiada por los competidores con bastante facilidad. El tipo de innovación que se presenta con mayor dificultar a la hora de ser replicada es la innovación en la gestión (*Management Innovation)* porque probablemente hay que entender la cultura subyacente del conjunto de principios establecidos por la empresa (Klippel et al., 2008). Los ejemplos típicos incluyen conceptos relativos a la Gestión de la Calidad Total, Organización de aprendizaje, orientación al cliente, o Lean Management (Gebauer, 2011).

El Lean Manufacturing es una filosofía de fabricación japonesa que hace hincapié en la excelencia empresarial mediante la eliminación continua de desperdicios y la mejora de la productividad. Según (Schonberger, 1996) "el Lean Manufacturing es la mejora productiva más importante en cuanto a innovación de la gestión desde el cambio de siglo".

En concreto los fabricantes de automóviles han transformado su filosofía de la producción en favor del paradigma de la producción ajustada. De esta manera, esperan mejorar la eficiencia y obtener mejores resultados en los mercados en que operan. Esta transformación debe tener lugar no sólo en sus plantas, sino que sus proveedores también deberán modificar sus sistemas de producción en línea con la filosofía *Lean Manufacturing* (Liker y Wu, 2000; Morris et al., 2006; Oliver y Delbridge, 2002).

En otro orden de cosas, parece haber suficiente evidencia empírica y teórica como para afirmar que las prácticas de gestión de recursos humanos, juegan un papel muy importante en la implantación exitosa de la producción ajustada y, sobre todo en su mantenimiento gracias a la creación de una cultura de mejora continua que da soporte al resto de prácticas lean (Garcia-Sabater y Marin-Garcia, 2010).

Las empresas proveedoras pueden beneficiarse de la implantación de prácticas de *lean manufacturing* (producción ajustada) para dar satisfacción a alguna de sus prioridades estratégicas ya sean la calidad, los plazos o los costes.

En el presente estudio describiremos cómo han evolucionado, en los últimos 10 años, las prácticas de producción ajustada en empresas del sector del automóvil.

(2) LEAN MANUFACTURING.

El entorno de la mayoría de empresas industriales está caracterizado por un aumento de la rivalidad con las empresas competidoras, la velocidad de los cambios y la inestabilidad de la demanda. Por ello, es recomendable que las empresas se posicionen y decidan cuáles son las prioridades de la estrategia de operaciones (Ketokivi y Schroeder, 2004; Martín Peña y Díaz Garrido, 2007; Urgal González y García Vázquez, 2005).

En la actualidad, para hacer frente a las presiones competitivas, es necesario complementar los esfuerzos que vienen realizando las empresas desde los años 80 en busca de la mejora continua de la productividad y la calidad (Suzaki, 1993; Vazquez-Bustelo y Avella, 2006; White y Prybutok, 2001). Para ello, es necesario identificar los problemas antes de que sus consecuencias se manifiesten espontáneamente, analizar soluciones para la supresión de actividades innecesarias, reducir el tiempo de fabricación, los tiempos de ajustes y el tamaño de los lotes (Garcia-Sabater y Marin-Garcia, 2010). Estas actividades son la base de un conjunto de prácticas que conforman los sistemas de fabricación avanzados. Estos sistemas han recibido muchos nombres, entre ellos: producción ajustada (lean manufacturing), gestión total de la calidad (total quality management/total quality control) o world class manufacturing. Existen muchas similitudes en estos conceptos (Marin-Garcia y Carneiro, 2010a; Prado Prado, 2002; White y Prybutok, 2001). En definitiva, se trata de distintos nombres para representar un conjunto de prácticas que pretenden aumentar la competitividad de las empresas. El objetivo de estas prácticas es la eliminación sistemática de todo tipo de “despilfarro” (Callen et al., 2000), considerando como despilfarro cualquier cosa que no aporte valor añadido al artículo que se produce (Suzaki, 1993).

Para poner en marcha los sistemas de lean manufacturing, se suelen proponer un conjunto de prácticas relacionadas con la gestión de operaciones (planificación y control de la producción, flujo de materiales, el sistema de mantenimiento, el sistema de calidad...), la relación con clientes y proveedores, el diseño del producto o la gestión de recursos humanos (gestión participativa, implicación del operario) (Marin-Garcia et al., 2010). Entre las más habituales podemos encontrar: Sistemas Visuales, Mejora Continua, TQM, Estandarización de Procesos, SMED, TPM, JIT, Relación con proveedores y Relación con clientes (Shah y Ward, 2007; Carrasqueira y Machado, 2008; Dabhilkar y Ahlstrom, 2007; Doolen y Hacker, 2005;

Gurumurthy y Kodali, 2008; Jorgensen et al., 2008; Marin-Garcia y Conci, 2009; Prado Prado, 2002; Treville y Antonakis, 2006; White y Prybutok, 2001).

En diversos trabajos se ha constatado que la aplicación de estas prácticas tiene efectos beneficiosos para la empresa. Estos efectos son mayores si se implantan conjuntos amplios de prácticas y no una sola de manera aislada, pues se puede aprovechar un efecto de sinergia entre ellas (White y Prybutok, 2001).

La mayoría de las experiencias relacionadas con producción ajustada se han realizado en empresas que fabrican elevadas cantidades de un mismo producto en procesos repetitivos (líneas de fabricación). Entre ellas, destacan la industria del automóvil y sus empresas auxiliares o las empresas de la electrónica de consumo. Sin embargo, existen también trabajos que justifican los beneficios de estos sistemas en otros sectores, tanto de empresas de procesos (alimentación, química, industria farmacéutica, detergentes...) como otro tipo de empresas (textil, maquinaria industrial, componentes metálicos, compresores, válvulas hidráulicas, electrodomésticos, plásticos...) (Schonberger, 1996), incluso en empresas que fabrican productos altamente diferenciados de los que se repiten muy pocas unidades (James-moore y Gibbons, 1997; White y Prybutok, 2001). No obstante, se ha de tener en cuenta que el uso de estas herramientas está más extendido en las empresas con configuraciones repetitivas (línea o proceso) que en las configuraciones no repetitivas (proyectos o talleres) (White y Prybutok, 2001). Además, los resultados que obtienen las empresas son relativamente mejores en las configuraciones repetitivas, donde se fabrican productos de consumo complejos y estandarizados. Sin embargo, otros tipos de procesos también pueden mejorarse con estas técnicas, aunque en menor medida (Lee, 1996).

Por otra parte, parece demostrado que las plantas con menos de 250 empleados usan menos estos sistemas (Schonberger, 1996; White y Prybutok, 2001). Para las pequeñas empresas es mejor hacer una implantación secuencial de las herramientas que están a su alcance, empezando por las más fáciles y menos costosas. Quizás para las grandes empresas también sea esta la táctica más eficiente para desplegar la producción ajustada.

(3) METODOLOGÍA DE ESTUDIO.

El grado de despliegue de las prácticas de producción ajustada se ha analizado mediante un cuestionario que se ha distribuido entre las empresas de la Comunidad Valenciana pertenecientes al cluster de proveedores de fabricantes de automóvil. La mayoría de estas empresas son pequeñas y medianas (Tabla 1). Se han comparado los datos del año 2010 con el histórico de los años 2000 y 2009.

Tabla 1. Distribución de las empresas por tamaño.

	2000	**2009**	**2010**
Menos de 50 trabajadores	39%	24%	35%
Entre 50 y 249 trabajadores	48%	56%	41%
Más de 250 trabajadores	13%	21%	23%
N	**31**	**33**	**17**

No se aprecia una diferencia significativa entre las muestras del año 2000, 2009 y 2010, aunque en estos 10 años ha habido un proceso de concentración que ha dado origen a fusiones, adquisiciones y cierres de empresa, generando un aumento de la cantidad de empresas grandes en el sector.

Para medir las variables se ha usado un cuestionario validado por otros autores (Marin-Garcia y Carneiro, 2010a; Marin-Garcia y Carneiro, 2010b). El cuestionario ha sufrido modificaciones de un año a otro. Por ejemplo en el cuestionario de 2010 se incluye una nueva dimensión denominada Cultura con vistas a comparar los datos obtenidos con los de otros clusters nacionales que utilizan esta dimensión en su diagnóstico. El resto de dimensiones se han mantenido aunque alguna de ellas ha sufrido alguna modificación en las preguntas que la conforman.

En el cuestionario se preguntaba el grado de despliegue de cada herramienta con un rango de respuestas entre 0: nada, hasta 100: mucho.

(4) RESULTADOS OBTENIDOS.

Se muestran en el presente estudio aquellas dimensiones que tenían en común los tres cuestionario y por tanto podemos comparar y analizar: TPM, Gestión Visual, TQM, Formación, Mejora continua, Estandarización, SMED, Just-in-time.

En la Figura 1 mostramos la evolución del grado de despliegue de las prácticas de Lean Manufacturing.

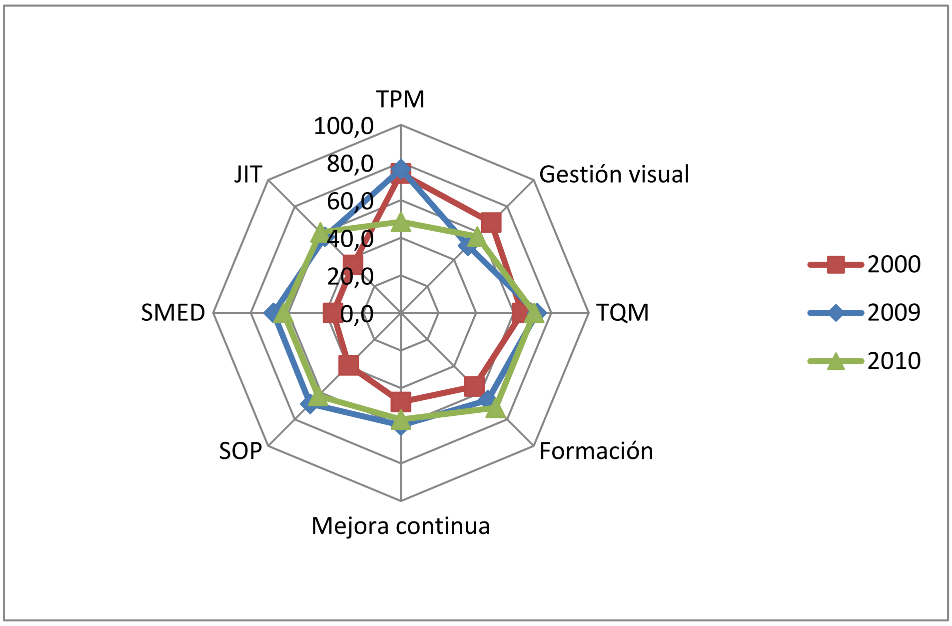

Figura 1. Evolución del grado de despliegue de las Herramientas Lean.

Prácticamente todas las prácticas han visto aumentado el grado de despliegue en el sector desde el año 2000 hasta el 2009. En 2010 se han mantenido en el mismo nivel o se han reducido. Esto puede ser debido al tamaño reducido de la muestra y al cambio en su composición.

El JIT era una de las menos usadas en el año 2000 y sigue siendo un de las más complicadas de implantar en el año 2010. En parte porque requiere del despliegue previo de otras herramientas que aún no han alcanzado el nivel adecuado de desarrollo en el sector y en parte porque los proveedores de segundo nivel son empresas de menor tamaño y recursos que encuentran muchas dificultades a la hora de implantar y mantener la producción ajustada en sus empresas. Sin embargo, a lo largo de estos 10 años el grado de implantación de prácticas como la Estandarización o el SMED ha aumentado mucho, permitiendo que el sector haya pasado de una etapa inicial a un etapa de despliegue medio de las prácticas de producción ajustada.

La Gestión Visual ha retrocedido en su grado de uso. Quizás esto sea debido a que en el año 2000 las empresas acababan de lanzar estas prácticas (que son por las que empezaron todas) y, con el tiempo, la práctica se ha ido degradando por falta de disciplina para el mantenimiento. También puede deberse al uso cada vez más frecuente de ordenadores para la captura y tratamiento de datos, mientras que aún no se ha popularizado el uso de pantallas informativas (táctiles o no) en las líneas de producción, de modo que la información que antes se distribuía en papeles (e incluso rellenada a mano), ahora es transmitida en formato electrónico, sin haber logrado el impacto visual de los procedimientos tradicionales.

En la dimensión TPM también se aprecia una disminución en el grado de implantación. Esta variación es debida a la variación en el contenido de las preguntas de los cuestionarios. Tanto en el cuestionario de 2000 y 2009 esta dimensión tenía relación con el Mantenimiento Preventivo mientras que en 2010 esta dimensión se ha completado con preguntas relativas al Mantenimiento Autónomo, cuyo grado de implantación suele ser menor.

(5) CONCLUSIONES

En este trabajo se han analizado las diferentes prácticas de *Lean Production* y la evolución de su grado de uso en la industria auxiliar del automóvil valenciana entre 2000 y 2010.

Como en todo estudio científico a través de encuestas, se hace necesario asumir la hipótesis de que los encuestados tenían un conocimiento suficiente para responder a las preguntas y que respondieron a las preguntas a conciencia y con la mayor veracidad. Además, se ha puesto de manifiesto por parte de las empresas encuestadas la falta de fiabilidad de los instrumentos de diagnóstico, así como la falta de usabilidad para la identificación de la secuencia más adecuada en la implantación de herramientas.

A pesar de las citadas limitaciones este estudio contribuye al mejor entendimiento de la situación del sector y su evolución en los últimos años.

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COMPETITIVE PRESSURE DETERMINANTS AND INNOVATION AT THE FIRM LEVEL

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Abstract

This paper provides empirical evidence on the relationship between indicators of competitive pressure and innovation incentives using panel data of Spanish manufacturing firms for the period 1990-2006. Instead of using standard indicators of competition, such as market concentration measures or firms' price costs margins, we analyze a number of indicators of competitive pressure directly related to the demand and cost conditions faced by firms. We consider the likely different incentives faced by firms to undertake product innovation versus process innovation efforts, and estimate a multivariate probit model for the probability of firms to introduce product innovations, process innovations or both. Our results are consistent with the theoretical predictions of Vives (2008) for free entry. We obtain that product market substitutability, entry costs and market size significantly affect the probability to introduce product and process innovations but that the effect of these variables differs among the type of innovation. We also find different effects of competitive pressure on innovation when taking into account the efficiency level of the firm relative to the efficiency distribution within its industry.

***Key words**:* competitive pressure, cost-reduction, process innovations, demand-enhancing, product innovations, relative efficiency.

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1. INTRODUCTION

The analysis of the effects of market competition on the innovative activity has received a good deal of attention by the economic literature, and yet, the issue is far from closed. Theoretical models are ambiguous in several ways about the effect of competitive pressure on firms' incentives to innovate. Also existing empirical studies provide diverse and often conflicting results, predicting that market competition may have either a negative or a positive effect on innovation.

The theoretical studies of competition and innovation go back to the work of Schumpeter (1943), who early related the innovative activity to market structure. Schumpeter's seminal work argued that firms with greater monopoly power have a greater incentive to innovate because they can better appropriate the returns of their R&D investment. Since then, many papers provide arguments about the negative effect of competition on this activity.[11] In contrast to the Schumpeterian thesis, a number of authors have stressed that competition may affect positively to the innovative activity: increased product market competition may increase the incremental profits from innovating and thus encourage firms' R&D investments. This is the so-called *escape competition* effect. This line of argument was postulated by Arrow (1962) in a context of perfect protection of the innovators' property rights. Also Porter (1990) argued that monopoly discourages innovation because firms do not need to innovate to stay in business.

According to the early theoretical contribution of Schumpeter and his followers, the first empirical models, using cross section data, found a negative relationship between competition and innovation.[12] The exception to these works was Scherer (1967), who, also using cross section analysis of firms' data, found evidence of an inverted-U shaped relationship between competition and innovation. However, later empirical works on this topic, based mainly on the estimation of linear specifications, achieve the general finding that innovation should increase with competition.[13] Consistent with Scherer's (1967) results, Aghion *et al*. (2005) present a theoretical model explaining the inverted-U shape relationship between competition and innovation, and provide empirical support for it using UK manufacturing data and using the

[11] Among them, Salop (1977) and Dixit and Stiglitz (1977), within the leading industrial organization models of product differentiation and monopolistic competition, deliver the prediction that more intense product market competition discourages innovation by reducing the post entry rents. Also, Gilbert and Newbery (1982), in a model of patent races, find that firms have more incentives to invest in R&D with less competition because they could still enjoy duopolistic profits in case of losing the race.
[12] See Cohen and Levin (1989) for a discussion of this earlier literature.
[13] See, for instance, Geroski (1995), Nickell (1996) and Blundell, Griffith and Van Reenen (1999).

Lerner Index (the price-cost margin, PCM hereafter) as main indicator of product market competition.[14]

The standard approach in the empirical industrial organization literature to proxy for product market competition has been the use of concentration measures (such as concentration ratios or the Hirshman-Herfinhdal index), firms' market shares or PCMs (see, e.g., Blundell *et al.*, 1995, Blundell *et al*., 1999, Nickell, 1996 and Aghion *et al.*, 2005). The use of these measures has been a widely accepted practice in empirical work, in spite of their drawbacks from a theoretical point of view, as stressed by authors such as, e.g., Tirole (1988). In fact, these drawbacks may be one of the reasons behind the contradictory results obtained when analyzing the empirical relationship between competition and innovation.[15]

Recently, new contributions to this literature have reconsidered the use of the standard indicators of product market competition in empirical work (see, e.g., Boone, 2000, Boone *et al.*, 2007, Boone, 2008, or Vives, 2008). In fact, the theoretical literature on competition and innovation considers that there are a number of parameters (also called the fundamentals of competition) capturing the competitive pressure faced by firms, which affect the degree of market competition in an unambiguous way. The degree of product substitutability or the easy of entry into the market are examples of these fundamentals: competition intensifies when goods become close substitutes (that is, as consumers simply chose the cheapest product) and lower entry costs rise competition by increasing the number of firms into the market. Therefore, in order to approximate the degree of product market competition faced by firms these parameters should be properly captured.

However, given that most of the surveys for empirical analysis suffer from a lack of information about these fundamentals of competition, it has been standard in the empirical literature the use of concentration and/or PCM as measures of competition. A fall in concentration or PCM has been empirically interpreted as an increase in competition. Nonetheless, enhanced competition may have different effects on market structure depending on the source of the rise in competition. Boone (2000) argues that, with asymmetric firms' cost efficiency levels, there is not a simple relation between product market competition and market structure. The problem when using concentration measures as indicators of competition is that, in some circumstances,

[14] Recently, a number of papers have also found empirical support for this inverted-U shape (see, for instance, Tingvall and Poldahl, 2006, for Sweden, or Kilponen and Santavirta, 2007, for Finland). However, Tishler and Milstein's (2009) model predicts a convex (U-shape) relationship between competition and innovation in oligopoly markets.

[15] For intance, Dasgupta and Stiglitz (1980) show that high degrees of concentration are not evidence of lack of effective competition.

concentration may raise as a consequence of the most inefficient firms exiting the market as competitive pressure intensifies (an effect known as the *selection effect* - see, e.g., Boone, 2000, and Boone *et al.*, 2007). In addition, enhanced competition may raise the market shares of the most efficient firms at the expense of the inefficient ones, implying an increase in the Herfindahl index (the *reallocation effect,* - Boone, 2000, and Boone *et al.*, 2007). If the PCM is taken as indicator of competition, it may be the case that enhanced competition due to a more aggressive conduct by firms raises the market share of efficient firms, leading to an increase in the average PCM at the industry level. In this case, an increase in the PCM should not be interpreted as an indicator of lower market competition (Boone *et al.*, 2007). Conversely, if less competitive pressure leads to higher costs due to X-inefficiency, or lack of cost reducing innovations, the PCM will decrease.

According to Vives (2008), among others, the Lerner index or the level of concentration should be considered as endogenous variables determined by the fundamentals of market competition. Following this author, in a free entry context enhanced competitive pressure may be captured by an increase in the degree of product substitutability, in the size of the market or in the ease of entry (a decrease in entry costs). Regarding innovation, he distinguishes between the incentives to invest in process innovation (reducing variable costs of production) from the incentives to invest in product innovation (product introduction). The work of Vives (2008) is particularly interesting for the aim of this paper because of two main reasons. First, from the theoretical point of view, Vives' model provides a general framework with robust results on the effects of several indicators of competitive pressure on innovation, reconciling theory with empirical results. Secondly, Vives derives specific implications for the empirical work. In the author's own words: "*Empirical analysis should consider carefully whether innovation is process or product, whether entry is restricted or not, and include as much as possible of exogenous determinants or instruments like market size, entry costs, or product substitutability variables as well as controlling for technological opportunity*" (Vives, 2008, p. 445).

The aim of this paper is therefore to contribute to the empirical evidence on the relationship between indicators of competitive pressure and innovation incentives at the firm level. In order to do so, we follow the empirical recommendations of Vives' (2008) and use measures of the fundamentals of competitive pressure theoretically justified by

Vives (2008) in a context of free entry.[16] Our dataset is a representative panel sample of Spanish manufacturing firms (the ESEE hereafter) for the period 1990-2006. As a first step, we perform linear regressions of the PCM measure on our set of determinants of competitive pressure, with the aim of investigating to what extent PCM is a valid measure of product market competition for empirical work, in line with the discussion above. Then, we estimate a *multivariate probit model* that allows distinguishing between the different factors affecting firms' decisions to introduce product and process innovations, focusing on the idea that the competitive pressure faced by firms affects these two decisions in a different way. We include in our estimations an extensive number of measures and indicators capturing different aspects of the competitive pressure faced by firms, such as product substitutability, market size, entry costs and technological opportunity.

In addition to Vives' predictions, in our empirical approach we also acknowledge the predictions of a number of theoretical papers that have stressed the importance of taking into account firms' efficiency asymmetries when trying to disentangle the complex relationship between product market competition and innovation (e.g. Boone, 2000, and Aghion and Schankerman, 2004). For this purpose, we estimate our multivariate model considering each firm's efficiency level relative to its industry's efficiency distribution. In particular, we consider if our competitive pressure variables exert a different effect on product or process innovation depending on how distant a firm's efficiency level is from that of the most efficient firm within its industry.

To our knowledge, the empirical literature that has tried to capture the relationship between innovation and competition using competitive pressure indicators capturing the fundamentals of competition is still very scarce. One exception is the work of Tang (2006), who, using cross section data of Canadian firms for 1999, finds that firms' perceptions about their competitive environment are important drivers of innovation. However, the work of Tang is not particularly linked to a theoretical model or prediction and is based on a limited set of variables. As for the case of Spain and with the same dataset than us, Artés (2009) uses the traditional measures of competition (such as concentration ratios, PCM, firms' market share or the number of competitors in

[16] Notice, however, that our work does not attempt to be a comprehensive test of Vives' theoretical predictions.

the market) to analyse the decision on whether to engage in R&D or not, and how much to invest in R&D. He finds that market concentration and other measures of monopoly power have a significant effect on the *yes/no* decision, but his results are not conclusive regarding the amount of investment in R&D.

To anticipate our main results, we obtain that product market substitutability, entry costs and market size significantly affect the probability to introduce product and process innovations but that the effect of these determinants of competitive pressure differ between these two types of innovations. Our results are consistent with the predictions of Vives (2008) for free entry. In addition, we find that the efficiency level of firms, in relation to the efficiency distribution within their industry, affects the relationship between competitive pressure and product and process innovation, as suggested by authors as Boone (2000).

Our findings are particularly important in at least two fronts. First, our results indicate that using traditional measures of market power, such as PCM, can be misleading when trying to infer the effect of competitive pressure on innovation incentives and, in particular, that a careful look at the fundamentals of competitive pressure can shed more light on the inconclusive results of the literature on competition and innovation. Secondly, our paper evidences the differential effects of competitive pressure determinants either on product or process innovation and, additionally, the different effect according to firms' efficiency levels with respect to their industry distribution. Thus, our results highlight the importance of distinguishing in the analysis the different sources of competitive pressure in the market. From these resukts we can infer some implications for research, competition policy and business strategy: empirical research on this area should take into account that results obtained without distinguishing between product and process innovations can be misleading; policy makers should consider the potential different effect of competition enhancing policies (like deregulation or trade liberalization) not only on firms' incentives to introduce process and product innovation but also on different firms according to their relative levels of efficiency; finally, from a business strategy point of view, firms' managers may be interested in acknowledging how changes in competitive pressure affect the incentives to innovate depending on the firms' position in the industries' efficiency distribution, a result that might even be used to improve their positioning in this distribution.

The rest of the paper is organized as follows. Section 2 presents an overview of the general framework which supports theoretically our empirical work. Section 3 explains the data, variables and econometric model we have used. Section 4 presents the main estimation results and, finally, section 5 concludes.

2. GENERAL FRAMEWORK

Without being our unique point of reference, the main general theoretical framework for our empirical analysis about competition and innovation relies on Vives (2008). Differently to other theoretical work in this area, which has relied on particular functional specifications for market structure and competition mode, Vives (2008) provides general results about the effects of competition on innovation that are robust to more general specifications. Additionally, with his work he tries to reconcile, within this literature, some theoretical results with the empirical evidence, not only at the industry level but also at the firm level. In doing so, he aims at providing a framework for the empirical work relating competitive pressure to innovation. However, he does not provide empirical evidence for his predictions, and this is the main purpose in our paper.

As argued by Vives (2008), firms' innovation incentives are not homogeneous and enhanced competitive pressure is likely to have a differential effect on process and product innovations. Therefore, both theoretical and empirical analysis should distinguish between product and process innovation incentives. Whereas product innovations are mainly a demand enhancing devise, process innovations are mainly cost reducing investments and, thus, the key drivers of both types of innovations are likely to differ (see, e.g., Boone, 2000, and Vives, 2008). Therefore, changes in competitive pressure may have differentiated effects on product and process innovations whenever they affect differently to firms' incentives for demand creation or cost reduction efforts. For instance, given that the rewards from unit costs reductions increase with the firm's output, any change in competitive pressure increasing per-firm output creates incentives for cost reduction expenditures and, therefore, for process innovation. In addition, changes in competitive pressure reducing the difference between the ex-post expected profits of a new product and the fixed cost of its introduction, will affect negatively the incentives for product innovation.

Endogenising market structure (what Vives considers a free entry market), Vives (2008) points to the following parameters (that he consider as fundamental variables) to measure an enhancement in competitive pressure: an increase in the degree of product substitutability (an increase in the easiness for consumers to switch among producers), an increase in the size of the market, and an increase in the ease of entry (i.e. a decrease in entry costs) for a new firm and/or a new product variety in the market. According to his general model, the empirical analysis should include as many as possible of these fundamentals that determine in an unambiguous direction the degree of competitive pressure, as well as controlling for technological opportunities. As Vives also notices, standard variables like PCM, market concentration measures, or even R&D expenditure per firm, may be explained by these fundamentals, although some of them may have an ambiguous relationship with competitive pressure.

According to Vives' (2008) model, the main three theoretical predictions, when endogenising market structure, about the parameters driving competitive pressure and their effects on product/process innovation are as follows:

> *Prediction 1*: An increase in product substitutability entails an increase in competitive pressure. It increases firms' incentives to cost reduction expenditures and, therefore, process innovation. It decreases firms' incentives for product innovation.

We consider that competitive pressure will be higher in markets where it is easy for consumers to switch producers. When firms' products are close substitutes for consumers, firms have little market power, since consumers simply buy the cheapest product. An increase in product substitutability increases firms' demand elasticity, implying that if a firm invests in cost reduction (process innovation) it could reduce prices and have a greater impact on its sales (because of the increase in the residual demand of the firm). Therefore, higher product substitutability creates incentives for process innovation. On the other hand, as firms differentiate their product, consumer preferences for a particular product or brand loyalty allow firms to raise their prices without loosing business to other firms. Thus, lower product substitutability may be considered as lower competitive pressure that increases profits to be captured by the introduction of a product innovation (a Schumpeterian argument also mentioned in Boone, 2000).

Ideally, we would like to estimate substitution elasticities among the output of industry producers. Since this is empirically not possible, in our empirical specification (and due to data availability) we use a number of measurable proxies as indicators of product substitutability. We consider that both advertising expenditures (*advertising-to-sales ratio)* and firms' promotional activities *(product promotion, branding, firm's image promotion, sales agreements, etc.)* contribute to lower product substitutability. Advertising and branding activities (related to firms' product and also to those services bundled with products, such as after-sales services) may be used by firms to differentiate their product from their rivals, leading consumers to perceive their products as being less than perfectly interchangeable, that is, reducing product substitutability, thus lowering the intensity of competition (Syverson, 2004).[17]

> *Prediction 2*: An increase in market size entails an increase in competitive pressure. It increases firms' incentives to cost reduction expenditures and, therefore, process innovation. It has an ambiguous effect on product innovation.

In industry equilibrium models under imperfect competition, an increase in market size increases the number of firms in the market and, therefore, enhances competitive pressure. However, a standard result in theoretical models of imperfect competition is that market expansion increases the number of firms in the market proportionally less than the increase in market size (see, e.g., Sutton, 1991) and, thus, rises per firm output and the incentives to cost reduction efforts (process innovation). By contrast, an increase in market size has two opposite effects on product innovation incentives. On the one hand, a larger market has a profitability-enhancing effect on product innovation (it creates "economic opportunities" for product innovation). On the other hand, it can also have a negative effect on product innovation when it increases so much the firms' effort on cost reduction and, therefore, the degree of rivalry (competition) that the expected rents from the product introduction decreases, discouraging product innovation.

In our empirical specification, we use three variables to proxy for market size. The first variable indicates the geographic size and scope of the main market served by the firm (whether it is national and international, or international only, as compared to local, regional or national only). The second one measures the firm's export intensity, and the third one indicates if the firm is facing an expansive market.

[17] Following Syverson (2004), barriers to product substitutability may be spacial (when transport cost are relevant), physical (related to firms' product attributes or characteristics) or brand driven (when advertising and branding lead consumer to perceive physically identical products as different). Syverson (2004) provides evidence that as the degree of product substitutability rises, industries' median productivity increases due to the fact that enhanced competitive pressure drives inefficient firms out of the market. See Syverson (2004) for a discussion on the determinants of product substitutability.

> *Prediction 3*: An increase in the ease of entry (i.e. a reduction in entry costs) for a new firm and/or a new product variety in the market entails an increase in competitive pressure. It decreases the incentives to do cost reduction efforts per variety, which is process innovation. It increases the incentives to do product innovation.

An increase in the ease of entry of new firms or new varieties into the market means enhanced competitive pressure, since competition becomes fiercer as more firms or more varieties compete in the market. The intuition behind ease of entry decreasing the incentives for process innovation is as follows. Lowering entry costs increases the number of firms in an industry by promoting entry, which implies less per-firm output and, therefore, lower incentives to undertake cost reduction efforts, that is, to introduce process innovation. However, lower fixed costs to introduce a new product increases firms' expected profits (net of fixed costs) from the new product, increasing the incentives for product innovation.

In our empirical specification we consider two measures of entry costs (or entry barriers). On the one hand, we construct a measure of *set-up* costs following Sutton (1991), which is closely related to costs of entering and establishing a new firm within an industry. This measure is a proxy for the amount of capital (relative to industry market size) required to build a minimum efficient scale plant.[18] This entry barrier to the industry is expected to be more important in the case of process innovations, since it prevents the entry of new firms. Secondly, we introduce a variable that accounts for the speed of *obsolescence* of products as an indicator of the "costs of introducing a new product". In fact, authors as Wörter *et al.* (2010) relate slow product obsolescence to high fixed costs of introducing a new product. The idea behind this argument is that slow product obsolescence proxies for the existence of high fixed costs of introducing a new product in the market, since the firms' willingness to assume such high fixed costs is only compatible with markets where products survive for a considerable length of time. In addition, if product obsolescence is high, it may affect negatively to process innovation, since rapid product obsolescence discourages changes in the production process because it implies that the product is likely to be modified in the near future (Tang, 2006).

Besides Vives' (2008) list of parameters to be included in estimation, we also consider other variables that have been suggested in the literature and which may also shape firms' competitive pressure. These variables are *capacity utilization by competitors* and the threat of *arrival to the*

18 This measure has been used in a number of papers, for instance, in Syverson (2004). See Sutton (1991) for a discussion on the advantages and limitations of using this measure.

market of equivalent or very similar products. Higher capacity utilization by competitors means fewer possibilities for them to react in output and, therefore, less competitive pressure for the firm. Regarding process innovation, if a firm' competitors are producing at high capacity levels, the incentives for cost reduction increase since the derived efficiency gains can be better exploited increasing the output of the firm, given that competitors cannot increase their output supply in the market. In terms of the theoretical models of market competition this would be interpreted as a decrease in the *conjectural variation* (the belief of a firm about how its opponents will react to a change in its own output level), which produces a more aggressive firm behaviour in terms of output (Boone, 2008) and, hence, a higher incentive to introduce process innovations.[19] In addition, the arrival of firm's equivalent products into the market, either national or imported, raises competitive pressure. Tang (2006) uses the constant arrival of competing products as a measure of product market competition that creates a constant threat and promotes product innovation. According to Boone (2007), equivalent imported products will create a tougher competitive regime for domestic firms.[20]

Finally, we also acknowledge in our empirical approach that the firms' efficiency level relative to their industry's efficiency distribution may be an important determinant of the effect of enhanced competitive pressure on firms' incentives to undertake product and process innovations. A number of theoretical papers based on firms' cost asymmetries have predicted differential effects of enhanced product market competition on firms' incentives to undertake innovations. Boone (2000) and Aghion and Schankerman (2004), for instance, predict that the incentives to invest in cost reduction (process innovations) and entry (product innovations) differ for low and high cost firms.

Regarding process innovations, enhanced competitive pressure increases the incentives for process innovation in the case of firms with intermediate efficiency levels. This is explained by an *adaptation effect* of competitive pressure: firms adapt to enhanced competitive pressure by raising their productivity (Porter, 1990, Nickell, 1996, Boone, 2000, and Boone *et al.*, 2007).

[19] Higher capacity utilization by competitors can also be taken as an indicator of stronger capacity constraints in the industry, which is likely to be associated with markets with more competition over quantities (Kreps and Scheinkman, 1983). In turn, markets competing over quantities are inherently less competitive than markets with competition over prices (Vives, 1985; Singh and Vives, 1984). The main predictions in Vives (2008) are independent of the competition mode (Cournot or Bertrand), although this topic has received considerable attention in the competition-innovation literature (see, for example, Bonanno and Haworth, 1998, or Milliou and Petrakis, 2010).

[20] Also in this line, Vives (2008) refers to import penetration as an exogenous determinant of market structure and competition, and Nickell (1996) and Blundell *et al.* (1999), among others, use the degree of imports penetration at the industry level as a measure of market competition.

Additionally, a *selection effect* of competitive pressure (Boone, 2000, and Boone *et al.*, 2007) eliminates relatively inefficient firms from the market, so that intermediate efficient firms are forced to adapt and to improve their efficiency. However, for the most efficient and the inefficient firms enhanced competitive pressure reduces their incentives for process innovations to improve efficiency. Inefficient firms know that even if they do a big effort in cost reduction the probability to survive is low. The most efficient ones know that even without doing too much effort they will survive. The intermediate efficient firms know that with enhanced competition, if they improve enough their efficiency, they have a chance to survive. Therefore, an increase in competitive pressure raises their incentives to do process innovations.

In the case of product innovations, enhanced competitive pressure raises the incentives of the most efficient firms to introduce product innovations because this rise in competitive pressure enables them to better exploit their cost advantage. In the case of the less efficient firms the argument goes in the opposite direction. This can be intuitively explained, following Boone (2000), by the Schumpeterian argument of monopoly power: as competitive pressure increases, the monopoly power and profit levels of inefficient firms are reduced and this discourages firms to undertake product innovations.

Thus, from the above discussion, we find interesting at the empirical level to analyse the effect of competitive pressure indicators on the incentives to innovate taking into account the relative efficiency levels of firms within each industry. To the best of our knowledge, there is a lack of empirical evidence on this issue probably due to the difficulty in capturing the notion of competitive pressure at the level of the individual firm, on the one hand, and the difficulty in measuring firm's heterogeneity (asymmetry) in cost efficiency, on the other hand.[21]

3. DATA AND ESTIMATION ISSUES

3.1. Data and variables

The data used in this paper are drawn from the ESEE for the period 1990-2006. This is an annual survey sponsored by the Spanish Ministry of Industry and carried out since 1990 that is

[21] The only empirical evidence we are aware of is the paper by Lee (2009). However, he does not distinguish between product and process innovation and, furthermore, instead of considering firms' asymmetries in terms of cost efficiency (as the theoretical models of Boone, 2000, 2001, suggest), relies on a measure of what he calls the firm's level of technological competence or capability relative to the world technological leader in its field.

representative of Spanish manufacturing firms classified by industrial sectors and size categories.[22]

The ESEE provides exhaustive information at the firm level on a number of issues, including information on innovation and competitive pressure. The information on innovation includes two direct measures of innovation outcomes, such as whether or not the firm has introduced product and/or process innovations in a given year.

The particular question related to product innovations included in the ESEE is as follows: "*Indicate if during year t the firm obtained product innovations (either completely new products or with so important modifications that they are different to those produced in the past)*". For process innovations, the particular question in the survey is: "*Indicate if during year t the firm introduced some important modification of the productive process (process innovation)*". These two innovation output indicators are binary variables. For instance, the product innovation indicator equals one if the firm introduced a product innovation in year *t* and zero otherwise.
Regarding the percentage of innovative firms in our sample, for the whole period, 66.4% of firms do not introduce any innovation, 8.6% introduce only product innovations, 15.1% introduce only process innovations and, finally, 10.0% introduce both product and process innovations. If we calculate percentages restricted to the subgroup of firms that are innovators (either of only product, only process, or both), the percentages are as follows: 25.5% of firms introduce only product innovations, 45.0% of firms introduce only process innovations, and 29.5% of firms report both types of innovations. Information about the year 1990 is not reported since the first year for estimation will be 1991, given that all the explanatory variables will be lagged one period in estimation. The reason for this is twofold: first, to avoid potential simultaneity problems, as it is standard in this type of models and, second, because firm/market characteristics should be observable to firms when taking their decisions in period *t* for period *t+1* and, therefore, its real effect is lagged.

Regarding competitive pressure variables, instead of using the standard measures of competition, such as the PCM or concentration ratios, we use a number of variables considered by theoretical models as the fundamentals driving market competition for firms in industries with endogenous market structure (see, for instance, Vives, 2008). These variables are the degree of product substitutability, the size of the market, the entry costs (which are either

[22] The sampling procedure of the ESEE is the following. Firms with less than 10 employees were excluded from the survey. Firms with 10 to 200 employees were randomly sampled, holding around 5% of the population in 1990. All firms with more than 200 employees were requested to participate, obtaining a participation rate of about 70% in 1990. Important efforts have been made to minimise attrition and to annually incorporate new firms with the same sampling criteria as in the base year, so that the sample of firms remains representative of the Spanish manufacturing sector over time. See http://www.funep.es/esee/ing/i_esee.asp for further details.

determined by set-up costs for a new firm to enter an industry, or the fixed costs for a firm to introduce a new product into the market) and, finally, other variables related to competitive pressure such as the capacity utilization by competitors and the price pressure from the arrival of competing products.[23]

Table 1 reports the correlation coefficients among all the variables we use to measure firms' competitive pressure. The main results in this Table are as follows. First, the product substitutability variables (*PS* in the Table) are mainly positively correlated (with the exception of *image promotion*, what could indicate that this activity is not complementary but substitutive with respect to *advertising, product promotion* or *branding*). Secondly, the three variables to proxy for market size (*MS* in the Table) are positively correlated among them and also with the *PS* variables. Thirdly, the two variables for entry costs (*EC* in the Table) are, as expected, positively correlated, because both of them indicate barriers to entry. The same reason explains why they correlate with identical signs with the other variables in the Table (in general, negative correlation with *PS*, positive with *MS*, and negative with the capacity utilization by competitors and price pressure from the arrival of competing products, what are named *OM* in the Table). Finally, the *OM* variables in the Table are negatively correlated among them. From this group, the *capacity utilization by competitors* is negatively correlated with the PS variables, what could suggest that when competitors are less able to react in output the firm has lower incentives to differentiate its product, and also negatively correlated with the other groups of variables. As regards the variables capturing price pressure from the arrival of competing products, they are negatively correlated between them because either firms' answer yes to one or to the other on average, but the two of them have the same correlation signs with the rest of the variables (in general, positive correlation with *MS*, negative correlation with entry costs, and mainly positive correlation with *PS*, with the exceptions of image promotion and after sales services). [See Table 1]

In summary, Table 1 shows in general quite low correlation among the variables measuring different aspects of competitive pressure. This suggests that our competitive pressure variables are probably capturing different aspects of competition and, therefore, they should be included simultaneously in the regressions to better capture the overall effect of competitive pressure on firms' innovation output. Regarding the sample used for estimation, and conditioning to firms reporting information on all the variables involved, we end up with a sample of 18,735 observations, corresponding to an unbalanced panel of 2,688 firms.

[23] The definition and measurement of variables is presented in Appendix A.

3.2. Modelling and estimation

In any given period a particular firm may introduce only product innovations, only process innovations, both types of innovations, or none of them. Therefore, we have four categories of firms according to their innovation status in a given period *t*. Tang (2006) estimates the probabilities of the non-zero categories (by reference to category zero) simultaneously with a *multinomial logit* model. In this paper we estimate a multivariate discrete choice model, but, differently to Tang (2006), our general modelling is a *multivariate probit* that avoids the assumption of independence of irrelevant alternatives of a *multinomial logit* model, which implies that the error terms of the different alternatives are uncorrelated.

The *multivariate probit* model we estimate in this paper is specified as follows:

$$y_{it}^{InnovStatus} = \begin{cases} 1 \quad if \quad \mu_t + \beta_{CompPress}^{InnovStatus} CP_{it} + \beta_{Controls}^{InnovStatus} C_{it} + \varepsilon_{it}^{InnovStatus} \geq 0 \\ 0 \qquad otherwise, \end{cases} \tag{1}$$

where the firm innovation status in a given period (only product, only process, both or none, as defined in appendix A) depends on firm/market characteristics (CP_{it} and C_{it}), macro conditions (μ_t), and noise (ε_{it}). In our empirical application, the vector CP_{it} includes the variables measuring competitive pressure, the vector C_{it} includes control variables, and time dummies are included to control for macro conditions.

In model (1), we acknowledge the potential interdependence between the error terms of the three equations (because the status of no innovation is treated as the reference category). Taking this into account leads us to the estimation of a *multivariate probit* model allowing for the $\varepsilon_{it}^{InnovStatus}$'s of the three estimated innovation statuses (only product, only process, or both) to be freely correlated among them, and being able to estimate these correlations. The assumed distribution among the error terms is a *multivariate standard normal*.

We estimate our multivariate probit model using the *mvprobit* Stata program developed by Cappellari and Jenkins (2003).[24] This program uses simulated maximum likelihood techniques to solve the computational problem of evaluating multi-dimensional integrals.[25] In addition to including the possible correlations between the errors, the program allows implementing a pseudo simulated maximum likelihood estimator by adjusting the estimates of the parameter covariance matrix to account for arbitrary correlations between all panel observations of a given firm (see Huber, 1967, and White, 1982).

4. ESTIMATION RESULTS

The main econometric results of our analysis are shown in Tables 2 to 5 in this section. As a first step of our econometric procedure we perform linear regressions of the PCM variable on our measures of product substitutability, market size, entry costs and other competitive pressure variables and controls. These regressions are aimed at investigating to what extent the PCM is a valid measure of product market competition for empirical work. Any indicator of competition should either increase or decrease in an unambiguous way in response to more intense competition fundamentals. If an increase in competitive pressure (in the form of higher product substitutability or a fall in entry barriers, for instance) increases firms' PCM, the empirical work can not use firms' PCM as a measure of competition and, thus, cannot interpret its effect on innovation as a competition effect. [See Table 2]

We have estimated two specifications. The first one assumes equal effect of the variables for all firms in our dataset (results reported in the first column of Table 2). The second one takes into account each firm's efficiency level relative to its industry's efficiency distribution (we use the 2-digit NACE classification, and the results are reported in the last three columns of Table 2). To take into account these relative efficiency levels we interact our competitive pressure variables with dummy variables indicating how distant is the efficiency level of the firm from that of the most efficient one within its industry (the one with the highest total factor productivity, TFP, hereafter). These dummy variables are constructed on the basis of a variable measuring within industry firms' efficiency distance to the technological frontier, which ranges

[24] This program may be obtained either at SSC public domain software archive (http://fmwww.bc.edu/RePEc/bocode/m) or inside Stata, typing 'ssc install mvprobit'.

[25] In particular, it uses the Geweke-Hajivassiliou-Keane simulator to replace multivariate standard normal probability distribution functions by their simulated counterparts, see Hajivassiliou and Ruud (1994) and Gourieroux and Monfort (1996).

from 0 (for the most efficient firm) to 1 (for the most inefficient firm).[26] According to this measure, firms have been defined as *efficient* if they are at most 35 % distant from the most efficient firm in their industry, as *medium-efficient* if they are between 35% and 65% distant from the most efficient firm, and as *inefficient* if they are 65% or more distant from the most efficient firm.[27]

Our interest lies on whether those variables capturing enhanced competitive pressure have an unambiguous negative effect on the firm' PCM. A first group of variables in Table 2 are those that proxy for product substitutability. Given the way they are constructed (see Appendix A), an increase in these variables implies lower product substitutability and, hence, less competitive pressure. The expected sign of the estimated effects of these variables on the PCM is then positive. If we look at the group of variables that proxy for product substitutability, we observe that *product promotion, branding* and *sales agreements* exhibit significant and positive estimated coefficients in the regression corresponding to the whole sample of firms. However, the results are more ambiguous when we interact these variables with the dummy indicators of efficiency distance. In this case both positive and negative signs coefficients are obtained. This would indicate that firms' PCM may be affected by an increase in competition in a different manner depending both on the indicator of competitive pressure used and on the relative position of the firm in its industry's efficiency distribution. For medium-efficient and inefficient firms, the negative and significant sign of the effect of *after-sales services* indicates that less competitive pressure, as proxied by this variable, lowers firms' PCM. The effect, as shown in Table 2, is stronger in the case of the less efficient firms. The intuition could be that low efficient firms may use *after-sales services* to compensate for their low competitiveness in the product market. As Boone (2007, 2008) stresses, conditional on price, if a firm's costs increase over time, its PCM tends to go down, without meaning an increase in competitive pressure. This intuition is also supported by the results we present below for our *multinomial probit* estimation of product and process innovation.

Regarding the variables capturing market size, as explained in section 2, an increase in market size entails an increase in competitive pressure and, therefore, we expect a negative effect on the PCM. However, in this case we also observe different results depending on the efficiency level of firms and the variable considered. On the one hand, an *expansive market* increases unambiguously firms' PCM, a result which holds regardless of the type of firm we consider. On

[26] Details on the construction of this variable are given in Appendix A.

[27] For the sake of a parsimonious regression, control variables are not interacted with these dummies and, thus, there is only one set of estimated control variables parameters in Table 2 for this second specification.

the other hand, the *main firm's market being national and abroad or only abroad* (as compared to local, regional, or only national) seems to exert a negative effect on the firms' PCM, although it is only significant for the group of medium-efficient firms. Finally, the *exports-to-sales* ratio seems to be negatively related to efficient firms' PCM, whereas the effect is positive for the whole sample of firms. The positive effect also appears in the case of the inefficient firms, although in this case the data does not allow us to reject the hypothesis of the coefficient being equal to zero. Since the export markets are usually associated to a higher degree of competitive pressure, the negative effect on efficient firms' PCM is thus as expected. These results can be explained by the fact that efficient firms may be relatively more oriented towards more difficult and highly competitive markets. This idea is supported by Mayer and Ottaviano (2007) and, for the case of Spain, by Máñez-Castillejo *et al.* (2010).

We analyse now the relationship between entry costs and PCM. Theoretically, the relationship between these two variables is unambiguous: if competition is intensified because weak entry barriers let more firms/products into the market, firms' PCM should fall. In our analysis, we use two variables as indicators of entry barriers (see Appendix A for details): the *set-up costs* measure of Sutton (1991), and a dummy variable indicating *slow product obsolescence*, which captures barriers to the introduction of new products. Higher *set-up costs* and *slow product obsolescence* imply higher barriers of entry and then lower competitive pressure, which should be associated with higher PCM. Therefore, the expected sign of the effect of these two variables on firms' PCM is positive. However, the estimation results in Table 2 show negative estimated signs both for *set-up costs* (significant for medium and inefficient firms) and for *slow product obsolescence* (significant for all firms and for inefficient firms), indicating that firms' PCM may not reflect properly the changes in firms' competitive pressure.

Finally, regarding other competitive pressure variables included in our analysis, as higher *capacity utilization by competitors* means less competitive pressure, we expect a positive effect of this variable on firms' PCM. Differently, *product price changes due to new products or competitors in the market* is expected to have a negative effect, since it is related to more competitive pressure. However, the estimated effect for these two variables is the opposite to what one would expect, that is, negative for the former (although only significant for medium-efficient and inefficient firms) and positive and significant for the latter in the case of all firms. Thus, again in these two cases the degree of competitive pressure is not captured by the PCM variable in the expected direction.

In summary, the results in Table 2 support the critical line of arguments that has arisen in the recent literature on competition and innovation and, in particular, the idea that the PCM may be a misleading indicator of competition in empirical analysis: a higher PCM is commonly associated with lower market competition when, in fact, it could be the result of enhanced competitive pressure. Moreover, as Boone (2000) has pointed out, with asymmetric firms (firms with different efficiency levels within the industry) there is no simple relation between competition and market structure. Thus, these results suggest the convenience of using more direct measures of competitive pressure, such as those related to fundamental market demand and cost conditions. [See Table 3]

We turn now to the results on the effect of competitive pressure variables on innovation incentives. Table 3 reports our results for the *multivariate probit* model that estimates three equations: the first equation estimates the probability of firms' obtaining product innovations only; the second one estimates the probability of firms' obtaining process innovations only; and, the third one estimates the probability of firms' obtaining both product and process innovations. We focus on the estimates for *only product innovators* and for *only process innovators*, given that results for the category of *both* can reflect a mixture of predictions from the theoretical literature. All equations include the same set of variables, including time dummies and other controls.[28]

A first important result is the unambiguous positive effect of our (low) product substitutability variables on product innovation. This result is robust to the several variables used in the analysis since all estimated coefficients are statistically significant and positive, indicating that the lower the degree of product substitutability (lower competitive pressure) the higher the incentives to introduce product innovations. These results are consistent with *Prediction 1* in section 2: in the case of product innovation, future returns are the main driver of innovation efforts. If a firm perceives that its clients can easily substitute its product by those of their competitors, then the future profit of innovation becomes uncertain. Thus, lower product substitution (higher values of our variables) has an *enhancing-profit* effect promoting product innovation.

Regarding process innovation we obtain that five out of six estimated coefficients of the measures of product substitutability have negative signs, although they only render statistical significance in two cases (*sales agreements* and *after-sales services*). These negative signs are also consistent with *Prediction 1*: product substitutability increases demand elasticity, what means that by investing in cost reduction expenditures (process innovation) the firm may reduce prices and enjoy a greater impact on its sales. However, *firm's image promotion* seems to have a positive impact on process innovation incentives. While *advertisement-to-sales ratio*, *product promotion* and *branding* may reduce product substitutability through product differentiation

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[28] As explained in the previous section, the multivariate probit model allows for correlation among the errors of the three equations, being these correlations estimated and reported at the bottom of Table 3. The estimated correlation coefficients are statistically significant, indicating that the standard multinomial logit assumption of independent equation errors would not have been valid.

(real or perceived by consumers), *firm's image promotion* may be a competition device for those firms which do not base their market strategy on product differentiation. In fact, as already stated in the previous section, in our data image promotion is negatively correlated to product promotion, branding and advertisement, indicating that these strategies are not complementary but substitutive. Thus, our results point out that although, in principle, activities of image promotion by firms could be considered as an indicator of product differentiation reducing product substitutability (see, for example, Syverson 2004) it may be the case that, once such activities as product promotion, branding activities or advertisement are controlled for in estimation, this variable is capturing a different firm competition strategy in the market. For instance, a firm that relies on its image as a competition tool may be interested in introducing process innovations that allow the firm to be perceived by consumers as a different type of firm. Examples are those firms interested in capturing consumers environmentally concerned, or consumers interested in the security aspects of the firms' production process, etc.

Regarding market size variables, they seem to have a positive impact on innovation incentives. In the case of product innovation, the two variables indicating the geographic scope of the market and the firm's export intensity are positive and statistically significant, thus indicating that the profitability-enhancing effect of a larger market overcomes the possible discouraging effect of a higher degree of rivalry. Although *Prediction 2* (derived from Vives, 2008) states that an increase in market size has an ambiguous effect on product innovation because of the action of the two previous effects, he notices that it is more likely an increase in product innovation since the profitability-enhancing effect (a "direct" effect) is likely to dominate the rivalry effect (an "indirect" one). This result suggests that firms' internationalization and market globalization is an important stimulus for product innovation.

For process innovation, however, the relevant variable is that which accounts for the fact that the market is expanding. An expansive market means that, even if there is an increase in the number of firms, per firm output increases since the increase in the number of firms is less than proportional to the increase in market size (see, e.g., Salop, 1979, Sutton, 1991, and Vives, 2008). This result is consistent with *Prediction 2* and is reinforced by the estimated effect of *firm size* (variable included as a control in the estimation), which has a positive and significant effect on process innovation (in line with Cohen and Klepper, 1996).

Turning to our measures of entry barriers, *set-up costs* and *slow product obsolescence*, the results obtained are consistent with *Prediction 3*: lowering entry costs raises the incentives for product innovations but decreases the incentives for process innovations. For product innovations, both indicators of entry barriers have a negative and significant effect on product innovation: on the one hand, as *set-up costs* increase, the number of new firms and products entering the market go down and, on the other hand, *slow product obsolescence* also discourages the introduction of new products. In the equation for process innovation only the *set-up cost* coefficient is statistically significant and positive, the intuition being that the higher the entry cost in an industry, the lower the number of firms and thus the higher the output per firm and, hence, the higher the incentives for process innovation.

The last indicators of competitive pressure are those related to *capacity utilization by competitors*, *product price changes due to changes in prices of equivalent imported products* and *product price changes due to new products or competitors in the market*. On the one hand, the last two indicators have a positive and significant effect on firms' incentives to introduce product innovations (probably as a strategy to avoid higher competitive pressure from similar products), although they do not seem to exert any significant effect on process innovations. These results are consistent with the widespread idea that product market competition promotes product innovation (Nickell, 1996, and Blundell *et al.*, 1999), and are also in line with the empirical results in Tang (2006). On the other hand, the positive and significant effect of an increase in the degree of *capacity utilization by competitors* in process innovation agrees with the argument already stated in section 2: the lower the capacity of competitors for reacting with their output supply, the more able is the firm to exploit the profits from a cost-reduction (process innovation) by increasing its level of output.

Finally, among the variables used as controls in the multivariate probit, we find particularly interesting the estimated effects of *firm size* (measured as *log* of real sales), which exhibit significant effects both in product and process innovation but with opposite signs: negative for product innovations and positive for process innovations. This result indicates that larger firms are more prone to invest in process innovations, a finding supported by authors such as Scherer (1991) or Cohen and Klepper (1996). [See Table 4]

In Table 4 we present the results following the model specification of Table 3 but for the case in which the multivariate probit model takes into account each firm's efficiency level relative to its industry's efficiency distribution. As explained for Table 2, the competitive pressure variables have been interacted with the corresponding dummy variables indicating whether the firm is efficient, medium-efficient or inefficient. Control variables are included in the model assuming equal coefficients for all types of firms.

The predictions in Boone (2000) about the differential effects of competitive pressure on innovation incentives according to firms' relative efficiency can be summarized as follows (see also section 2). For product innovation, enhanced competitive pressure increases firms' incentives in the case of efficient firms but decreases them in the case of inefficient ones. For process innovation his model predicts that an increase in competitive pressure reduces process innovation incentives both for efficient and inefficient firms, but increases them for medium efficient firms.

As already established in section 2, competitive pressure in a market may increase as a result either from an increase in the degree of product substitutability, in market size or a decrease in entry barriers. Thus, according to Boone's predictions, an increase in these variables will imply higher incentives to product innovation if the firm has a high level of relative efficiency but lower incentives to this type of innovation if the firm is an inefficient one. As regards process innovation, an increase in the degree of product substitutability, in market size or a decrease in entry barriers will induce higher incentives in the case of medium-efficient firms, but it will reduce process innovation incentives if firms are either very efficient or very inefficient firms. Regarding product substitutability, the results in Table 4 for product innovations are in line with results in Table 3 and, thus, consistent with Vives (2008) predictions: a decrease in product substitutability, which entails a decrease in competition, increases product innovation. The positive and significant sign of the variables capturing product substitutability are robust to our efficiency levels classification in most of the cases but we can observe that the magnitude of the effects seem to be clearly stronger for inefficient firms, in line with Boone (2000) predictions for product innovation.

For process innovation incentives, Vives (2008) prediction points out to a negative coefficient for the variables proxying for less product substitutability, a result that is in line with Boone's predictions for the case of medium efficient firms. Looking at the results in Table 4 for process innovation we observe that, in fact, this result is unambiguous only in the case of medium efficient firms, since they are the only ones that exhibit negative signs for all those cases whenever the coefficients are statistically significant (*advertisement to sales ratio* and *sales agreements*). This result for medium efficient firms is explained in Boone (2000) by the *adaptation* and the *selection effects* of competitive pressure: enhanced competitive pressure eliminates relatively inefficient firms from the market, forcing medium efficient firms to adapt and to improve their efficiency levels (process innovation). However, in the case of efficient and inefficient firms, our results are inconclusive regarding product substitutability variables.

If we turn now to the results for the market size variables, they are mostly in line with Vives (2008): larger market size, which entails an increase in competition, increases the incentives for product and process innovation. In the case of product innovation, the geographic scope of the market *(main market being national & abroad*) exerts a positive and significant effect on product innovation, being much more marked the higher the efficiency level of firms. This result can be interpreted in terms of Boone's prediction of higher impact of competitive pressure on product innovation in the case of efficient firms, and follows the intuition that efficient firms are better prepared to take advantage of the economic opportunities offered by a larger market.

Regarding process innovation, we find that the variable capturing that the firm is facing an *expansive market* has a positive and significant effect on process innovation for the three efficiency levels considered, but its effect is larger the lower the efficiency level. This finding seems to be pointing out that, regardless of the size of the market, firms encounter higher incentives to perform process innovation when the market is expanding. This effect is stronger for inefficient firms, maybe because they have lower pre-innovation profits (Aghion *et al*., 2005) and the expectation of a larger residual demand increases the perceived marginal profit derived from process innovation.

The estimated effects of entry costs in product and process innovation are in line with Vives (2008) predictions but only partly consistent with Boone predictions. In the case of product innovation, the effect of *slow product obsolescence* is significant and negative, and also stronger the lower the efficiency level of the firm and, therefore, contrary to Boone's prediction. Regarding process innovation our results are in line with Boone (2000): the effect of *set-up cost*s for process innovation is only significant for efficient and inefficient firms. This result is stronger for inefficient firms, what could be indicating that the protective effect of entry barriers is more relevant for this type of firms, which cannot easily cope with high entry barriers (as argued by e.g. Melitz, 2003).

Finally, other measure of competitive pressure such as *product price changes due to new products or competitors in the marke*t has a stronger effect on product innovation the higher the efficiency level of the firm. For process innovation, this variable exerts a negative and significant effect for the group of inefficient firms, supporting Boone's predictions. Regarding the variable *capacity utilization by competitors*, we obtain a significant and positive coefficient in the case of inefficient firms for product innovation, also in line with Boone (2000) prediction.

In summary, the results reported in Table 4 are consistent with the results in Table 3, but also give support to the differentiated effect of changes in competitive pressure on the incentives to innovate when the relative efficiency level of firms is taken into account, as suggested by the literature. In particular, our results are partly consistent with Boone (2000), and suggest that further research is needed in order to disentangle the role of firms' relative efficiency in encouraging product and process innovations. [See Table 5]

In Table 5 we present the results of two robustness checks we have carried out with our data. First, we have estimated our multivariate model controlling for firms' R&D (real) expenditure. This robustness check aims at disentangling whether our general results in Table 3 are affected by an omitted variables bias due to the potential correlation between some of our competitive pressure variables and firms' R&D investments. In fact, there is a considerable amount of empirical literature that associates R&D with innovation outputs and competition with R&D efforts. Thus, it could be argued that our results in Table 3 might not hold when firms' R&D investment is controlled for. The results obtained in this case are reported in the first three columns of Table 5, and they are similar to the results in Table 3.[29]

Secondly, to further control for the possible simultaneity between our innovation outcome measures (product or process innovation) and our explanatory variables (that could also bias our results),[30] we have run our econometric model taking 4-year averages of our explanatory variables to explain product or process innovations in the following year (the first year after the 4-year period). For each of the initial dummy variables, we have defined a dummy variable taking value 1 for the category more frequently repeated during the 4-year period (the mode), ruling out cases with ties. The model also includes the R&D expenditure variable as in the previous robustness check. These results are displayed in the last three columns of Table 5. We observe that in most of the cases the coefficients keep their signs and their values are close to the ones in Table 3, but lose their statistical significance (the problem of losing statistical significance is more severe for the product innovation equation).[31]

5. CONCLUDING REMARKS.

In this paper we have provided new empirical evidence on the effects of a number of indicators of the competitive pressure faced by firms on their incentives to introduce product and process

[29] In fact, there are only three minor differences affecting the product innovation equation. The first is the estimated coefficient of the *exports-to-sales ratio*, which in Table 3 was positive and significant at the 10% level and now is positive but not statistically significant. The second is the estimated coefficient of the *expansive-market* variable, which in Table 3 was negative and insignificant (although the associated *p*-value was slightly above 10%) and now it is negative and significant at the 10% level. The third is the estimated coefficient for *set-up costs* that in Table 3 was negative and significant at the 10% level and now is negative but non significant (although the associated *p*-value is not too further above 10%).

[30] Notice that we have already controlled for this, at least partially, in our benchmark estimation, given that, as stated in section 3, all the explanatory variables are lagged one period.

[31] Our approach under this robustness check implies using in estimation only the waves after each 4-year group and, accordingly, discards many waves in estimation. While the full estimation sample when including R&D expenditures corresponds to 18,625 observations, our approach for this robustness check uses only 3,947 observations (see the bottom of Table 5). This important reduction in sample size could be behind the loss in significance level for the affected parameters, although its sign and value remains close to the estimates with the full sample. The loss of significance of some parameters is more severe for the product innovation equation, because only 8.6% of firms' observations correspond to the introduction of only product innovations, while 15.1% introduce only process innovations.

innovations. Our analysis is based on the recent strand of the literature stressing that traditional measures of competition, such as concentration ratios or PCM, may not capture properly the extent of firms' competitive pressure. We have used a number of indicators considered by the theoretical literature as the fundamentals of market structure, that is, indicators directly related to the fundamental demand and cost conditions faced by firms, such as product market substitutability, entry costs and market size, which are supposed to have an unambiguous relation to product market competition.

We have used a panel data set of Spanish manufacturing firms for the period 1990-2006, which is representative of Spanish manufacturing at the industry and size level. As a first step, we have estimated the effect of a number of measures of competitive pressure on firms' PCM, with the aim of showing how this measure does not unambiguously reflect the changes in competition induced by the changes in the fundamental variables. We have then estimated a multivariate probit model for the probability of firms to introduce product innovations, process innovations or both. Our econometric results indicate that measures of product substitutability, entry costs and market size, significantly affect the probability to introduce product and process innovations, but that the effect of these variables differs among the type of innovation introduced by firms. These results turn out to be consistent with the empirical predictions of Vives (2008) for industries under free entry (where market structure is endogenous). In particular, our results have shown, in line with Vives (2008), that product and process innovations are driven by different fundamentals of competitive pressure, and that changes in these fundamentals will affect each type of innovation in a different way. On one hand, the incentives for product innovations are determined by those fundamentals related to future returns from this type of innovation. Thus, for instance, higher product substitutability and/or lower costs associated to the introduction of a new product may be considered as enhanced competitive pressure that, by raising potential profits, encourage firms to introduce product innovations. On the other hand, the incentives for process innovations are driven by those fundamentals affecting the possibility to raise firms' output, given that a higher output per firm allows the firm to better exploit the cost reduction associated with a process innovation. Thus, in this case those fundamentals of competitive pressure affecting process innovation are those related to a larger market size and the possibility for the firm to appropriate a higher proportion of this market, such as whether the market is expansive, the use of firm's image promotion activities or a higher level of capacity utilization by competitors.

Regarding policy implications, this paper has stressed that product market competition may be captured by different indicators of competitive pressure. In addition, it has pointed out the complexity of the relationship between competition and innovation, augmented once we introduce in the analysis the distinction, according to the theoretical models of competition and innovation, between product and process innovation incentives. Recognizing these factors should be important for policy makers trying to promote innovation through measures affecting competition, as they can evaluate the different effects of acting through different competitive pressure variables on different types of innovations (either product or process innovations may be affected, and sometimes in opposite directions). Competition authorities and regulators should also be cautious about using traditional measures of competition, such as concentration and price cost margins, as measures of competition intensity on a particular industry. Further, our results have provided evidence on the importance of taking into account firms' heterogeneity in terms of efficiency when analysing the effects of competitive pressure variables on firms' incentives to introduce product and process innovations, in line with works such as Boone (2000).

3.2.1 APPENDIX A

3.2.2 **Variables definition**

Innovation output measures	
Process innovations only	Dummy variable taking value 1 if the firm has implemented process innovations but not product innovations, 0 otherwise.
Product innovations only	Dummy variable taking value 1 if the firm has implemented product innovations but not process innovations, 0 otherwise.
Both product and process innovations	Dummy variable taking value 1 if the firm has implemented both process and product innovations, 0 otherwise.
Product substitutability variables	
Advertisement-to-sales ratio	Advertisement expenditure normalized by sales (in %).
Product promotion	Dummy variable taking value 1 if the firm declares to perform product promotion activities.
Branding	Dummy variable taking value 1 if the firm declares to perform brand promotion activities.
Firm's image promotion	Dummy variable taking value 1 if the firm declares to perform firm's image promotion. The excluded reference category in estimation is no promotion at all.
Sales agreements with wholesalers or retailers	Dummy variable taking value 1 if the firm declares to perform agreements with wholesalers or retailers. The excluded reference category in estimation is no such agreements (either because of no agreements with them or because the firm does not sell to wholesalers or retailers).
After-sales services	Dummy variable taking value 1 if the firm declares to perform after-sales services to clients.
Market size variables	
Expansive market	Dummy variable taking value 1 if the firm declares to face an expansive market in relation to a non expansive market.
Main market is national & abroad, or only abroad	Dummy variable taking value 1 whenever the firm exports, and 0 otherwise.
Exports-to-sales ratio	Value of exports normalized by sales (in %).
Entry costs	

Set-up costs	We follow the method in Sutton (1991) for measuring set-up costs (sunk entry costs). They are measured as the output share of an industry's median-size firm multiplied by the capital-output ratio for the industry as a whole. The former part of the product is considered in Sutton (1991) as a measure for the firm's minimum efficient scale. Therefore, the total measure for set-up costs is a proxy for the amount of capital (relative to the industry's total market size) required to build such a firm. The same proxy for set-up costs is also used in Syverson (2004). See Máñez Castillejo *et al*. (2005) for our measures of firms' output and capital stock.
Slow product obsolescence	Dummy variable taking value 1 if the firm declares that the type of products sold in the industry change with a frequency of more than one year, irregularly or no change, against the reference category of the type of products changing more than once in a year.
Other competitive pressure variables	
Product price changes due to changes in prices of equivalent imported products	Dummy variable taking value 1 if the firm declares that the reason for a change on its prices has been changes in prices of equivalent imported products.
Product price changes due to new products or competitors in the market	Dummy variable taking value 1 if the firm declares that the reason for a change on its prices has been the appearance of new products or competitors in the market.
Capacity utilization by competitors	Yearly weighted average of the productive capacity utilization of the other firms in the same industry (in %). The weights are given by each firm's particular sales over the total sales of the industry for a given year. The industry classification accounts for the 20 industrial sectors of the NACE-93 classification.
Traditional measure for competition	
Price cost margin (PCM)	It has been calculated as the firm's ratio of (output - labour costs - intermediate inputs costs) over output. See Máñez Castillejo *et al*. (2005) for the used measures to construct this index per firm.
Control variables	
Medium-technological sectors	We follow the revised OECD [2002] industry classification, which groups industries according to their patterns of generation and acquisition of technology. According to this classification we include as med-tech food and tobacco, rubber and plastic, metallurgy, machinery and mechanical equipment, and motors and cars.
High-technological sectors	According to the revised OECD [2002] industry classification, we include as high-tech chemical products, office machines, electronic, and other transport material. The reference category is low-tech, which includes the meat industry, beverages, textiles, leather and shoes, wood, paper, printing, non metallic miner, metallic products, furniture, and other manufacturing goods.
Firm's age	Number of years since the firm was born.

Size	Log of firm's real sales. Firms' sales are in euros that have been deflated using specific industry deflators according to 20 sectors of the NACE-93 classification.
Percentage of highly-skilled labour	Ratio of the number of highly qualified workers (superior engineers and graduates) to total employment (in %).
Percentage of medium-skilled labour	Ratio of the number of medium qualified workers (technical engineers, High School Commercial Bachelors and helping people with a qualification title) to total employment (in %).
Year dummies	Dummy variables taking value 1 for the corresponding year and 0 otherwise.
Robustness variables	
Firm's R&D expenditure	Log of firm's real R&D expenditures. Firms' R&D expenditures are in euros that have been deflated using specific industry deflators according to 20 sectors of the NACE-93 classification.
Firm's distance to the technological frontier	Following Aghion *et al.* (2005), this is the ratio (not %) of the distance between the most efficient firm in the industry in a particular year (the one with the highest TFP) and the TFP for each particular firm in the same industry that year, over the TFP of the firm with the highest TFP in the industry that year. This variable has been used to classify firms in 3 different efficiency groups: efficient firms, medium efficient firms, and inefficient firms. The classification comes from a partition of the distribution of the distance to the technological frontier variable in approximately 3 thirds. Therefore, the top third of the distribution corresponds to efficient firms, the bottom third to inefficiency firms, and the intermediate third to medium efficient firms. For details on the construction of the TFP see Rochina-Barrachina *et al*. (2010) and references therein.

Table 1. Correlation coefficients among competitive pressure variables

	Expected sign of the variables with respect to competitive pressure													
	(-)	**(-)**	**(-)**	**(-)**	**(-)**	**(-)**	**(+)**	**(+)**	**(+)**	**(-)**	**(-)**	**(+)**	**(+)**	**(-)**
Competitive pressure variables	PS: Advert-to-sales	PS: Prod promo	PS: Brand	PS: Image Promo	PS: Sales agree	PS: After sales service	MS: Expan mark	MS: Export	MS: Export-to- sales	EC: Set-up costs	EC: Slow prod obsol	OM: Price chan import	OM: New prod/ compe	OM: Capaci use compe
PS: Advertising-to-sales ratio (Advert-to-sales)	**1.00**													
PS: Product promotion (Prod promo)	**0.19**	**1.00**												
PS: Branding (Brand)	**0.09**	**-0.10**	**1.00**											
PS: Image promotion (Image promo)	**-0.02**	**-0.46**	**-0.18**	**1.00**										
PS: Sales agreements (Sales agree)	**0.15**	**0.25**	**0.11**	**-0.11**	**1.00**									
PS: After-sales services (After sales service)	**0.01**	**0.08**	**-0.02**	**0.08**	**0.02**	**1.00**								
MS: Expansive market (Expan mark)	0.04	0.04	0.01	0.07	0.05	0.05	**1.00**							
MS: Main market is national & abroad or only abroad (Export)	0.06	0.09	0.03	0.06	0.05	0.04	**0.07**	**1.00**						
MS: Exports-to-sales ratio (Export to sales)	0.04	0.10	0.05	0.05	0.10	0.01	**0.07**	**0.60**	**1.00**					

EC: Set-up costs (Set-up costs)	-0.002	-0.005	-0.02	0.05	0.005	-0.01	0.01	0.04	0.02	**1.00**				
EC: Slow product obsolescence (Slow prod obsol)	-0.02	-0.02	-0.04	0.02	-0.05	0.02	0.001	0.004	-0.03	**0.05**	**1.00**			
OM: Changes in prices of equivalent import prod (Price chan import)	0.002	0.02	0.01	-0.02	0.01	-0.002	-0.01	0.06	0.07	-0.003	-0.04	**1.00**		
OM: New products or competitors in the market (New prod/compe)	0.04	0.04	0.0001	-0.02	0.05	-0.01	0.002	0.01	0.01	-0.03	-0.02	**-0.04**	**1.00**	
OM: Capacity utilization by competitors (Capaci use compe)	-0.03	-0.03	0.0003	-0.03	0.01	-0.08	0.08	-0.04	-0.03	-0.12	-0.02	**-0.01**	**-0.003**	**1.00**

Note: The numbers in this table have been obtained by upgrading the sample percentage of small and large firms to the population percentages, according to the sampling procedure in the ESEE described in section 3.

Table 2. Price-cost margin and competitive-pressure variables.

	All firms	Efficient Firms	Medium-efficient firms	Inefficient firms
Product Substitutability variables				
Advertisement-to-sales ratio	0.00112	0.000944	0.000678	0.00205
	(0.00125)	(0.000831)	(0.00144)	(0.00315)
Product promotion	0.0228**	0.00751	0.000384	0.0235
	(0.0111)	(0.00861)	(0.00784)	(0.0527)
Branding	0.0428***	0.00587	0.0225**	0.110**
	(0.0137)	(0.0153)	(0.0114)	(0.0483)
Firm's image promotion	0.0149	-0.00955	0.00196	0.0236
	(0.00917)	(0.00711)	(0.00611)	(0.0460)
Sales agreements with wholesalers or retailers	0.0160**	0.0154**	0.00729	0.0325
	(0.00759)	(0.00723)	(0.00683)	(0.0405)
After-sales services	-0.00817	0.00418	-0.0341***	-0.219***
	(0.00684)	(0.00626)	(0.00583)	(0.0724)
Market size variables				
Main market is national & abroad or only abroad	-0.00976	-0.00117	-0.0127**	-0.171
	(0.00826)	(0.00658)	(0.00629)	(0.119)
Exports-to-sales ratio	0.000535**	-0.000325**	-5.75e-05	0.000871
	(0.000220)	(0.000134)	(0.000135)	(0.00129)
Expansive market	0.0273***	0.0150***	0.0205***	0.0566**
	(0.00548)	(0.00473)	(0.00442)	(0.0273)
Entry costs				
Set-up costs	-0.00296	-0.00558	-0.0533***	-0.291***
	(0.0102)	(0.00778)	(0.0124)	(0.104)
Slow product obsolescence	-0.0188**	0.0111	-0.00765	-0.0772*

	(0.00735)	(0.00747)	(0.00708)	(0.0398)
Other competitive-pressure variables				
Product price changes due to changes in prices of equivalent imported products.	-0.0206	0.00415	-0.0177	-0.114
	(0.0127)	(0.0107)	(0.0124)	(0.0819)
Product price changes due to new products or competitors in the market.	0.0176**	-0.00200	0.00107	0.0652
	(0.00893)	(0.00894)	(0.00954)	(0.0434)
Capacity utilization by competitors	-0.000276	-0.000301	-0.00188***	-0.00430***
	(0.000984)	(0.000447)	(0.000471)	(0.000738)
Controls				
Medium-technological sectors	-0.0125		0.00667	
	(0.00847)		(0.00711)	
High-technological sectors	-0.0622***		-0.0708***	
	(0.0120)		(0.0110)	
Firm's age	0.000159		-0.000100	
	(0.000199)		(0.000166)	
Size (log of firm's real sales)	-0.00222		0.00129	
	(0.00277)		(0.00204)	
Percentage of highly-skilled labour	-1.27e-05		-0.000451	
	(0.000586)		(0.000557)	
Percentage of medium-skilled labour	0.000861**		0.000370	
	(0.000337)		(0.000307)	
Constant	0.0436		0.154***	
	(0.0820)		(0.0419)	
Root MSE	0.36309		0.23169	
Observations	20838		18930	

R-squared	0.065	0.236

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table 3. Multivariate probit model (Benchmark)

	Only product	Only process	Both
Product Substitutability variables			
Advertisement-to-sales ratio	0.0202***	-0.00743	0.0112**
	(0.00625)	(0.00634)	(0.00560)
Product promotion	0.335***	-0.0257	0.235***
	(0.0603)	(0.0501)	(0.0571)
Branding	0.414***	-0.0544	0.269***
	(0.0825)	(0.0774)	(0.0878)
Firm’s image promotion	0.129**	0.108**	0.0471
	(0.0537)	(0.0428)	(0.0497)
Sales agreements with wholesalers or retailers	0.111**	-0.137***	0.179***
	(0.0454)	(0.0416)	(0.0477)
Alter-sales services	0.141***	-0.103**	-0.000895
	(0.0446)	(0.0403)	(0.0438)
Market size variables			
Main market is national & abroad or only abroad	0.167***	-0.0279	0.135***
	(0.0595)	(0.0445)	(0.0514)
Exports-to-sales ratio	0.00185*	-0.000277	0.00209**
	(0.00111)	(0.000840)	(0.000936)
Expansive market	-0.0552	0.169***	0.191***
	(0.0339)	(0.0303)	(0.0347)
Entry costs			
Set-up costs	-0.138*	0.230***	-0.0670
	(0.0814)	(0.0616)	(0.0751)
Slow product obsolescence	- 0.306***	0.0756	- 0.206***

	(0.0649)	(0.0532)	(0.0587)
Other competitive-pressure variables			
Product price changes due to changes in prices of equivalent imported products.	0.186***	-0.0928	0.0250
	(0.0699)	(0.0669)	(0.0784)
Product price changes due to new products or competitors in the market.	0.202***	-0.0782	0.142**
	(0.0675)	(0.0612)	(0.0640)
Capacity utilization by competitors	-0.00134	0.00496*	-0.00182
	(0.00274)	(0.00261)	(0.00291)
Controls			
Medium-technological sectors	0.00514	0.0211	0.175***
	(0.0504)	(0.0430)	(0.0532)
High-technological sectors	0.143**	-0.0553	0.218***
	(0.0676)	(0.0618)	(0.0676)
Firm's age	-0.000385	-0.000641	-0.00172*
	(0.000948)	(0.000856)	(0.000955)
Size (log of firm's real sales)	-0.0425***	0.0911***	0.156***
	(0.0148)	(0.0118)	(0.0142)
Percentage of highly-skilled labour	0.00317	-0.000200	-0.000857
	(0.00316)	(0.00306)	(0.00288)
Percentage of medium-skilled labour	0.00578***	9.30e-05	0.00566**
	(0.00224)	(0.00226)	(0.00231)
Constant	-0.918***	-2.796***	-3.765***
	(0.312)	(0.277)	(0.307)
Errors correlation coefficients	ρ21	ρ31	ρ32
	-0.271***	-0.303***	-0.417***
	(0.0135)	(0.0164)	(0.0148)

Observations	18735
Log pseudolikelihood	-19740.40

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table 4. Multivariate probit model: Efficient vs. Non-efficient firms

	Efficient firms			Medium-eff. firms			Inefficient firms		
	Only product	Only process	Both: product & process	Only product	Only process	Both: product & process	Only product	Only process	Both: product & process
Product Substitutability variables									
Advertisement-to-sales ratio	0.0297***	-0.0131	0.0182**	0.0186**	-0.0200**	0.00601	-0.00046	0.0172*	0.0124
	(0.00989)	(0.00917)	(0.00909)	(0.00815)	(0.00899)	(0.00758)	(0.00826)	(0.00953)	(0.0104)
Product promotion	0.252**	0.00578	0.301***	0.294***	-0.0253	0.198***	0.616***	0.0567	0.0887
	(0.100)	(0.0902)	(0.102)	(0.0763)	(0.0649)	(0.0735)	(0.145)	(0.126)	(0.131)
Branding	0.334**	-0.0923	0.364**	0.392***	-0.111	0.248**	0.804***	0.204	-0.162
	(0.155)	(0.138)	(0.155)	(0.108)	(0.109)	(0.113)	(0.215)	(0.162)	(0.209)
Firm's image promotion	0.0791	0.176**	0.0714	0.0679	0.0673	0.0435	0.425***	0.181*	0.00237
	(0.0964)	(0.0803)	(0.0885)	(0.0644)	(0.0527)	(0.0643)	(0.132)	(0.109)	(0.139)
Sales agreements with wholesalers or retailers	0.0101	-0.110	0.202***	0.178***	-0.0954*	0.246***	0.258**	-0.204**	0.0634
	(0.0792)	(0.0707)	(0.0766)	(0.0591)	(0.0570)	(0.0611)	(0.111)	(0.101)	(0.114)

Alter-sales services	0.153**	-0.0434	-0.105	0.0998*	-0.0691	0.0446	0.112	-0.462***	0.00947
	(0.0705)	(0.0637)	(0.0674)	(0.0581)	(0.0512)	(0.0569)	(0.141)	(0.129)	(0.141)
Market size variables									
Main market is national & abroad or only abroad	0.212***	-0.104	0.180**	0.143*	0.0216	0.102	0.0679	0.111	0.106
	(0.0789)	(0.0665)	(0.0796)	(0.0856)	(0.0596)	(0.0640)	(0.193)	(0.148)	(0.172)
Exports-to-sales ratio	0.000299	0.00101	0.000909	0.00278*	-5.30e-05	0.00243**	0.000153	-0.00414	0.00288
	(0.00159)	(0.00123)	(0.00144)	(0.00147)	(0.00108)	(0.00111)	(0.00335)	(0.00268)	(0.00301)
Expansive market	-0.0836	0.156***	0.170***	-0.0692	0.180***	0.224***	0.162	0.288***	0.0859
	(0.0555)	(0.0507)	(0.0575)	(0.0470)	(0.0403)	(0.0458)	(0.116)	(0.0940)	(0.109)
Entry costs									
Set-up costs	-0.175	0.234***	-0.127	-0.110	0.152	-0.142	0.0477	0.406**	0.0226
	(0.113)	(0.0722)	(0.0968)	(0.125)	(0.101)	(0.113)	(0.277)	(0.198)	(0.243)
Slow product obsolescence	-0.188**	0.0704	-0.265***	-0.371***	0.0828	-0.116	-0.389**	-0.0161	-0.567***
	(0.0939)	(0.0865)	(0.0927)	(0.0883)	(0.0701)	(0.0838)	(0.188)	(0.179)	(0.180)
Other competitive-pressure variables									
Product price changes due to changes in prices of	0.0566	-0.170	0.145	0.173*	-0.135	-0.0126	0.509**	0.0710	-0.287

equivalent imported products.									
	(0.118)	(0.107)	(0.130)	(0.0976)	(0.0928)	(0.0958)	(0.213)	(0.193)	(0.256)
Product price changes due to new products or competitors in the market.	0.286**	-0.136	0.326***	0.188**	-0.0370	0.203**	0.148	-0.391*	-0.119
	(0.119)	(0.100)	(0.102)	(0.0895)	(0.0821)	(0.0943)	(0.205)	(0.203)	(0.243)
Capacity utilization by competitors	-0.00140	0.00356	0.000762	-0.00408	0.00377	-0.00109	0.0106***	0.00212	-0.00145
	(0.00297)	(0.00288)	(0.00318)	(0.00293)	(0.00280)	(0.00319)	(0.00328)	(0.00294)	(0.00344)
Controls									
Medium-technological sectors	0.0261	0.0177	0.221***						
	(0.0543)	(0.0459)	(0.0572)						
High-technological sectors	0.129*	-0.0748	0.238***						
	(0.0702)	(0.0633)	(0.0726)						
Firm's age	-0.000726	0.000576	-0.00151						
	(0.00100)	(0.00090)	(0.00101)						
Size (log of firm's real sales)	-0.0576***	0.0833***	0.154***						
	(0.0162)	(0.0128)	(0.0154)						
Percentage of highly-skilled labour	0.00496	-0.00146	6.91e-05						
	(0.00330)	(0.00300)	(0.00312)						
Percentage of medium-skilled labour	0.00615**	0.000154	0.00432*						

	(0.00241)	(0.00222)	(0.00247)
Constant	-0.484	-2.563***	-3.844***
	(0.336)	(0.294)	(0.335)
Errors correlation coefficients	ρ21	ρ31	ρ32
	-0.270***	-0.289***	-0.419***
	(0.0138)	(0.0168)	(0.0152)
Observations	16918		
Log pseudolikelihood	-17773.32		

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

Table 5. Multivariate probit model: robustness checks

	Including R&D			**4-year averages**		
	Only product	Only process	Both: product & process	Only product	Only process	Both: product & process
Product Substitutability variables						
Advertisement-to-sales ratio	0.0182***	-0.00752	0.00579	0.0221*	-0.0178*	-0.000155
	(0.00639)	(0.00627)	(0.00536)	(0.0114)	(0.0107)	(0.00977)
Product promotion	0.322***	-0.0213	0.182***	0.331***	-0.0329	0.111
	(0.0609)	(0.0499)	(0.0573)	(0.0934)	(0.0786)	(0.0853)
Branding	0.401***	-0.0510	0.229***	0.543***	0.0528	0.136
	(0.0823)	(0.0787)	(0.0843)	(0.131)	(0.124)	(0.135)
Firm's image promotion	0.141***	0.114***	0.0340	0.0954	0.0416	0.0105
	(0.0546)	(0.0429)	(0.0501)	(0.0870)	(0.0655)	(0.0769)
Sales agreements with wholesalers or retailers	0.121***	-0.135***	0.202***	0.109	-0.225***	0.222***
	(0.0451)	(0.0417)	(0.0471)	(0.0735)	(0.0674)	(0.0705)
Alter-sales services	0.1000**	-0.0964**	-0.0454	-0.0139	-0.117*	-0.0195
	(0.0439)	(0.0406)	(0.0433)	(0.0696)	(0.0607)	(0.0662)
Market size variables						

Main market is national & abroad or only abroad	0.147**	-0.0199	0.105**	0.120	0.0459	0.113
	(0.0584)	(0.0449)	(0.0502)	(0.0940)	(0.0790)	(0.0864)
Exports-to-sales ratio	0.000799	-0.000419	0.000297	0.00192	-0.00150	-0.000799
	(0.00111)	(0.000852)	(0.000940)	(0.00186)	(0.00152)	(0.00161)
Expansive market	-0.0631*	0.171***	0.184***	-0.00128	0.296***	0.224***
	(0.0341)	(0.0304)	(0.0347)	(0.0745)	(0.0582)	(0.0639)
Entry costs						
Set-up costs	-0.126	0.229***	-0.0473	-0.0371	0.228*	0.0756
	(0.0791)	(0.0621)	(0.0719)	(0.150)	(0.124)	(0.144)
Slow product obsolescence	-0.279***	0.0814	-0.122**	-0.376***	0.134	-0.0806
	(0.0654)	(0.0527)	(0.0573)	(0.0899)	(0.0894)	(0.0860)
Other competitive-pressure variables						

Product price changes due to changes in prices of equivalent imported products.	0.174**	-0.0959	-0.0378	0.0543	-0.114	-0.455*
	(0.0703)	(0.0667)	(0.0745)	(0.196)	(0.194)	(0.237)
Product price changes due to new products or competitors in the market.	0.188***	-0.0729	0.151**	0.272	-0.0557	0.0691
	(0.0675)	(0.0610)	(0.0646)	(0.182)	(0.184)	(0.180)
Capacity utilization by competitors	-0.00172	0.00468*	-0.00209	-0.00217	-0.000565	-0.00226
	(0.00277)	(0.00266)	(0.00290)	(0.00578)	(0.00515)	(0.00586)
Controls						
Medium-technological sectors	-0.0204	0.0165	0.128**	-0.0489	-0.00870	0.122*
	(0.0499)	(0.0433)	(0.0518)	(0.0767)	(0.0617)	(0.0715)
High-technological sectors	0.0748	-0.0597	0.0978	0.185*	-0.234***	0.140
	(0.0679)	(0.0628)	(0.0670)	(0.104)	(0.0908)	(0.103)
Firm's age	-0.000584	-0.000822	-0.00272***	0.000243	-0.000621	-0.00423***
	(0.000955)	(0.000876)	(0.000942)	(0.00147)	(0.00125)	(0.00143)
Size (log of firm's real sales)	-0.0983***	0.0877***	0.0652***	-0.100***	0.0981***	0.0680***
	(0.0163)	(0.0128)	(0.0150)	(0.0242)	(0.0200)	(0.0235)
Percentage of highly-skilled labour	0.00160	-0.000518	-0.00344	-0.00449	-0.00327	-0.00674
	(0.00325)	(0.00313)	(0.00326)	(0.00493)	(0.00425)	(0.00473)

Percentage of medium-skilled labour	0.00429**	6.24e-05	0.00163	0.00326	0.000908	0.00262
	(0.00214)	(0.00230)	(0.00224)	(0.00320)	(0.00311)	(0.00305)
Log of (real) R&D expenditures	0.0368***	0.00263	0.0632***	0.0419***	0.00697	0.0731***
	(0.00440)	(0.00370)	(0.00395)	(0.00795)	(0.00663)	(0.00740)
Constant	-0.272	-2.821***	-2.714***	-0.303	-2.649***	-2.708***
	(0.284)	(0.236)	(0.265)	(0.498)	(0.427)	(0.490)
Errors correlation coefficients	ρ21	ρ31	ρ32	ρ21	ρ31	ρ32
	-0.252***	-0.340***	-0.410***	-0.223***	-0.359***	-0.458***
	(0.0134)	(0.0176)	(0.0154)	(0.0274)	(0.0325)	(0.0265)
Observations	18625			3947		
Log pseudolikelihood	-19149.37			-3896.86		

Robust standard errors in parentheses: *** p<0.01, ** p<0.05, * p<0.1

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BUSINESS MODEL INNOVATION AS A NEW DISCIPLINE IN THE FIELD OF STRATEGIC MANAGEMENT

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ABSTRACT

The business model has received growing attention in the recent decade (De Miguel Molina, Roldsgaard, Segarra Oña, De Miguel Molina 2011), but the business model as a concept remains under-estimated (Teece 2010). The growing public recognition of the usefulness of the business model seems to fly against an academic reluctance to acknowledge the term, its uses and its consequences (Baden-Fuller and Morgan 2010). Management academics rarely put the concept at center stage as they prefer their established concepts such as absorptive capacity, open innovation, management innovation and clusters, but the global economy's punctuated equilibrium has shifted strategic management in a new direction concentrating on the company's business model with emphasis on sustainable economics. The paper suggests that the business model as a concept is highly relevant and topical for teaching at university because companies are challenged to find new ways to sustain growth in a time of sustained crisis.

Keywords:

Business model innovation; Sustainable economics; Strategic management; University teaching

(6) INTRODUCTION

In economics, sustainable growth refers to increases in profits, adjusted for changes in the relationship between revenues and costs, which can be sustained over long periods of time. The global economy has shifted direction in 2008 for which reason this paper that the concept of 'management innovation' (e,g. Birkinshaw et. al. 2008) may need some re-formulations to adjust and adapt to the challenges after the financial crisis in 2008. The increasing cost focus in the global economy is observable in almost all industries; from public-private organizations in national settings to multinational enterprises in international settings; from universities to hospitals; onto football clubs; from large corporations to small businesses. The different types of business organizations have in common that they are challenged to restructure and adapt their business model to turbulent environments. The financial crisis is accompanied by accumulating levels of uncertainty from the volatility stock crisis, which have changed the context for strategic management. Metaphorically, an accumulated "double dip" wave has swung across companies; across industries; across economies; with double force. The accumulated wave of uncertainty is observable in the increasing number of corporate and governmental spending programs, which indicates that the conditions for managing innovation are changed. The management challenge is presently to explore new routes for organizational reorientation and recreation with emphasis on sustainable economics.

(7) FROM THE ELECTRONIC BUSINESS MODEL CRISIS TO THE CORPORATE BUSINESS MODEL IN A SUSTAINED CRISIS

Discussions about the business model started to take form, but did not originate from the collective collapse of the electronic business models in 2001. In the early post- Internet bobble burst years there is a growing debate about the business model, but they are mostly related to the electronic business model. The strategic management academic curiosity is fueled by questions such as 'why did these internet companies fail?' and 'how did these companies get access to financial funding in the first place?' These questions attract attention from management academics across different research communities with different research norms and traditions, but the business model is also misused by practicians to get funding from banks – and business models have ignored competition and strategy. Michael E Porter (2001:73) explains the problem:

> Words for the Unwise: The misguided approach to competition that characterizes business on the Internet has even been embedded in the language used to discuss it. Instead of talking in terms of strategy and competitive advantage, dotcoms and other Internet players talk about "business models." This seemingly innocuous shift in

> terminology speaks volumes. The definition of a business model is murky at best most often, it seems to refer to a loose conception of how a company does business and generates revenue. Yet simply having a business model is an exceedingly low bar to set for building a company.

Magretta (2002) responds the business model is the managerial equivalent of the scientific method because the hypothesis is the starting point, which is tested and corrected when necessary. Teece further develops the concept of a business model and its inherent relation to the management hypothesis (2010:172):

> A business model reflects the management's hypothesis about what customers want, how they want it, and how the enterprise can organize to best meet those needs, get paid for doing so, and make a profit.

Hamel (2000) suggests that a business model is a business concept that has been put into practice, while Gambardella and McGahan (2010) conclude that the business model is a 'mechanism for turning ideas into revenue at reasonable cost'. Until 2008, the discussions about business models are often related mostly to the crisis of the electronic business model in 2001, but the progression from financial crisis in 2008 to the stock crisis in 2011 gradually shifts focus of the business model from the electronic business model to the corporate business model with emphasis on its economic-financial sustainability.

(8) MANAGEMENT ACADEMICS RARELY PUT THE CONCEPT OF A BUSINESS MODEL CENTER STAGE EVEN THOUGH IT IS PROFOUNDLY IMPORTANT TO THE WORLD OF WORK

Business models have been examined from very different perspectives and the interest has increased greatly during the past 10 years (De Miguel Molina et. al. 2011). Start-up entrepreneurs and corporate executives have long exploited the business model as a tool for innovation, but in management academia everyone talks about the business model, but nobody knows what it is - or how to do it (Johnson et. al. 2008). Baden-Fuller and Morgan (2010:156) explain this point of criticism:

> Business models are profoundly important to the world of work - yet management academics rarely put the concept centre stage … Public perception of its usefulness seems to fly against this academic reluctance (in main-stream journals and texts) to acknowledge the term, its uses and its consequences.

The point of criticism indicate that the business model deserves a level of attention more in line with its widespread and increasing use in the field of strategic management (see figure 1). Baden-Fuller and Morgan (2010) indicate that the business model embodies multiple and mediating roles: from business concept; to contexts for scientific investigation; onto recipes for creative managers. The business model is a concept, a visual mapping tool, a calculative model, a social-economic construction of a common language about how the company makes a profit, and therefore an instrument to respond to the challenge of sustainable growth in a sustained crisis. The business model as a concept is cross disciplinary in nature, but particularly relevant within the field of strategic management because it sets the boundaries for how (and why!) the company makes money or fails to do so. Despite different definitions of the business model, a company's business model is ultimately evaluated upon its ability to make money. In sum, the business model refers to the company's ability to maintain or increase profits over long periods of time, which is increasingly relevant in a time of sustained crisis.

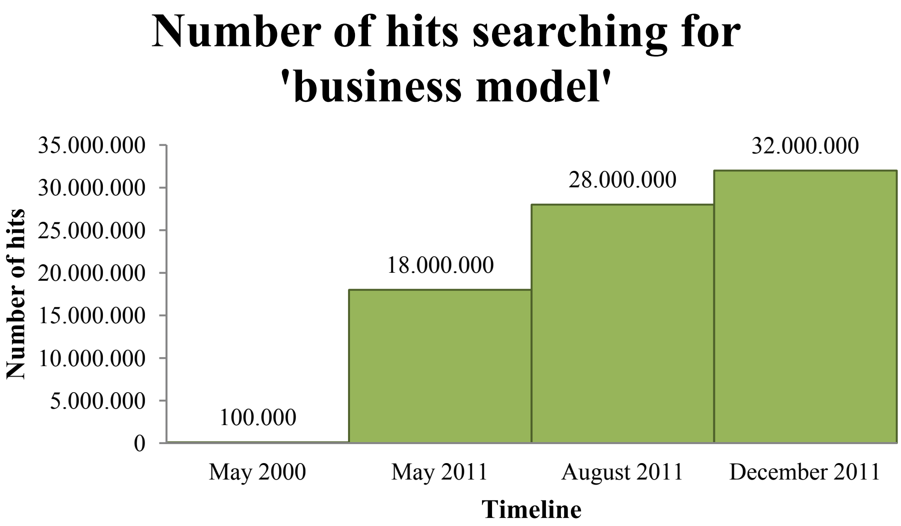

Figure 1. Googling 'Business model' for 11 years.

(9) BUILDING RISK INTO THE BUSINESS MODEL BEYOND FILLING FOR INTELLECTUAL PROPERTIES

After 10 years of research within the area of technological innovation, Teece (2010:175) sugggests that the absence of business models in economic theory 'probably stems from the ubiquity of theoretical constructs that have markets solving the problems that – in the real world

– business models are created to solve'. Doz and Kosonen (2010) explain the problem with reference point to the case of Nokia Corporation:

> Many companies fail not because they do something wrong, but because they keep doing what used to be right thing for too long - and thus suffer from the rigidity of their own business models.

The example of Nokia Corporation re-opens an important chapter in the strategic management book. Alan Afuah (2004) describes the business model as a framework for making money, while Itami and Nishino (2010) suggest that the learning system behind the business model is the 'real meat'. In any case, the financial sustainability of the business model depends on the management's ability to respond and adapt to changing conditions in the present, while preparing for the future. An exemplary case is evident in the comparison of Sony's Walkman and Apple's series of iPods. The visible difference is easy to see, but the difference between the two products is much more than the design of the product. The intuitive approach to product innovation promoted by Steve Jobs is decisive for success, but the business model behind the iPods may be perceived even more important (Johnson et. al. 2008). Apple's series of products and cross- services have developed new ways to make money. Apple has reinvented the profit model by launching the iTunes software program. The iTunes software program is an integrated system with *low cost* music tracks, which has disrupted the portable music player industry and challenged the established music industry. The platform innovation is an example of how a company has changed the rules of competition by developing a low cost structure with redefined the revenue streams. The example of Apple indicates that the business model is much more than 'a complex set of interdependent routines that is discovered, adjusted, and fine-tuned by doing' (Winter and Szulanski 2001). The radical-disruptive business model has changed the rules of competition and changed customer behaviors. Business model innovation is not only about technology, but increasingly about designing the right business model to commercialize the technology. Chesbrough (2010) specifies that the same technology yield different returns different business models. An overlooked outcome of the sustained crisis is the necessity to build risk into the business model. Building risks into the business model is increasingly important in a time of market disorder, which is the context in which many companies find themselves at the present (Girotra & Netessine 2011).

(10) CONCLUSIONS

The paper describes the transition from the electronic business model to the corporate business model with emphasis on sustainable economics. The focus of innovation management has shifted from 'further organizational goals' (Birkinshaw et. al. 2008) to sustainable economics in a time of sustained crisis. Companies fight for survival and they need new concepts and tools for innovation. Business model innovation is a response to the challenge of sustaining growth in a sustained crisis. The sustained crisis tends to emphasize negatively related elements such as corporate and governmental cost cutting programs, but it also offers an opportunity to re-build the company's business model. Apple has changed the business model for these products, which has enabled it to building a 'shield' around its business model to protect it. The absence of protecting the business model is risky particularly in a time of sustained crisis. The paper concludes that the bottom line remains a decisive factor in the capitalists system, despite much talk of a promising triple bottom line, because making money remains a necessity for any company to stay in business. An overlooked outcome of the sustained crisis is the rise of a strategic space for the study of the company's business model (see figure 2).

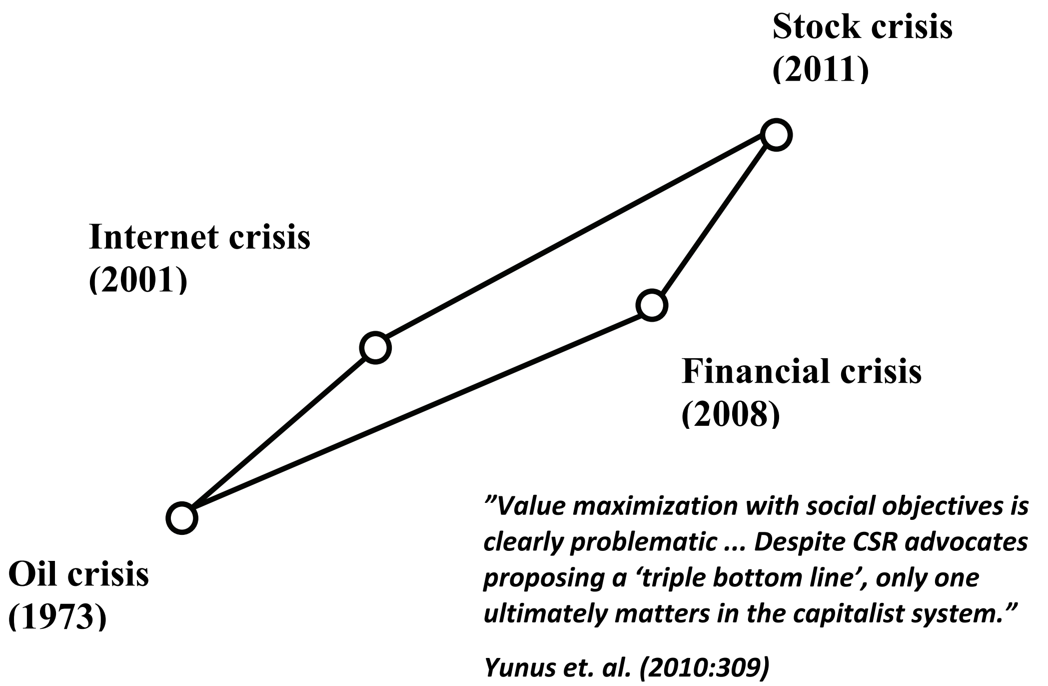

Figure 2. The business model as a new strategic space for management academics

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SHARED COMPETENCES, LEARNING CAPABILITES AND INNOVATION PERFORMANCE: AN INTERPLAY OF COMPLEMENTARY EFFECTS

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ABSTRACT

This paper contributes to defining the competences accumulated and shared in an industrial district, and how they differ from firm-specific, knowledge-based capacities. From a dataset of 952 Spanish firms and 35 industrial districts, we provide empirical evidence that industrial districts are spaces with dense networks of information and knowledge transfer, inter-personnel relationships and a strong specialised stock of human capital, which are accessible and shared by all firms embedded in such a district. However, we explain the complementarity between district and firm-specific capacities in order to develop the notion of absorptive capacity, by indicating that the diffusion of shared competences is not as easy and free as previous literature postulates, and that it requires a firm's internal learning effort to better absorb localised knowledge spillovers. Results enable us to shed new light on how firms' knowledge creation and diffusion processes benefit from these external knowledge flows. The finding also suggest that incremental innovation performance is positively influenced by both internal knowledge creation capacity and absorptive capacity, although internal knowledge creation is not sufficient to obtain a greater radical innovation performance unless it is complemented with the absorptive capacity. These results contrasts the notion of self-sufficiency in knowledge generation and point out the need for an effect combination of internal and external knowledge to obtain competitive innovation outputs.

Key words:

Industrial district; shared competences; absorptive capacity; knowledge creation capacity; knowledge spillovers; incremental innovation; radical innovation

1. INTRODUCTION

From the open innovation approach, Chesbrough (2003) identifies winner firms as those making the best use of internal and external ideas simultaneously. It is generally accepted that no firm can entirely rely on its own internal knowledge capacities and sources to create competitive advantages through innovation, and it needs to both develop its capacity (Volberda et al., 2010; Zahra & George, 2002; Cohen & Levinthal, 1990) to absorb new external knowledge, and to combine inflows and outflows of knowledge (Teece et al., 1997; Prahalad & Hamel, 1990). Although several studies have pointed the existence of a complementary effect between the internal and external sources of knowledge on innovation, very few studies have adopted in their analysis a capabilities-based approach.

The internal knowledge creation capability allows firms to adopt a better control of their knowledge management processes and its application to innovation. In addition, the internal knowledge creation capability guarantees the company a reduced dependence on its environment and the obtaining of internal tacit knowledge, difficult to imitate and replicate in the market. However, the application of firm's internal knowledge to obtain breakthrough or radical innovation is not guaranteed, being its potential limited for the creation and / or sustenance of competitive advantage in dynamic environments (Henderson & Clark, 1990; Bierly & Chakrabarti , 1996).

Rapidly changing environments, advancements in technologies, and intensity of competition have exacerbated the problems organizations face in attaining self-sufficiency in knowledge creation. In this vein, firms' ability to create new products and processes rely increasingly on effective combination of the knowledge they generate internally with that they obtain from external sources (Cassiman & Veugelers, 2006; Zahra & George, 2002; Henderson & Clark, 1990). To capture external learning, we rely on the well-known concept of absorptive capacity (Cohen & Levinthal, 1990).

An extensive body of literature argues that innovation must be regarded as resulting from distributed inter-organisational networks, rather than from single firms (Douglas & Ryman, 2003; Dyer & Singh, 1998; Powell et al., 1996; Coombs et al., 2003). Other research lines have focused on how knowledge creation and diffusion processes might benefit from localised knowledge spillovers between firms in the same industry (e.g., West et al., 2006; Verspagen & Schoenmakers, 2004). The most interesting case of firms' spatial co-location is that of industrial districts. However, as Volberda et al. (2010) point out in their bibliometric analysis, the interorganisational antecedents have been relatively neglected in absorptive capacity literature and the emergence of absorptive capacity from the interactions of its distinct level antecedents remains unclear. This paper enables us to shed new light on how intra-district firms' knowledge creation and diffusion processes benefit from the knowledge flows within a cluster, and how they differ from firm-specific, knowledge-based capacities, by adopting a cross-level approach to this end.

The canonical approach (e.g., Becattini, 1979) defines industrial districts as ideal environments with rich, localised knowledge spillovers, within which firms can access knowledge exchanges that flow more smoothly (Malipiero et al., 2005) or free of charge (Boari & Lipparini, 1999). This view neglects the coexistence of cooperation and competition relations within the cluster (You & Wilkinson, 1994; Dei Ottati, 1994), the empirical evidence of strong intra-district heterogeneity in knowledge-based capabilities and performance (Camisón, 2004; DeCarolis & Deeds, 1999; McEvily & Zaheer, 1999; Lazerson & Lorenzoni, 1999), and the uncertainty over whether intra-district knowledge flows are so free and straightforward (e.g., Ferreira & Serra, 2009). The relationship between intra-district shared competences and firms' internal knowledge creation remains equally controversial, with positions which predict that location in a cluster could reduce intra-district firm R&D investment (Henderson & Cockburn, 1996; Bernstein & Nadiri, 1989) in contrast to other scholars who anticipate a stimulating effect (Maskell & Malmberg, 1999; Veugelers, 1997; Harabi, 1995). Thus, the understanding of the dynamics of the knowledge creation and diffusion flows within industrial districts and their relationships with firms' internal processes (substitution versus complementary effect) still remains unclear (e.g., Arikan, 2008; Camisón, 2004; Tallman et al., 2004; Pouder & John, 1996). Therefore, there is an ongoing debate on how firms inside an industrial district absorb the knowledge that may be flowing freely within its boundaries, and how they benefit from this cluster-based knowledge to create advantages in their internal knowledge stock.

We try to explain the firm's stock of knowledge-based capabilities by using suprafirm-level variables in our theoretical discussion, as proposed by the Scandinavian Approach (Foss, 1996; Foss & Eriksen, 1995). This new research line predicts competitive asymmetries between firms within the same industrial district derived from their different patterns of appropriation of shared competences (Arikan, 2008; Lorenzen, 2007; Camisón, 2004; Lorenzen & Foss, 2003; Lawson, 1999; Maskell & Malmberg, 1999; Maskell et al., 1998; Lorenzen, ed., 1998; Foss, 1996), which are in turn connected with their heterogeneous firm-specific capacities.

The concept of shared competences is still extremely ambiguous. Our first contribution is to provide a theoretically-based concept of shared competences accumulated in an industrial district, differentiated from firm-specific, knowledge-based capacities, together with valid measurement instruments to capture the conceptual frontiers existing among these constructs. Shared competences are a collective concept dealing with factors shared by all firms located in an industrial district, and therefore it is a higher level concept (Lorenzen, ed., 1998; Foss, 1996; Foss & Eriksen, 1995). This theoretical approach to the topic entails the development of a multi-level study (Klein et al., 1994; Mossholder & Bedeian, 1983). This cross-level approach can make an interesting contribution to the understanding of knowledge creation and diffusion flows by firms located within an industrial district, and to the multi-level nature of the capabilities concept (Peteraf, 2005). Second, this article also extends previous research by offering new empirical evidence to show that industrial districts are pools of shared competences to which intra-district firms have common access. A third contribution is empirical evidence on the complementarity between cluster-based and firm-specific knowledge capacities aimed to develop the firm's external knowledge absorptive capacity (Volberda et al., 2010; Zahra & George, 2002; Cohen & Levinthal, 1990). The results are interesting in that they raise certain questions about the definition of intra-district shared competences as free and public goods, and they add value to the existing literature on absorptive capacity from a cross-level perspective. Fourth, our study provide empirical support for the mutually reinforcing impact of both learning capabilities to obtain radical innovation performance. This last result confirms the open innovation model on the necessity to combine internal sources of knowledge with knowledge obtained from different sources external to the firm (Cassiman and Veugelers, 2006; Zahra and George, 2002). Five, the study's model and findings highlight absorptive capacity's key role not only as a catalyst of new external knowledge but also as an integrator of internal and external sources of knowledge to enhance innovation capacity (Kogut & Zander, 1992).

In order to obtain accurate, significant empirical evidence of the relationship between the variables studied, we first conceptualise firms' absorptive capacity, their internal knowledge creation capacity, their radical and incremental innovation performance, and intra-district shared competences. Having determined this theoretical framework, we then construct our theoretical model and propose the research hypotheses. In the following section, the general guidelines are established for the design of the empirical study. We test the hypotheses proposed in the theoretical model using structural equations models. This is followed by a statistical analysis of the results. The final part of the paper discusses the study's conclusions, academic and managerial implications, together with its limitations and suggestions for future research.

2. THEORETICAL FRAMEWORK

The canonical approach to industrial districts (Brusco, 1982; Becattini, 1979) considers them as homogeneous spaces with a rich stock of resources and capabilities that firms can access. This definition comes close to that of Porter (2000: 16), who conceptualises the cluster as a "geographically proximate group of interconnected companies and associated institutions in a particular field linked by commonalities and complementarities". This common space is a factor that should favour internal district homogeneity. The intense interdependence among people and firms derived from stable, long-term, direct relationships between the agents in the local environment, within a relatively homogeneous community with a shared value system, should also play a key role in supporting intra-district symmetry. Knowledge circulating within an industrial district is thus viewed as a public good bounded in space (Krugman, 1999), in which knowledge flows more smoothly within the cluster boundaries (Malipiero et al., 2005), available knowledge is "in the air" (Audretchs & Feldman, 1996), circulates freely and spontaneously (Boari & Lipparini, 1999; Breschi & Lissoni, 2001), and whose exchange is informal in nature (Griliches, 1979). The concept of "localised knowledge spillovers" has been widely accepted to describe the spatial boundaries of knowledge flows, which could be particularly strong when firms cluster in order to take advantage of the available knowledge within certain boundaries encompassing strong agglomeration economies. Spillover effects are externalities of economic activity or processes affecting those who are not directly involved in it. Knowledge spillover is a non-rival knowledge market externality that has the effect of exchanging ideas and stimulates technological improvements in a neighbourhood through a firm's own innovation. The transmission of knowledge and the model of reference within the specific industrial atmosphere of the district also act as a force to foster shared behaviours. Thus, the canonical approach studies industrial districts as a homogeneous group, the target unit is conceptualised as a single whole unit, and is described by a single value.

At the opposite extreme, much organisational and strategy literature has adopted an independent approach to study firms in relation to a group such as the potential cluster they are located within. From this perspective, researchers have specified the level of theory as the independent firm, and they predict that individual firms (even when located in a cluster) will be independent of that group's influence. Because cluster membership would be irrelevant to the theory's constructs, the distinction of within-cluster and between-cluster variation is viewed as irrelevant. Variation in the constructs is conceptualised only as between-firm variation. The main line of this level of theory is the Resource-Based View (RBV), a plural approach with different and complementary perspectives to analyse the firm's resources and capabilities. Within the RBV dynamic perspectives (Eisenhardt & Martin, 2000; Teece et al., 1997; Zollo & Winter, 2002), the Competence-Based View (CBV) is of particular interest (Foss, 1997, 1993; Foss & Knudsen, eds., 1996; Grant, 1996; Kogut & Zander, 1992); this perspective considers tacit knowledge and intangible assets as the basic source of competitive advantage. CBV is a firm-level theory that explains the firm's knowledge process as a consequence of between-firm variability in the learning process that leads to the reconfiguration and transformation of existing capabilities and innovation in products, processes and activities.

The analysis of the knowledge development process must also pay attention to two sub-processes: internal knowledge creation and external knowledge absorption (Chakravarthy et al., 2003). Although different in nature, these two components are interrelated: innovative assets are considered to be a consequence of the complementarity between the creation of internal knowledge and the assimilation of external knowledge (Cohen & Levinthal, 1990; Teece et al., 1997; Zahra & George, 2002).

We understand firms' *internal knowledge creation capacity* to mean all the competences associated with the creation of an internal system of continuous learning in the firm. Firms' internal knowledge creation is, fundamentally, generated by R&D investment and internal problem solving (Prieto et al., 2009; Grant, 2000). Other antecedents of firms' internal knowledge creation are employees' abilities, level of education, experience, training and the skills they acquire in the workplace through their interaction with other agents with different knowledge bases (Nonaka & Takeuchi, 1995). For this reason authors such as Mahnke et al. (2005) highlight the formation of self-management teams and informal social networks. The firm's directors can also collaborate by developing an appropriate structure (Nonaka & Takeuchi, 1995; Tsai, 2002), an organisational culture and leadership focused on knowledge and learning objectives (Nonaka, 1991). Lloyd (1998) notes that greater autonomy allows employees to adopt more complex learning by creating new ideas and mental models. However, an inward-looking approach to innovation, where the firm relies on its in-house resources and capabilities only, appears to be insufficient to build innovation capacity for continuously developing new products and processes (Cassiman & Veugelers, 2006).

External knowledge flows also provide opportunities for firms to broaden their knowledge base, make up the internal shortages common to all firms today (Grant & Baden-Fuller, 2004), develop useful knowledge more quickly than their rivals (Prahalad & Hamel, 1990; Teece et al., 1997), and increase their flexibility (Grant, 1996; Almeida et al., 2003). Thus, external learning helps firms avoiding "lock-out effects" and "competency traps" (Zahra and George, 2002).A firm's *external knowledge absorptive capacity* involves the usage of mechanisms through which knowledge outside the firm is identified, acquired, assimilated, transformed and applied. This definition by Zahra & George (2002) reformulates the traditional three-dimensional model introduced by Cohen & Levinthal (1989, 1990), as it identifies four different, complementary dimensions: acquisition, assimilation, transformation and application. The concept of each of these processes is described in Table 1. Zahra & George (2002) suggest that these dimensions can be integrated within two complementary components: (a) potential absorptive capacity, which comprises external knowledge acquisition and assimilation capacities; and (b) realised absorptive capacity, which includes both knowledge transformation capacity and the capacity to exploit newly developed knowledge. Furthermore, external knowledge absorptive capacity relies on firms' internal capacities and on how they structure their relationships with the environment. Firms need internal effort and R&D investment (Leahy & Neary, 2007; Cohen & Levinthal, 1990) and must adjust their internal structures to support the formation and sustenance of other capacities (Zahra et al., 2009; Fosfuri & Tribó, 2008; Vanhaverbeke & Peeters, 2005; Caloghirou et al., 2004) in order to absorb new external knowledge. (See 1 ABOUT HERE-

According to Benner & Tushman (2003) *exploitative or incremental innovations* involve improvements in existing components and build on the existing technological trajectory, whereas *exploratory or radical innovation* involves a shift to a different technological trajectory.

CBV can provide a suitable approach from which to take a theoretical assumption of heterogeneity of intra-district firms within a higher level unit, the cluster, in studying the effects on knowledge creation and absorption processes of a firm's integration in an industrial district (Grant, 1991: 548). This extension stems from the suggestion by Peteraf (2005) that the RBV is a useful approach with which to explore multi-level linkages and the multi-level nature of capabilities. A competence-based view of competitive advantage naturally links the firm to its market environment and the other players in that environment. The CBV extension to industrial districts is mainly grounded on the Scandinavian Approach (e.g. Foss & Eriksen, 1995; Foss, 1996).

3. THEORETICAL MODEL AND HYPOTHESES

3.1. District embeddedness and intra-district shared competences

Following the CBV, previous works (Camisón, 2004; Douglas & Ryman, 2003; Dyer & Singh, 1998) refer to the competences shared by network or cooperative organisations. The concept of *shared competences* understood by Foss (1996) as "all intangible, higher-order resources and capacities" and by Lorenzen (1998: 143) as a higher-order knowledge base shared by firms located in an industrial district, is of interest, but still extremely ambiguous. Intra-district shared competences are a measure of the structural attractiveness of knowledge spillovers that are accessible to intra-district firms. Shared competences are common assets inside the district; in other words, they are not exclusive to one single firm inside the industrial district. In addition, Arikan (2008) has developed the concept of a cluster's knowledge creation capacity, which is also based on the stimulating conditions of inter-firm knowledge exchanges within industrial districts.

By integrating the social capital approach into the CBV, we define shared competences as consisting of social capital that stimulates the wealth of intra-district knowledge flows, and complementary assets as an institutional framework facilitating support services to organisations. From this theoretical definition, we define intra-district shared competences in industrial districts in terms of two dimensions: external capacity of knowledge creation and transfer, and coordination of collective effort.

External capacity of knowledge creation and transfer. This dimension integrates the knowledge spillovers emerging from a collective, localised learning curve (Lorenzen, 2007, 2003, 1998; Lawson & Lorenz, 1999), the rapid transfer of information and innovations with few restrictions among intra-district firms, and the benchmarking processes with which companies access the knowledge and successful experiences (in innovation, strategy, and internal organisation models) of their neighbours (Camisón, 2004).

Rich, local diffusion of knowledge is not a simple consequence of geographical proximity. It also requires a relationship pattern for the informal transfer of ideas and technology within the local territorial environment. The literature on open innovation concludes that the relevance of inter-personal and inter-organisational networks for knowledge diffusion processes is rooted in the nature of knowledge creation and transfer as a socially embedded process. Therefore the intra-district collaboration model is only possible where a community of people (Grandori et al., 1999) with strong social links and widely agreed standards of behaviour (Lazerson & Lorenzoni, 1999; Becattini, 1979) is deeply embedded in local traditions (Malmberg & Maskell, 2002), by way of a cognitive community (Lorenzen & Foss, 2003). This highly permeable and flexible social structure enables firms to extend their skills in exchanging quality knowledge, particularly knowledge with a certain tacit component.

Coordination of collective effort. This dimension reflects the presence of local institutions that provide a host of collective support mechanisms for intra-district firms. Local institutions have been recognised as relevant actors in industrial districts (McEvily & Zaheer, 1999). You & Wilkinson (1994) point to four functions carried out by this institutional structure: to create an environment for cooperation, to provide appropriate procedures to resolve conflicts, to sanction transgressors and to provide appropriate support for firms to be aligned with environmental changes. First, these locally oriented organisations are dynamic agents and infrastructures designed to disseminate specialist knowledge and information flows, and to support business innovation (Camisón, 2004; Breschi & Lissoni, 2001). Local institutions can act as intermediary actors that play a relevant role in providing intra-district firms with new information and knowledge, including firms associated with sparse networks strewn with structural holes (Burt, 1997). Consequently, local institutions can help individual firms to overcome the disadvantages that stem from being redundantly connected with other participants in an industrial district; they thereby extend the benefits derived from access to diverse information and knowledge and from brokerage opportunities related to the maintenance of non-redundant relationships. Local institutions also provide training and services to coordinate cooperation relationships (Newlands, 2003). Collective strategy also includes public institutions (Henry and Pinch, 2001) that coordinate the agents located within the industrial district, support business development, and promote the design of a local strategic orientation in the cluster. Finally, there is a process of institutional creation of collective reputation based on communication activities carried out cooperatively by groups of competitors, business associations or public institutions, which can be clearly differentiated from those of competitors outside the agglomeration.

This approach defines industrial districts as an external space containing resources and capacities to which firms can access (Camisón, 2004), or as a context of opportunities and restrictions generating superior order capacities (Foss & Eriksen, 1995). This common space is a factor that favours internal district homogeneity.

Shared competences include explicit and tacit knowledge accumulated in a district that is accessible to the intra-district firms, but not available to outsider firms located beyond its boundaries. The literature (e.g., Hall, 1993) has repeatedly emphasised the special value of intangible assets as a source of sustainable competitive advantages, due to the barriers raised to duplication (Rumelt, 1991; Barney, 1991) and to substitution by similar strategic assets (Amit & Schoemaker, 1993; Peteraf, 1993). Barriers to the imitation, appropriation or substitution of shared competences are even greater because they are largely district-specific, idiosyncratic, complex and based on tacit knowledge (Belussi, 1999; Enright, 1998), traditional routines, business practices, unique institutions and multiple links between actors that cannot be reproduced outside the area and greatly restrict their mobility (Porter & Sölvell, 1998). In addition, Sölvell & Zander (1998) use the concept of the isolating mechanism in local innovation systems to underline the strategic nature of these collective capacities. In sum, the agents that coordinate the collective effort will offer more opportunities to access that knowledge to firms located inside than to competitors located outside the district. Our first hypothesis is therefore:

Hypothesis 1 (H1). There is a positive relationship between a firm's embeddedness in an industrial district and the shared competences accessible within it.

3.2. Intra-district shared competences and absorptive capacity

The existence of a large number of links (Tsai & Ghoshal, 1998), their strength or degree of closeness (Brown & Konrad, 2001), and the repetition of the interactions (Maskell & Malberg, 1999; Triglia, 2001) that an organisation carries out with other agents in its environment increase its abilities to evaluate, acquire and assimilate knowledge spillovers resulting from these intra-district mechanisms (Cohen & Levinthal, 1990; Dyer & Singh, 1998; Lane & Lubatkin, 1998). The positive association between social interaction and knowledge acquisition and assimilation capacities is consistent with the assumptions that learning, especially learning involving information that is difficult to transfer, is enhanced by intensive, repeated interactions (Kogut & Zander, 1996). A large proportion of knowledge spillovers might consist of district-specific tacit knowledge flows, which are difficult to codify and can only be transferred through the face-to-face interactions that frequently occur in industrial districts.

The existence of a series of intermediary agents or gatekeepers, such as local institutions, that work to support the district as a whole, (Brusco, 1982) and the leading firms, connected by diverse external networks and knowledge communities, allow the intra-district firms to combine knowledge exploitation and exploration strategies. These local institutions, together with the large number of interactions that take place among firms located in a physically close space, lead to a reduction in the costs of access to information and knowledge from both inside and outside the industrial district (Maskell, 2001; McEvily & Zaheer, 1999). Thus, firms in the district not only save on search costs, but also access sources of reliable external information, since the local institutions are specialised experts in the acquisition of knowledge. These low costs are translated into a greater capacity to value, acquire, interpret and assimilate not only intra-district information and knowledge, but also that deriving from external networks.

Both the mutual trust and the behavioural norms of reciprocity among the various agents enable firms to extend their skills in exchanging quality knowledge, particularly knowledge with a certain tacit component (Levin, Cross & Abrams, 2003). Mutual trust among intra-district agents, derived from restraints on the threat of opportunism (Dei Ottati, 1994; Foss & Koch, 1996), produces savings in surveillance mechanisms, thus freeing up resources that can be used for more extensive communication (Rutherford, Buchholtz & Brown, 2007).

In light of the above insights, we put forward the following hypothesis:

Hypothesis 2 (H2). Ceteris paribus, the greater the amount of shared competences in an industrial district, the higher the firm's capacity to absorb external knowledge will be.

3.3 Intra-district shared competences and internal knowledge creation capacity

Some research holds that the possibility of internally generated knowledge being exploited by a firm's closest competitors may lead that firm to reduce investment in R&D and training (Bernstein & Nadiri, 1989). A further objection to a positive relationship between shared competences and internal knowledge creation is raised by the diversity argument. The literature on creativity postulates that diversity within a shared context is what matters to innovation, and therefore more shared knowledge leads to less diversity and innovation. Furthermore, firms located in industrial districts enjoy access to the stock of shared competences and knowledge in their immediate environment, which may be detrimental to the internal generation of knowledge when the flows of external knowledge substitute rather than complement those generated internally (Henderson & Cockburn, 1996). If these ideas are correct, location in an industrial district would encourage firms to cut back on their efforts to create knowledge internally and concentrate on exploiting the knowledge spillovers that circulate in their environment.

Of course, all firms located in industrial districts enjoy access to a common stock of shared competences and knowledge in their immediate environment. However, the acquisition and subsequent use of external knowledge is not cost free (Harabi, 1995). Although the knowledge that firms generate inside industrial districts is not easily protected, this does not mean that knowledge will be automatically acquired by other firms. Therefore, our first hypothesis should be qualified.

The existence of social interaction and supportive local institutions plays a key role in knowledge transfer, especially of tacit knowledge, but does not guarantee that the recipient firm will be able to internalise that external knowledge. As absorptive capacity is path dependent (Cohen & Levinthal, 1990), firms should have an internal critical mass of knowledge that allows this new external knowledge to be valued, understood, related to the previous knowledge base, and finally applied (Fabrizio, 2009; Nieto & Quevedo, 2005). Without this previous related knowledge base, intra-district firms will not be able to identify the innovativeness potential of the external knowledge, whether tacit or explicit, for the creation of competitive advantages, and may even be unaware of the existence of the cooperative knowledge networks. Although explicit knowledge may be relatively easy to identify through passive efforts such as attending conferences or more active methods such as benchmarking (Lane & Lubatkin, 1998), it may be difficult to understand and relate with the firm's specific needs and processes.

Considering the fact that the firm's knowledge base is constrained to certain scientific and technological domains (Lane & Lubatking, 1998), it is logical to assume that the effect of shared competences on the development of absorptive capacity is also limited. Thus, firms that do not want to lose their competitive position in the district and want to take maximum advantage of the knowledge opportunities in their environment must also work to broaden the scope of their knowledge background and develop new routines and structures and a culture that fosters internal knowledge generation (Caloghirou et al., 2004).

The existence of shared competences will stimulate rather than substitute or diminish investment in firms' own R&D resources (Harabi, 1995; Veugelers, 1997). In this way, the district acts as a "cognitive laboratory" (Bellandi, 1989) or a collective R&D laboratory, in which innovation continuously flourishes (Camisón, 2004). Likewise, the existence of certain norms, a culture, a language and a common value system encourage the construction of new compatible communication codes and systems and the creation of new shared mental and organisational models, open to the development of knowledge, learning and experimentation (Maskell & Malmberg, 1999). On the other hand, the relationships of competition and fierce rivalry between firms, explained by their physical proximity and the similarity of the goods and products they offer, stimulate the continuous internal generation of knowledge and new technologies in firms striving to hold onto their competitive advantage in the market.

Our third hypothesis is therefore:

Hypothesis 3 (H3). Ceteris paribus, the higher the amount of shared competences in an industrial district, the higher the firm's internal knowledge creation capacity will be.

3.4 Internal knowledge creation capacity and absorptive capacity

The existence of a set of shared competences in the firm's environment will not be sufficient to ensure that it internalises them satisfactorily (Pennings & Harrianto, 1992). The identification, acquisition, and above all, implementation of external knowledge are by no means simple processes (Veugelers, 1997). Organisations have to invest time and effort in developing their absorptive capacities (Leahy & Neary, 2007; Cohen & Levinthal, 1990). The absorption of knowledge that can be strategically exploited to gain competitive advantages is particularly complicated.

However, the individual firms located in industrial districts are still free agents that play a leading role in their own development (Lazerson & Lorenzoni, 1999; DeCarolis & Deeds, 1999; McEvily & Zaheer, 1999). If capacities and external tacit knowledge are to be acquired, they must be combined with certain firm-specific capacities and practices to absorb those external competences (Camisón, 2004; Malmberg & Maskell, 2002; Lawson, 1999; Foss, 1996). The cumulative and path dependent process of capacity accumulation is therefore highly specific to each firm, so that even if the same amount of time has passed and firms operate in the same macro environment and industry, they may end up with different levels of technological capacities. A firm's ability to access and exploit external tacit knowledge depends on the internal development of qualified specialist technicians, scientists and engineers (Rothwell & Dogson, 1991), on cultural patterns and a communication system open to change and learning, and on a specific knowledge base (Cohen & Levinthal, 1990; Lane & Lubatkin, 1998; Matusik & Heeley, 2005). Specifically, following the study of De Clercq & Dimov (2008) we suggest a variety of mechanisms that explain why internal knowledge creation capacity in a particular domain develops domain-specific absorptive capacity.

First, the diversity and depth of the knowledge base provide the firm with different frames of reference, standards, languages and codes, which give the firm a more comprehensive understanding of the new information it receives, increasing its ability to scan and identify valuable tacit knowledge in the environment. Internal knowledge creation capacity generates the ability to discover the best and greatest number of ideas (Chesbrough, 2003), and to access and select external opportunities more efficiently (Chatterji, 1996) and faster (Cohen & Levinthal, 1990). At the same time, internally developed knowledge and technologies increase operational flexibility, also facilitating the external acquisition of technology (Gans & Stern, 2000). Moreover, through the process of interacting with other employees, new knowledge can be acquired, thereby increasing the capacity to access knowledge from external firms (Liao et al., 2007).

Second, a larger prior knowledge base facilitates more abstract mapping of the domain of the firm's activity and allows for a higher level of articulation and codification of its knowledge base. These abstract representations lead to improved assimilation and integration of the new information into the existing knowledge base (Zollo & Winter, 2002).

Third, according to Cohen & Levinthal (1990) the diversity of the knowledge base will augment the organisation's capacity for making new linkages and associations between new external knowledge and pre-existing concepts. Knowledge developed internally therefore enhances the firm's ability to incorporate additional knowledge into its internal processes (Arora & Gambardella, 1994) and apply it for commercial ends through its incorporation into the firm's operations (Zahra & George, 2002).

In light of the above, we can state that internal knowledge creation capacity is required to acquire, assimilate, transform knowledge from outside the boundaries of a firm and apply it to innovation (Bierly & Chakrabarti, 1996; Cohen & Levinthal, 1990). Therefore, our hypothesis is as follows:

Hypothesis 4 (H4). The greater the firm's internal knowledge creation capacity, the higher its capacity to absorb external knowledge will be.

3.5. Internal knowledge creation and absorptive capacity effects on innovation performance

The internal knowledge generation has unquestionable advantages for the firms' innovation process. First, the internal knowledge creation can provide firm more control of its knowledge management and application processes, ensuring less reliance on the external environment. Second, the knowledge generated internally is easier to assimilate and integrate into the patterns, culture and organizational systems of the firm to create new capabilities. Third, tacit knowledge about techniques and products created through the interaction of organizational members is based on experience and firm-specific routines which are difficult to replicate and imitate in the market. Fourth, according to our hypothesis four the internal knowledge creation enhances the absorption of new external knowledge (Cohen & Levinthal, 1990).

Despite the previous advantages pointed out, the literature highlights that the knowledge generated inside firm has a lower potential for the obtaining of breakthrough innovations, which limits its potential to create and/or sustain competitive advantage in dynamic environments (e.g. Capron & Mitchell, 2009). The knowledge which is internally generated from the firm's existing knowledge base or stock is associated with the enhancement or incremental modification of existing products, processes and organizational methods, that is, with the processes of exploitation and incremental innovations (Henderson & Clark, 1990; Bierly & Chakrabarti, 1996; Lavie, 2006).

Therefore, in light of previous arguments we hypothesize that:

Hypothesis 5 (H5). The greater the firm's internal knowledge creation capacity, the higher its capacity to obtain an incremental innovation performance.

The generation of a radically new knowledge within the company without a corresponding effort to define the new market trends in products, processes, technologies and customers, that is, the future evolution of the industry has a high probability of failure. External learning capabilities are needed for leveraging internal capabilities (Chatterji, 1996). That is, without an external learning capacity, the firm would not be able to fully capitalise on its internal knowledge to innovate.

The use of knowledge from external sources expands a firm's knowledge base (Nonaka & Takeuchi, 1995), helps firms avoid "lock-out effects" and "competency traps", ease the constraints from scarcity of internal resources, especially knowledge resources, provides access to new ideas that promote the generation of new products and technology (Rosenkopf and Nerkar, 2001; Gupta et al., 2006; Lichtentaler, 2009), and enables the firm to improve, expand, and use existing knowledge and competences to transform its operations (Cohen & Levinthal, 1990). Firms may invest in external learning to gain knowledge unrelated to their current areas of expertise or to use knowledge that advances their existing technologies and products (Cohen & Levinthal, 1990). The application of these two types of external learning is critical to a firm's ability to develop exploratory and exploitative innovations (Bierly et al., 2009).

The transformation capacity, although largely obviated in studies on absorptive capacity, is a core skill underlying the multi-dimensional configuration of the construct, as it determines the firm's success in extracting the potential of external knowledge, previously identified and assimilated. The transformation capacity allows the combination of internally generated knowledge and knowledge acquired from external sources.

The transformation capacity generates a knowledge which is more idiosyncratic and difficult to imitate, replace and replicate by competitors than the external knowledge available to the company, and even than its own internal knowledge. The transformation capacity is which allows a complementarity between sources of knowledge for obtaining radical innovation. Therefore, firms increasingly compete on a deeper factor – the capacity to combine and integrate their internal knowledge with knowledge from outside (Teece, 2007; Zahra & George, 2002; Zahra & Nielsen, 2002).

In light of the above insights, our hypothesis 6 and 7 are:

Hypothesis 6 (H6). The greater the firm's absorptive capacity, the higher its capacity to obtain an incremental innovation performance.

Hypothesis 7 (H7). Internal knowledge creation capacity has a positive indirect effect on radical innovation through the mediating effect of absorptive capacity.

Control variables. We controlled for one internal (size) and one external (environmental uncertainty) variables that might influence a firm's innovation capacity. Size was measured by a continuous scale using the number of employees of the firm. Environmental uncertainty was operationalized by using a 25-item scale developed by Camisón (2004) based on the three dimensions of dynamism, complexity, and munificence advanced by Dess and Beard (1984), Respondents evaluated each items on a five-point Likert scale, in which 1 described the most stable and certain environment and 5 the most uncertain environment. Environmental uncertainty was measured by taking the average rating of the items.

Figure 1 presents the complete model. (See Figure1)

4. DATA, MEASUREMENT AND METHODS

4.1 Data set

We empirically tested the hypotheses using a data set that covers the geographical area of Spain and includes the complete set of Spanish industrial firms registered in the Spanish National Statistics Institute's Central Company Directory. We set the initial sample size at 2,000 firms to guarantee a maximum margin of error of ±2.2 with a confidence interval of 95.5 %. We selected units on the basis of stratified random sampling, focusing on industry and firm size variables. The population was classified into 14 sectors according to 3-digit SIC codes, and into four size groups according to the European Union's definition of micro, small, medium and large firms (the number of employees <10, 10-49, 50-249, and ≥250, respectively). We used the optimal sample allocation procedure in each group, and simple random sampling to select cases until the allocated size was reached.

The information was gathered through self-administered electronic questionnaires, by following a set of procedures for the electronic survey technique from Simsek & Veiga (2000). We used a webpage-based instrument for data collection, following the recommendations from Stanton & Rogelberg (2001) to avoid technological pitfalls; data collection took place between February and May 2007. The questionnaire was sent by e-mail to the sample firms' President, Chairperson, or CEO, taking necessary measures to ensure respondent anonymity and confidentiality (Simsek & Veiga, 2001, p. 230-232). The questionnaire was sent out twice, and was followed up with a phone call to non-respondents. A total of 952 firms returned usable and fully completed responses, providing a response rate of 47.6%. The questionnaire consisted of six sections and 127 questions. The data set cited here has wider purposes than those presented in this study; the paper therefore only uses and presents the questions and data relative to district embeddedness, intra-district shared competences, internal knowledge creation capacity, and absorptive capacity. All the information refers to December 2006.

The average size of the companies surveyed was 301 workers, with average sales of €22.87 million. Micro-firms made up 15.8% of the sample, while 47.3% were small firms, 22.6% medium firms and 14.4% large companies. The final sample included firms from all industries, with the exception of the energy sector.

The possible existence of non-response bias was explored with a time trend extrapolation test (Armstrong & Overton, 1977). This test operates under the assumption that "early" and "late" respondents are not significantly different. No significant differences in explanatory or dependent variables were detected from the *t* tests ($p > .05$), suggesting an absence of non-response bias in terms of firm characteristics.

To test the validity of both the research findings and the measurement instruments included in the questionnaire, we performed a methodological triangulation exercise by combining different methods (Creswell, 2003). The triangulation method enhances the credibility of results (Brewer & Hunter, 1989) while reducing the risk of observations that reflect some artefact or bias inherent in any single method (Denzin, 1978). We combined elements from qualitative study and quantitative survey methods. Qualitative inquiry prior to the distribution of surveys (Jick, 1979) was administrated through a pre-test of the questionnaire in 14 firms randomly selected from the sample for the survey research. The purpose of the pre-test was to ensure that the statements were understood without ambiguity and to collect suggestions about their design.

Following the quantitative survey, a qualitative inquiry was undertaken through a personal interview with 36 chairpersons or CEOs, in which the answers initially included in the questionnaire were tested, and were also supported through direct observation and an analysis of the firms' internal documents. These case studies demonstrated the validity of the responses to the quantitative survey, and showed that the questionnaires had been answered by the person they were addressed to (firm's chairperson or CEO).

4.2 Statistical techniques

We used a two-stage structural equation model (SEM) to test the theoretical model (Anderson & Gerbing, 1982; Hair et al., 1998). In the first stage, we developed a measurement model and performed confirmatory factor analyses (CFA) to demonstrate the model's psychometric properties of reliability, validity and dimensionality (Bagozzi, 1981). In the second stage, we tested the hypotheses through covariance structure models. We used the EQS 6.1 (Bentler, 1995) to estimate structural models, and the maximum likelihood method with robust estimators to estimate the parameters to alleviate the requirements of normality.

4.3 Measurement of the variables

The theoretical model comprises one exogenous variable (district embeddedness), three endogenous variables (intra-district shared competences, internal knowledge creation capacity and absorptive capacity), and three control variables (size, age and sector). The Appendix presents the description of the items for measuring both the exogenous and endogenous variables of the theoretical model.

The exogenous variable *district embeddedness* was measured as a dichotomous variable according to whether or not the firms are located in an industrial district. To measure the firm's embeddedness in an industrial district, the first phase was to define the potential clusters in which a firm can be located. Spain has a significant number of local production systems in various activities and geographical areas, which involves the notable decentralisation of production and industrial diffusion. We adopted the list of 35 clusters delimited by Camisón (2004) as a basis for identifying Spanish industrial districts. In the field work, the sample firms were provided with this list in order to determine which industrial district they belong to.

The three endogenous variables are latent constructs that were measured by 5-point Likert-type self-evaluation scales, reflecting managers' perception of the endowment of shared competences in their industrial district (1 = "very low", 3 = "average", and 5 "very high"), and the firm's strength as compared to its industry competitors (1 = "much worse than our competitors", 3 = "on a par with our competitors", and 5 = "much better than our competitors") for each of the attributes of the internal knowledge creation capacity and absorptive capacity. To prevent the risk that respondents' answers might not be independent if all questions for the same dimension of a construct are presented in related sections, we randomised question presentation in the questionnaire by mixing the items. In order to avoid the "robot effect" in responses, we opted for a control process that consisted of formulating certain items inversely (see Appendix).

We opted to use management self-assessment, which permits the transfer of judgment, knowledge, and experience of key individuals to a linguistic multi-item scale. Self-assessment is well established in current strategic research. Managerial self-evaluations have precedence in measuring firms' resources and capacities (e.g., Camisón & Forés, 2009; Dhanaraj & Beamish, 2003; Hooley, Greenley, Cadogan & Fahy, 2005), and the structural characteristics of the environment in which it is located (e.g. Camisón, 2004), since various studies have found that they are convergent measures with equivalent objective indicators (e.g. Camisón, 2005). Furthermore, in order to reduce the potential problem of autocorrelation and the impact of non-respondents' implicit effectiveness theories, we placed dependent variables after independent variables in the questionnaire (Williams, Cote, & Buckley, 1989; Podsakoff & Organ, 1986). In addition, we verified the convergent validity of the subjective measures from self-evaluation with objective measures both internal and exogenous to the firm (details in section 5).

Intra-district shared competences

Some previous papers (e.g., Camisón, 2004) have measured shared competences in industrial districts with multi-dimensional scales. From the theoretical definition included previously in this paper, we define *intra-district shared competences* as a second-order latent construct, made up of two dimensions or first-order factors: external capacity of knowledge creation and transfer, and coordination of collective effort. The final scale to measure shared competences in industrial districts includes 11 items from Camisón's (2004) scale, and is presented in Appendix, Section I.

Internal knowledge creation capacity

In spite of the extensive literature on internal knowledge creation capacity, the lack of consensus surrounding this construct has given rise to an insufficient debate about its measurement (Easterby-Smith et al., 2000). The majority of these studies measure internal learning capacity through spending on R&D (e.g. Bierly & Chackrabarti, 1996). The excessive focus on the analysis of R&D makes it impossible to move forward in the study of this capacity for the internal development of knowledge in firms where these activities become less evident (as in the case of SMEs) or less intensive (as in low-tech industrial sectors). Following the theoretical definition included previously in this paper, we define *internal knowledge creation capacity* as a unidimensional multi-item scale, following the line proposed by García-Morales, Ruiz-Moreno & Llorens-Montes (2007). The six items comprising the scale are the result of a thorough review of the previous literature (e.g. Camisón, 2005, 2004; Kontoghiorghes et al., 2005; Templeton et al., 2002; Lähteenmäki et al., 1999; Goh & Richards, 1997; Garvin, 1993), in which additional efforts were made to select aspects related to the learning and creation of knowledge, and the discovery of new solutions within the firm. Specifically, these attributes gather managers' and employees' commitment to change and learning, firms' abilities to develop an innovation culture, an organisational design open to learning, and investment in R&D (Appendix, Section II).

Absorptive capacity

Lane et al. (2006) state that empirical research on absorptive capacity has been hindered by the lack of a clear definition and operationalisation of the construct, which in turn has resulted in inconsistent findings (Matusik & Heeley, 2005). Whereas some studies have employed multiple-indicator scales to measure this construct (Szulanski, 1996; Lane & Lubatkin, 1998; Lane et al., 2001; Tu et al., 2006), most studies use proxy variables related to firms' R&D activity. We start by conceptualising the construct in line with Zahra & George's (2002) theoretical definition, and develop a scale to capture the richness of the construct by considering *absorptive capacity* as a third-order latent construct formed by two dimensions of potential absorptive capacity and realised absorptive capacity, which in turn are second-order factors consisting of two sub-dimensions. The final scale to measure *absorptive capacity* includes 19 items from the Camisón & Forés (2009) scale, and is presented in Appendix, Section III.

Incremental innovation performance

The OECD's Oslo Manual (2004) classifies incremental innovation as changes in products and processes like changes which are "insignificant", minor, or do not involve a sufficient degree of novelty. We measure this concept by introducing four items that captures the firm's effort to enhance or introduce minor changes in their existing products, processes, technologies and management methods. The final scale to measure *incremental innovation performance* is presented in Appendix, Section IV.

Radical innovation performance

Radical innovations are fundamental changes that represent revolutionary changes in technology. They represent clear departures from existing practice (Ettlie, 1983). We measure this concept by introducing four items that captures the firm's effort to develop new products, processes, technologies and management methods. The final scale to measure *radical innovation performance* is presented in Appendix, Section V.

Table 2 presents the descriptive statistics and correlations of the study variables. (See Table 2)

5. RESULTS

5.1 Measurement model

To develop the measurement model, we ran a joint confirmatory factor analysis for all latent factors (see Table 3). This analysis resulted in certain modifications to the initial model in order to achieve a good fit; namely, items EC5 and CC6 from the initial scale of intra-district shared competences and AC3, AS4, AS5, TR3 and AP2 from the initial scale of absorptive capacity were eliminated following the instructions of the LMTEST.

To test the dimensionality of the constructs, we studied the goodness of fit of the factor measurement model on the basis of the estimation technique proposed by Hair, Andersson Tatham & Black (1998). Table 3 summarises results, including the internal consistency or reliability measures (conjoint reliability index). All index fits show good statistics. Moreover, the standardised factorial loadings of each indicator are positive in the factor to which they have been theoretically assigned (with null weightings in other factors), and exceed the minimum value of 0.50 (Hair, Andersson, Tatham & Black, 1998) for all except one item (TR5 = 0.435, Table 3), which came very close to the minimum level; we therefore decided not to eliminate it so as not to weaken the definition of the construct domain, and their measurement errors are not correlated. The values of the estimated parameters are also statistically significant ($t \geq 1.96$; $\alpha = 0.05$) (Anderson and Gerbing, 1982). The reliability measures of latent constructs (conjoint reliability index) also meet the statistical threshold of 0.60 in exploratory research (Churchill, 1979) (see Table 3). We used the R^2 statistic (Hair et al., 1998) to estimate the reliability of the individual items. (See Table 3)

We evaluated discriminant validity from the correlations matrix between each dimension of the model. The correlations between the dimensions of the same construct were greater than the correlations with the dimensions of other constructs, confirming the discriminant validity of the model (see Table 2). We also performed a complementary assessment of discriminant validity with Chi-square difference tests on the values obtained to an unconstrained model (i.e. a model where the factor correlations are not constrained to unity) and a constrained model (Anderson & Gerbing, 1988). The results, as presented in Table 4, show significant differences between the Chi-square values obtained for the dimensions of intra-district shared competences and the dimensions and sub-dimensions of absorptive capacity constructs, indicating that these constructs are not perfectly correlated and, while they do measure some commonalities, each dimension measures a unique aspect on its own. (See Table 4)

Finally, we evaluated both concurrent and predictive criterion validities (Bollen, 1989). The concurrent validity was tested by verifying whether the measurement of capacities on the basis of managers' perceptions was convergent with the objective measurement on the basis of quantitative data. The comparison was made for four items: (1) AP4, which was correlated with the number of patents; (2) TR2, correlated with the number of information technology-based innovations introduced by the firm; (3) AC2, correlated with the number of technological cooperation agreements established by the firm; and (4) AS5, correlated with the percentage of firm personnel involved in external knowledge-based activities. The Pearson's correlation coefficients were positive (0.45, 0.34, 0.37, and 0.30, respectively) and statistically significant ($p < 0.01$). The predictive validity, following the RBV's identification of capacities as basic sources of economic rents, was tested by the correlation between the absorptive capacity scale and organisational performance. We measured performance by ROA from the 2007 annual accounts compiled in the Iberian Balance Sheet Analysis System (SABI) database. The results indicated positive correlations ($p < 0.001$) between ROA and both PACAP ($r = 0.55$) and RACAP ($r = 0.49$).

5.2 Structural model

The hypotheses were jointly assessed by the structural model (Figure 1). The model was correctly identified and can be properly estimated. It is over-identified (degrees of freedom > 0) and has adequate fit indexes (BB-NNFI = 0.996, CFI = 0.997, IFI = 0.997, NC = 1.02, RMSEA = 0.08). All the parameters were significant at the 0.05 level, the factor loadings were greater than 0.50 for all except one item (TR5 = 0.456, Figure 1), and the composite reliabilities exceeded 0.60. The measurement model therefore fits the data with reliable and valid measurement indicators. The hypothesised model explained 21% of the variance in firm's incremental performance and 64% of the variance in firm's radical innovation performance. (See Figure 1)

Our first hypothesis 1 predicted that district embeddedness would be positively associated with intra-district shared competences. The structural model confirms the existence of a direct, positive and statistically significant relationship between the two constructs ($\beta 1 = 0.290$, $p < 0.01$) (Hypothesis 1).

The second hypothesis, which predicted a positive, direct relationship between the shared competences in an industrial district and external knowledge absorptive capacity, was also shown to be positive. In the structural equation of the relationship model we obtained a positive and statistically significant coefficient ($\beta 2= 0.224$, $p < 0.01$) (Hypothesis 2).

Our third hypothesis suggested that the greater the amount of shared competences in an industrial district, the higher the firm's capacity to develop knowledge internally would be. The structural model confirms the existence of a direct, positive and statistically significant relationship between the two constructs ($\beta 3= 0.402$, $p < 0.001$) (Hypothesis 3).

Focusing on the internal aspects of the company, the fourth hypothesis suggested that firms with a greater capacity for internal knowledge creation would have a higher capacity to absorb external knowledge. The results confirm this hypothesis, as they indicate a direct, positive and statistically significant relationship between the two constructs ($\beta 4 = 0.482$, $p < 0.001$) (Hypothesis 4).

Our five and six hypotheses that predicted that firms with a greater internal knowledge creation capacity and with a greater absorptive capacity would have a higher incremental innovation performance were also supported ($\beta 5 = 0.203$, $p < 0.01$) (Hypothesis 5) ($\beta 6 = 0.272$, $p < 0.001$) (Hypothesis 6).

Finally, Hypothesis 7 that predicted that internal knowledge creation capacity has a positive relationship on radical innovation performance through absorptive capacity was supported too

($\beta 7 = 0.347$, $p < 0.001$) (0.720*0.482) (Hypothesis 7). The results reports that absorptive acts as a fully mediating variable on the development of new products, processes, technologies and management methods.

The control variable uncertainty concerning the environment significantly affects both incremental (-0.096, $p<0.05$) and radical innovation performance (-0.092, $p<0.05$), confirming the contingent proposition from organization theory. The finding on size differs depending on the innovation type. The effect of size on incremental innovation performance is positive and significative (0.143, $p<0.01$). Our results support the view that larger firms are likely to have greater resources and capabilities that allow to elongate the existing knowledge base. That is, larger firms spend more efforts to accumulate knowledge that perpetuating the innovations related to the research lines consolidated in the firm. This path dependence in large corporations creates organizational inertia that can inhibit entrepreneurial spirit of their employees to introduce radical improvement. Our empirical results show that size did not significantly affect radical innovation performance (-0.058, ,n.s.). The distinction between different types of innovation can help to solve the inconclusiveness of the relationships between size and innovation, as scholars have argued for positive, negative, and curvilinear relationships (Sorensen and Stuart, 2000; Levithal and March, 1993).

6. DISCUSSION

Research on the effect of location in an industrial district and the stock of shared competences as triggers of the intra-district firms' knowledge accumulation process is scarce. This paper contributes to the discussion of absorptive capacity from a cross-level approach by developing an integrative model that identifies two multilevel antecedents of absorptive capacity: shared competences, as inter-organisational flows of learning embedded in the specific context of industrial districts, and firms' internal capacity to develop a continuous learning system; and two main outputs: exploitative and explorative innovations. Our research extends the previous theoretical framework by studying in depth the relationships between district-level and firm-level capacities that have not been sufficiently explored in the literature.

This study follows the line established by Camisón (2004), by distinguishing two levels of strategic assets: corporate competences and shared competences. Our first contribution is to provide a theoretically-based concept of shared competences accumulated in an industrial district, differentiated from firm-specific, knowledge-based capacities, which has been successfully tested through confirmatory factor analysis. Shared competences are defined as a dense matrix of social relationships, combined with local institutions that facilitate cooperation and reciprocity, stimulating the wealth of intra-district knowledge flows.

Industrial districts are environments defined by localised knowledge spillovers to which intra-cluster firms can access. The strong, stable, long-term inter-personnel and inter-organisational relationships, the density in networks of information and knowledge exchange, the support role of local institutions, the stock of human capital with a high inter-firm turnover, and a social structure that shares a value system, create a common space with a great force towards homogeneity. However, this canonical definition of industrial district does not fit with previous empirical evidence, which reveals a strong heterogeneity of intra-district firms (e.g., Camisón, 2004; DeCarolis & Deeds, 1999; McEvily & Zaheer, 1999; Lazerson & Lorenzoni, 1999; Rabellotti & Schmitz, 1999). Our research reconfirms intra-district heterogeneity, and also highlights an indirect relationship between embeddedness in an industrial district and the firm's absorptive capacity, through the mediating effect of intra-district shared competences. The absence of a direct effect of a firm's embeddedness in an industrial district on its absorptive capacity appears to belie the strong belief rooted in canonical literature (e.g., Boari & Lipparini, 1999; Harabi, 1995) which perceives that the knowledge flows circulating within a cluster can be automatically acquired and applied by all firms embedded in it. An organisation will not benefit from localised knowledge spillovers if it is not embedded in the inter-personnel and inter-organisational networks that enhance access to the pool of shared competences. In other words, firms located in an industrial district should be active players in the system dynamic if they want to access the collective assets that the local community possesses.

Neither does the traditional definition fit with the Scandinavian Approach notion of the industrial district, based on the assumption of heterogeneity. This perspective continues to see the cluster as a context that must be considered when interpreting an individual firm's position in the district and vis-à-vis competitors. But the Scandinavian Approach also highlights the cluster dependence of the firm's knowledge process, because the intra-district shared competences do not secure the firm's competitive advantage deriving from location within the district. The shared competences and the localised learning and knowledge transfer processes are accessible only to firms embedded in the industrial district. The sustainability of knowledge-based competitive advantages, insistently repeated by the CBV in terms of individual firms, can now be extended to the ambit of the district. The barriers to the imitation, appropriation or substitution of idiosyncratic shared competences are based on a pattern of human capital development, learning and knowledge flows, traditional routines, business practices, unique institutions and multiple links between actors, which cannot be reproduced outside the area and greatly restrict their mobility. Therefore, shared competences can be the basis for a cluster-based competitive advantage over other clusters and other firms located outside the cluster. But shared competences are embedded in the intra-district processes, networks and institutions, and they are not the legal property of any particular firm. Consequently, the generation of firm-specific competitive advantages requires complementarity between cluster-based and firm-specific capabilities. The acquisition and subsequent use of external knowledge is neither easy nor free of charge, and only when firms develop a critical mass of know-how internally will they be able to take advantage of the pool of external technological opportunities and spillovers. Intra-district firms must also develop their capacity for internal learning by making use of the advantages for innovation that industrial districts offer.

Competitive asymmetries between firms within the district will derive more from their different patterns of appropriation of shared competences, which are connected with their heterogeneous firm-specific capacities, as some previous papers have predicted but without providing empirical evidence (e.g., Camisón, 2004; Malmberg & Maskell, 2002; Lawson, 1999; Foss, 1996). The endowment of shared competences in industrial districts has a direct influence on the intra-district firms' capacity to absorb external knowledge, but this direct effect is lower than the indirect effect mediated by firms' internal knowledge creation capacity. This finding coincides with the notion of absorptive capacity introduced by Cohen & Levinthal (1990), highlighting the importance of a previous knowledge base to enable the effective absorption and use of external knowledge spillovers.

Our research also shows that the relationships of collaboration, together with the flows of tacit, codified knowledge and the support of local institutions that integrate the shared competences of an industrial district, stimulate the capacity to create internal knowledge among the firms located inside it. This empirical evidence sheds light on the question of whether flows of external knowledge substitute rather than complement those generated internally, reducing support for the hypothesis that shared competences may be detrimental to firms' internal knowledge and instead, strengthening the argument that they help intra-district firms to develop their internal learning capability (Maskell & Malmberg, 1999). The absence of a direct effect of the firm's embeddedness in an industrial district on its internal knowledge creation capacity reinforces this argument by showing that the richer a district is in knowledge spillovers, the greater the benefit firms obtain through internal learning in the intra-district firm.

Our empirical study provides evidence on the direct effect of both internal knowledge creation capacity and absorptive capacity on incremental innovation performance. Absorptive capacity also reports a direct significant effect on radical innovation performance. However, the direct effect of internal knowledge creation capacity on radical innovation is not significant. This result is supported by dynamic capabilities logic and open innovation models suggesting that the need for absorptive capacity would be particularly high in turbulent environments, where the rules of the market change rapidly and frequently make the existing products obsolete (Teece, 2007; Chesbrough et al., 2006). Even the largest and most technologically self-sufficient organisations would need to rely on external sources of knowledge to develop innovations that depart from the existing technologies and markets (Powell et al., 1996).

This result reinforces the complementary relationship between the firm's internal knowledge creation capacity and absorptive capacity. Thus, although the firm's internal knowledge creation capacity is required for the firm's capacity to absorb and combine new external knowledge flows with existing internal knowledge base, its effect on the development of new products, processes and technologies depends, in the last vein, on the success of this integration of sources of knowledge. That is, without an external learning capacity, the firm would not be able to fully capitalise on its internal knowledge to innovate. Absorptive capacity allows the integration of externally sourced knowledge with in-house knowledge, creating a "causally ambiguous" advantage in products and processes that cannot be easily observed and thus imitated by competitors (Lichtentaler, 2009; Song et al., 2005). To gain substantial benefit, competitors would need to imitate a firm's overall learning processes, including both internal and external learning, a socially complex capacity that will be very difficult to imitate.

The importance of external knowledge for reactivating internal knowledge has been supported by prior research (e.g. Tsai, 2001; Kogut & Zander, 1992). Absorptive capacity stimulates the influence of internal learning on innovation by providing the firm a market orientation, new commercialization opportunities for the internally generated knowledge (Teece, 2007), and insights into the functions that internal technological knowledge may fulfil (Lichtenthaler, 2009). Chesbrough et al. (2006) point out that lack of ability to absorb external knowledge might elongate the time takes a firm to truly benefit from its innovations as they might be commercialized more slowly in the market because of a lengthening process of learning. Accordingly, absorptive capacity is not a substitute, rather a stimulator of the internal learning capacity of the firm.

These arguments contradicts research that posits high levels of one learning process (e.g. internal) would imply low levels of the other process (e.g., external) as firms compete for scarce resources (Gupta et al., 2006). In contrast, they support previous empirical findings; for example, Cassiman & Veugelers's (2006) finding that the role of technology purchasing by contractual agreements (regarded as the "buy" decision in the context of "make and buy" strategic choices) complement internal research or "make" decision, and Liao et al.'s (2007) finding that absorptive capacity is the mediating variable of knowledge sharing and innovation capacity, acting as a bridge between two. In sum, this study's results provide support for the perspective that organizational learning processes are not mutually exclusive, high levels of internal and external learning may coexist, and their conjoint development will enhance organizational innovation (Kessler et al., 2000).

Our research results make an interesting contribution to the discussion opened up by scholars who claim that the industrial district model is a dated concept in the global interconnected world, or who have doubts about the strength of intra-district knowledge flows (e.g., Ferreira & Serra, 2009). The clusters we have studied are local learning and collective knowledge creation laboratories, and these learning processes and intra-district knowledge flows determine the endowment of higher-order capacities shared by firms located in an industrial district (Arikan, 2008; Lorenzen, 1998; Foss, 1996). These localised knowledge spillovers can offer a good basis for intra-district firms' competitive advantages in innovation derived from knowledge-based capabilities.

The results of the study also have interesting implications for managers. Simply being located inside an industrial district, however rich its knowledge flows or dense its network of contacts and support institutions, might not help to assimilate this shared knowledge. Firms must strive to reinforce their internal learning capacity by taking advantage of the opportunities that this common space offers on an exclusive basis. Only when this critical mass of knowledge has been accumulated will an intra-district firm take maximum advantage of the acquisition, internalisation and application of the external knowledge circulating inside the district. In other words, firms' capacity for internal knowledge creation and their capacity to absorb external knowledge are complementary, and an exceptional wealth of potential for assimilating external knowledge should not detract firms from investing internally in R&D and in striving to build a culture that favours change and innovation.

This study has a number of limitations that might also constitute opportunities for future research. First, the responses are based on self-evaluation from a single respondent, in this case the firm's managers, which may cause problems of internal validity, although we have tried to minimise the risk of bias. Second, the research was conducted using a sample of Spanish firms, and as such, we should be cautious about generalising from the results. The specific features of the Spanish industrial context could affect the usability of our findings in future research in other societal contexts. These particular characteristics include an historical tradition of clustered industries, a strong territorial dependence and embeddedness of industrial districts that has led to close involvement of public organisations and other regional institutions (e.g., universities, technological institutes) in collective efforts to develop cluster competitiveness, and a specialisation pattern of clusters in low/medium technology-based manufacturing, Only by extending this research to other countries could we learn whether the results are biased and the findings generalisable. Finally, the data used in this study are cross-sectional. Considering the dynamism of the proposed model, an interesting avenue for further research would be to test the stability of the empirical evidence obtained by working with longitudinal data. Although the approach used reduces this problem by means of measurement scales with items that reflect dynamic characteristics, our results should be interpreted as an association between variables and not in terms of causality. Moreover, the division of organisational learning into different external and internal processes is more pedagogic than structural. With longitudinal data we can study the possible recursive relationship between firms' organisational knowledge creation and absorptive capacity (Cohen & Levinthal, 1990; Veugelers, 1997; Autio et al., 2000). Thus, through longitudinal research we can make a systematic study of the determinants, processes and outcomes of a firm's knowledge creation and absorptive capacity (Volberda et al., 2010).

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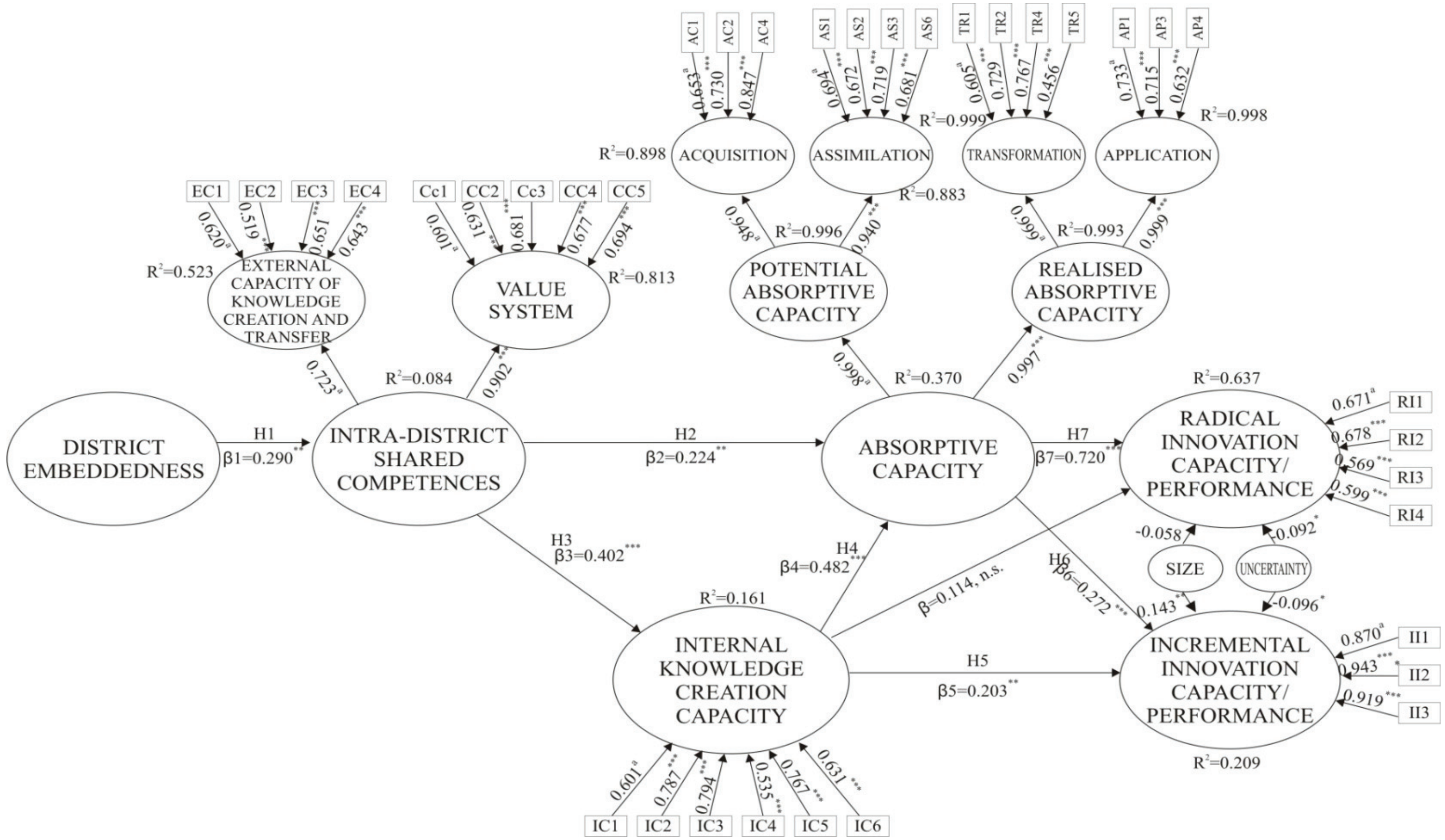
FIGURE CAPTIONS

Figure 1. Theoretical Model [b]



χ^2=686.6921; d.f. = 673; BB-NNFI = 0.996 ; CFI =0.997; IFI =0.997; NC = 1.02; RMSEA = 0.008

[a] Parameter equal to one to determine the scale of the latent construct.

[b] See annexes for a full description of the items.

* p < .05; ** p< .01, ***p<0.001

Table 1. Dimensions of absorptive capacity by Zahra & George (2002)

• Acquisition capacity is defined as the firm's ability to locate, identify, value and acquire external knowledge that is critical to its operations (Lane & Lubatkin, 1998; Zahra & George, 2002).
• Assimilation capacity refers to the firm's capacity to absorb external knowledge. This capacity can also be defined as the processes and routines that allow the new information or knowledge acquired to be analysed, processed, interpreted, understood, internalised and classified (Szulanski, 1996; Zahra & George, 2002).
• Transformation capacity is the firm's capacity to develop and refine the internal routines that facilitate the transfer and combination of previous knowledge with the newly acquired or assimilated knowledge. Its main objective is to establish how to adapt the new knowledge to the reality and needs of the organisation (Zahra & George, 2002).
• Finally, application or exploitation capacity refers to the firm's ability to use new knowledge, for commercial ends, to achieve its objectives (Lane & Lubatkin, 1998). This capacity can also be defined as the organisational capacity based on routines that enable firms to incorporate acquired, assimilated and transformed knowledge into their operations and routines not only to refine, perfect, expand and leverage existing routines, processes, competences and knowledge, but also to create new operations, competences and routines (Zahra & George, 2002).

Table 2. Means, standard deviations and correlations among study variables

	Variable	Mean	SD	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1	District embeddedness	0.772	0.294	1.00													
2	Intra-district Shared competences	2.928	0.574	0.251**	1.00												
3	Industrial atmosphere	2.912	0.631	0.227**	0.842**	1.00											
4	Value system	2.943	0.705	0.205**	0.876**	0.476**	1.00										
5	Internal knowledge creation capacity	3.489	0.561	0.101*	0.368**	0.287**	0.342**	1.00									
6	Absorptive capacity	3.216	0.603	0.141**	0.283**	0.157**	0.320**	0.565**	1.00								
7	Potential absorptive capacity	3.186	0.637	0.148**	0.255**	0.129**	0.300**	0.526**	0.945**	1.00							
8	Realised absorptive capacity	3.246	0.639	0.119*	0.280**	0.168**	0.305**	0.542**	0.945**	0.786**	1.00						
9	Acquisition capacity	3.142	0.712	0.137**	0.302**	0.158**	0.351**	0.438**	0.866**	0.908**	0.729**	1.00					
10	Assimilation capacity	3.231	0.695	0.132**	0.158**	0.075	0.190**	0.516**	0.845**	0.903**	0.694**	0.641**	1.00				
11	Transformation capacity	3.256	0.660	0.118*	0.295**	0.173**	0.325**	0.590**	0.866**	0.730**	0.906**	0.655**	0.667**	1.00			
12	Application capacity	3.236	0.736	0.100*	0.222**	0.137**	0.239**	0.412**	0.866**	0.710**	0.925**	0.678**	0.608**	0.676**	1.00		
13	Incremental innovation performance	2.880	1.038	0.077	0.308**	0.181**	0.346**	0.385**	0.383**	0.360**	0.369**	0.290**	0.365**	0.387**	0.297**	1.000	
14	Radical innovation performance	3.444	0.696	0.128*	0.105*	0.003	0.168**	0.389**	0.591**	0.580**	0.537**	0.469**	0.584**	0.500**	0.484**	0.293**	1.000

* $p < 0.05$; ** $p < 0.01$

Table 3 Confirmatory Factor Analysis of the construct measurement model[b]

Factors	Standardised factor loadings	t values[c]	R^2	Conjoint reliability
Intra-district shared competences				0.773
External capacity of knowledge creation and transfer	0.999 [a]		0.999	0.652
EC1	0.618[a]		0.382	
EC2	0.528	8.241	0.278	
EC3	0.652	8.939	0.425	
EC4	0.636	7.691	0.405	
Coordination of collective effort	0.647	3.030	0.419	0.741
CC1	0.595 [a]		0.354	
CC2	0.632	3.807	0.399	
CC3	0.680	3.998	0.462	
CC4	0.684	4.273	0.469	
CC5	0.693	4.368	0.480	
Internal knowledge creation capacity				0.796
IC1	0.588 [a]		0.345	
IC2	0.804	15.836	0.646	
IC3	0.821	13.347	0.675	
IC4	0.526	8.741	0.276	
IC5	0.766	16.102	0.587	
IC6	0.579	21.727	0.335	
Absorptive capacity				0.966
Potential absorptive capacity	0.997 [a]		0.993	0.843
Realised absorptive capacity	0.998	10.474	0.997	0.965
Acquisition capacity	0.961 [a]		0.924	0.716
AC1	0.641 [a]		0.411	
AC2	0.729	10.349	0.532	
AC4	0.857	11.687	0.735	
Assimilation capacity	0.922	9.822	0.851	0.726
AS1	0.693 [a]		0.481	
AS2	0.671	10.116	0.450	
AS3	0.720	13.167	0.518	
AS6	0.683	10.388	0.467	
Transformation capacity	0.990 [a]		0.980	0.682
TR1	0.596 [a]		0.355	
TR2	0.741	10.207	0.549	
TR4	0.769	8.276	0.591	
TR5	0.435	6.793	0.189	
Application capacity	0.999	18.445	0.999	0.672
AP1	0.724 [a]		0.525	
AP3	0.731	10.209	0.535	

AP4			0.640	11.881	0.410	
Incremental innovation performance						0.862
II1			0.874 [a]		0.763	
II2			0.948	18.116	0.898	
II3			0.917	17.565	0.840	
Radical innovation performance						0.680
RI1			0.579 [a]		0.336	
RI2			0.485	5.362	0.235	
RI3			0.702	22.770	0.493	
RI4			0.774	9.226	0.599	
Goodness of fit indexes[d]						
RMSEA	Below 0.08	0.028				
IFI Fit Index	Up to 0.9	0.966				
CFI Fit Index	Up to 0.9	0.965				
BB-NNFI Fit Index	Close to 0.9	0.962				
Normed Chi Square	Between 1 and 5	1.24				

Notes:

[a] Parameter equal to one to determine the scale of the latent construct.

[b] See annexes for a full description of the items.

[c] The t values over 1.645 are significant at a level of 5% (one tail).

[d] RMSEA = Root Mean Square Error of Approximation index; IFI = Incremental Fit Index; CFI = Comparative Fit Index; BB-NNFI = Bentler-Bonnett Non Normed Fit Index; NC = Normed Chi-Squared.

Table 4. Discriminant validity of the constructs

Variable	Model	χ^2	df	$\Delta\chi^2$
Shared competences	1. Unconstrained model	47.114	24	_
	2. External capacity of knowledge creation and transfer – coordination of collective effort	93.148	25	46.034**
Potential absorptive capacity	1. Unconstrained model	18.441	13	_
	2. Acquisition – assimilation	91.313	14	72.872**
Realised absorptive capacity	1. Unconstrained model	18.734	13	_
	2. Transformation – application	87.733	14	68.999**
Absorptive capacity	1. Unconstrained model	106.267	72	_
	2. Potential absorptive capacity – realised absorptive capacity	163.161	73	56.894**

Notes:

$\Delta\chi^2 = \chi^2$ (unconstrained model) - χ^2 (constrained model).

* *p-value* < 0.05, ** *p-value* < 0.01 level.

A-B implies that constructs A and B are set to be completely correlated.

APPENDIX

Section I. Intra-district shared competences

When responding to the following items, consider the endowment of shared competences present in the industrial district in which your firm is located (see attached list of Spanish industrial districts). Evaluate each item on a scale from 1 to 5 where 1 is very low, 3 average, and 5 is very high.

Intra-district shared competences	
Item	*Description*
	External capacity of knowledge creation and transfer
EC1	Availability of a rich pool of qualified and specialised human capital in the industrial district (local pool of human capital)
EC2	The firm’s human capital has acquired its statutory and / or continuing education in local educational institutions or companies located in the industrial district (local education and experience of human capital)
EC3	There is a model or pattern of relationships for the informal transmission of innovations and knowledge within the local territorial environment that cannot be reproduced outside the area (local diffusion of innovations)
EC4	When designing its strategy and internal organisational relationships, the firm benefits from the successful experiences of neighbouring firms in the industrial district (permeability of the economic and social structure)
EC5	The firm can easily establish nonproduction-related cooperation agreements within the district with suppliers, competitors, and customers that are difficult to reproduce outside it (easily of local cooperation) †
	Coordination of collective effort
CC1	Availability of support services to obtain information and knowledge for firms located within the industrial district in which the firm is based (collective information and knowledge services)
CC2	Availability of support services for R&D (technological institutes or universities, R&D centres, etc.) and employee training in new products, processes and technologies for firms located within the industrial district (collective support services for R&D and training)
CC3	The physical environment is coordinated by public institutions (public coordination of territory)
CC4	Existence and importance of an overall business strategic orientation for all the firms in the industrial district (strategic local orientation)
CC5	Public administration support the business development in the industrial district (public administration support)
CC6	Firms benefit from the collective reputation developed by the external communication activities carried out cooperatively by groups of competitors or business associations in the industrial district (institutional creation of collective reputation) †

† Item dropped from the final scale

Section II. Internal knowledge creation capacity

When responding to the following items, consider the firm's capacity to develop new knowledge through its internal resources, capacities and systems. Evaluate the strength of the firm's competitive position for each item in relation to the direct industry competitors' average on a scale of 1 to 5 where 1 is "much worse than our competitors", 3 is "on a par with our competitors", and 5 is "much better than our competitors".

Internal knowledge creation capacity	
Item	*Description*
IC1	Firm's efficiency in the development of a culture and organisational systems designed to attract, develop and retain talent (innovative culture and systems)
IC2	Firm's capacity to integrate the employees with the organisational objectives of knowledge creation and learning (employees' fit with firm's learning objectives)
IC3	Degree of employees' motivation and commitment to quality and innovation at a personal level (employee's commitment to innovation)
IC4	Degree to which managers consider change as natural and desirable, encourage employees to learn, experiment, constantly question the way things are done to improve them, solve problems and offer suggestions (managerial support to learning) Degree to which the organisation stimulates the development of competencies and the knowledge sharing among employees by encouraging horizontal and vertical communication, and the development of work teams and discussion forums (organisational design for learning)
IC5	Firm's capacity to efficiently assign resources to the R&D department (R&D investment)
IC6	Firm's efficiency in the development of a culture and organisational systems designed to attract, develop and retain talent (innovative culture and systems)

Section III. Absorptive capacity

When responding to the following items, consider the firm's capacity to absorb external knowledge. Evaluate the strength of the firm's competitive position for each item in relation to the direct industry competitors' average on a scale of 1 to 5 where 1 is "much worse than our competitors", 3 is "on a par with our competitors", and 5 is "much better than our competitors".

Absorptive capacity	
Item	*Description*
	A) Potential Absorptive Capacity(PACAP)
	Acquisition Capacity
AC1	Degree of management orientation of waiting to see what happens, instead of concern and orientation towards the environment to monitor a wide-range of trends continuously and to discover new opportunities to be exploited proactively (management's orientation towards external learning)*
AC2	Frequency and importance of co-operation with R&D organisations –universities, business schools, technological institutes, etc. – as a member or sponsor to create knowledge and innovations (R&D cooperation)
AC3	Firm's capacity to capture relevant, continuous and up-to-date information and knowledge on current and potential competitors (knowledge of the competition) †
AC4	Firm's effectiveness in establishing programmes oriented towards the internal development of technological acquisition of competencies from R&D centres, suppliers or customers (technological competences acquisition capacity)
	Assimilation Capacity
AS1	Firm's ability to use employees' knowledge, experience and competency in the assimilation and interpretation of new knowledge (knowledge assimilation capacity by human resources)
AS2	Firm's capacity to assimilate new technologies and innovations that are useful or have proven potential (technology assimilation capacity)
AS3	Firm benefits when it comes to assimilating the basic, key business knowledge and technologies from the successful experiences of enterprises in the same industry (industrial benchmarking)
AS4	Degree to which company employees attend and present papers at scientific conferences and lecturer at universities, and other companies' employees visit the company on research assignments (involvement in knowledge diffusion flows) †
AS5	Firm's employees attendance at training courses, trade fairs, exhibitions and meetings (knowledge absorption from formal and informal professional sources) †
AS6	Firm's ability to develop knowledge management programmes guaranteeing employee's capacity to understand and carefully analyse knowledge and technology from other organisations (external knowledge management)
	A) Realised Absorptive Capacity (RACAP)

	Transformation Capacity [a]
TR1	Degree to which firm prevents all employees voluntarily transmit acquired scientific and technological information to each other (exchange of scientific and technological information)*
TR2	Firm's capacity to use information technologies in order to improve information flow, develop the effective sharing of knowledge and foster communication between members of the firm, including virtual meetings between professionals who are physically separated via Internet B2E portals, e-mail, teleworking, etc. (transmission of IT- based knowledge)
TR3	Firm's capacity to adapt technologies designed by others to its particular needs (knowledge adaptation capacity) †
TR4	Awareness by the firm of its competencies in innovation, especially with respect to key technologies, and capability to eliminate obsolete internal knowledge, stimulating in exchange the search for alternative innovations and their adaptation (knowledge renewal capability)
TR5	Firm's capability to co-ordinate and integrate all phases of the R&D process and its inter-relationships with the functional tasks of engineering, production and marketing (integration of R&D)
	Application Capacity
AP1	Degree of application of knowledge and experience acquired in the technological and business fields to the firm's strategy that enables it to stay at the technological leading edge in the business (knowledge application capacity)
AP2	Organisation's capacity to use and exploit new knowledge in the workplace to respond quickly to environment changes (new knowledge exploitation capacity)†
AP3	Firm's ability to respond to the requirements of market demand or competitive pressure, rather than innovating to gain competitiveness by broadening the portfolio of new products, capabilities and technology ideas (response to market)*
AP4	Firm's capacity to put technological knowledge into product and process patents (patents development capacity)

* Items are reverse scored

† Item dropped from the final scale

Section IV. Incremental innovation performance

When responding to the following items, consider the firm's capacity to enhance existing products, processes, technologies and management methods. Evaluate the strength of the firm's competitive position for each item in relation to the direct industry competitors' average on a scale of 1 to 5 where 1 is "much worse than our competitors", 3 is "on a par with our competitors", and 5 is "much better than our competitors".

Incremental innovation performance	
Item	*Description*
II1	Incremental innovation of products
II2	Incremental innovation of processes
II3	Incremental innovation of technologies
II4	Incremental innovation of management methods†

† Item dropped from the final scale

Section V. Radical innovation performance

When responding to the following items, consider the firm's capacity to develop new products, processes, technologies and management methods. Evaluate the strength of the firm's competitive position for each item in relation to the direct industry competitors' average on a scale of 1 to 5 where 1 is "much worse than our competitors", 3 is "on a par with our competitors", and 5 is "much better than our competitors".

Incremental innovation performance	
Item	*Description*
RI1	Radical innovation of products
RI2	Radical innovation of processes
RI3	Radical innovation of technologies
RI4	Radical innovation of management methods

EFECTO DE LA PROACTIVIDAD MEDIOAMBIENTAL SOBRE LA INNOVACIÓN Y LA MEJORA CONTINUA EN LA EMPRESA.

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ABSTRACT

Las prácticas de mejora continua se han relacionado con la competitividad empresarial y se ha destacado la necesidad de de un compromiso por parte de la gerencia, inversión de tiempo y recursos. La innovación es parte intrínseca de la definición de competitividad y, por otra parte, el interés por el medioambiente es cada vez mayor tanto por parte de las empresas como a nivel social. Estos tres conceptos diferentes, mejora continua, innovación y proactividad medioambiental, tienen cosas en común. La interrelación entre ellos se basa en que las consecuencias deseadas de la innovación, de la mejora continua y de la proactividad medioambiental convergen hacia una misma meta, la mejora de la productividad y por lo tanto de la competitividad de la empresa. Esta relación, hasta el momento, no ha sido estudiada desde un punto de vista empírico. Ese será el objetivo de este trabajo, para lo que se realizará un estudio cuantitativo con información obtenida de la base de datos PITEC, analizando los datos relativos a 8038 empresas españolas utilizando técnicas cuantitativas. Los resultados indican que efectivamente tras la clasificación de las empresas en grupos con diferente proactividad medioambiental, se observa que las empresas con mayor proactividad medioambiental muestran una relación directa con las actividades de innovación y mejora continua.

Key words:

Environmental commitment; innovation; continuous improvement; management.

1. INTRODUCCIÓN.

La mejora continua se define como el proceso planificado, organizado y sistemático de cambio continuado (Bond, 1999). Está basada en el ciclo de Deming, que consiste en cuatro fases: estudio de la situación actual, adquisición de información para proponer sugerencias de mejora; ajuste e implantación de propuestas seleccionadas; comprobación de resultados de las propuestas; implementación y estandarización de las propuestas con las necesarias modificaciones (García-Sabater, Marín-García, 2009). Las prácticas de mejora continua se han relacionado con la competitividad empresarial y se ha destacado la necesidad de de un compromiso por parte de la gerencia, inversión de tiempo y recursos (Albors et al., 2009).

Por otra parte, aunque los orígenes del concepto innovación fueron introducidos por Schumpeter en 1939, sigue siendo un campo de estudio actual en el ámbito académico. Este autor definió la innovación como un proceso que incluye la introducción en el mercado de un nuevo bien, la introducción de un nuevo método de producción, la apertura de un nuevo mercado y la conquista de una nueva fuente de suministro. Se han encontrado varias definiciones elaboradas por diferentes autores de dicho concepto. Según Gee (1981), innovación es el proceso en el cual a partir de una idea, invención o reconocimiento de necesidad, se desarrolla un producto, técnica o servicio útil. Según Perrin (1995) la innovación puede definirse como formas nuevas de hacer las cosas mejor o de manera diferente, muchas veces por medio de saltos cuánticos, en oposición a ganancias incrementales. En línea con esta última definición Trott (2008) propone la diferencia entre innovación radical e innovación incremental. Las innovaciones radicales suelen aparecer explorando nuevas tecnologías, pueden enfocarse a productos, procesos o servicios con novedades sin precedentes, crean un cambio dramático que puede transformar o incluso crear nuevos mercados o industrias. Las innovaciones incrementales surgen de la tecnología existente, enfocadas a mejoras en procesos, productos o servicios, mejoran la competitividad en los mercados o industrias existentes. El Manual de Oslo (2005) ha distinguido tradicionalmente entre la innovación de productos y procesos y, en la edición más reciente, considera también la organización y comercialización, pero aún no ha definido las innovaciones relacionadas con las cuestiones ambientales, lo que la academia está considerando como la eco-innovación (Peiró, Signes et al, 2011). Algunos motivos que animan a las empresas para innovar son: la mejora de la productividad (De Benito Valencia, 2000), la mejora de la calidad (Albors et al., 2009), la reducción de costes de producción (Bond, 1999). Del mismo modo la mejora continua se considera una herramienta para incrementar la competitividad (Albors et al., 2009).

Por otra parte, el interés por el medioambiente es cada vez mayor tanto por parte de las empresas como a nivel social. En la actualidad, el número de trabajos que han analizado los factores determinantes que promueven un comportamiento medioambiental responsable es importante. Entre estos factores, el apoyo y el compromiso de la gerencia son considerados como factores fundamentales necesarios para explicar el comportamiento medioambiental de una empresa (González-Benito y González-Benito, 2006, Aragón–Correa et al., 1998). Incluso es considerado como el central y esencial para el desarrollo de estrategias medioambientales proactivas. (González-Benito, González-Benito, 2010, López-Gamero et al., 2011).

Estos tres conceptos diferentes, mejora continua, innovación y proactividad medioambiental, tienen cosas en común. La interrelación entre ellos se basa en que las consecuencias deseadas de la innovación, de la mejora continua y de la proactividad medioambiental convergen hacia una misma meta, la mejora de la productividad y por lo tanto de la competitividad de la empresa (Hitchens, 2005, Esty, 2006, Gonzalez-Benito, 2010). Esta relación, hasta el momento, no ha sido estudiada desde un punto de vista empírico. Ese será el objetivo de este trabajo, para lo que se realizará un estudio cuantitativo con información obtenida de la base de datos PITEC relacionando las variables innovación, mejora continua y orientación eco-innovadora

La estructura de este artículo es la siguiente, primero se va a hacer una revisión de literatura existente en mejora continua, innovación y proactividad medioambiental centrándonos en la relación entre estos tres conceptos. En el siguiente apartado se plantea la hipótesis del trabajo. A continuación se explica la metodología utilizada y las características de la muestra para el estudio empírico aplicado a los sectores industriales. Por último se plantean y discuten los resultados obtenidos y exponen las principales conclusiones, limitaciones del estudio y futuras líneas de investigación.

2. REVISIÓN DE LITERATURA

La revisión de literatura de los conceptos estudiados sigue la siguiente estructura. En primer lugar se introduce el concepto de mejora continua, con una explicación del mismo. En segundo lugar se introduce el concepto de proactividad medioambiental, se explican los factores que la promueven, y los beneficios que se esperan de ella. En tercer lugar se exponen las relaciones que se han encontrado en la literatura entre mejora continua e innovación. En cuarto lugar se explica la relación encontrada entre mejora continua y proactividad medioambiental. En último lugar se añade la relación entre proactividad medioambiental e innovación.

La mejora continua es un sencillo concepto que puede ser aplicado para mejorar cualquier aspecto del ámbito de la producción: costes, calidad, flexibilidad y productividad (Bessant et al., 1993). Se puede definir como un proceso organizado y sistemático de cambios continuos. Está basada en el ciclo virtuoso de mejora de Deming que consiste en cuatro fases : "Plan", estudiar la situación actual y desarrollo de propuesta de cambios para mejorarla; "Do", obtención de información para elaborar la propuesta; "Check", examinar el efecto de los cambios para comprobar si el efecto es el deseado; "Action", implementación de la propuesta. El objetivo es corregir la causa del problema y no solo combatir sus síntomas para así erradicarlo y por lo tanto conseguir la mejora permanente (Bond, 1999). El objetivo de la mejora continua es conseguir mejoras en costes, calidad, flexibilidad o en la productividad, produciéndose estas mayoritariamente de una forma gradual o incremental (Bessant et al., 1993). La mejora continua representa el proceso de búsqueda de mejora en sí mismo, no solo la resolución de los problemas (Rodríguez y Gómez, 2010).

Podría definirse proactividad medioambiental como el comportamiento que incita a la implementación voluntaria de prácticas e iniciativas que conducen a mejorar la relación de la empresa con el medioambiente (González-Benito, González-Benito, 2006).

Los factores determinantes de la proactividad medioambiental pueden clasificarse en internos de la empresa o externos a ella. Los internos son: el tamaño grande de la empresa, el formar parte de una corporación internacional y el apoyo y compromiso de la alta gerencia. Los factores externos a la empresa son: el sector industrial al que se pertenece, ya que cada industria tiene un potencial diferente de polución y está sujeta a diferentes controles por parte de las administraciones públicas, instituciones y consumidores, y la localización, ya que de ella dependen tanto la legislación medioambiental (Rivas y Magadán, 2007, Vargas-Vargas et al., 2010) como la presión social (González-Benito, González-Benito, 2006). De entre estos determinantes, el considerado central y esencial para el desarrollo de estrategias medioambientales proactivas es la presión y compromiso de los accionistas (González-Benito, González-Benito, 2010). Aragón-Correa et al. (2008) estudiaron las pequeñas y medianas empresas con el fin de verificar que el tamaño de la empresa es relevante, pero no una condición determinista que impida desarrollar estrategias medioambientales proactivas. La relación entre la presión del accionariado y las prácticas medioambientales proactivas varían con respecto al tamaño de las empresas. Las empresas pequeñas son más sensibles a dichas presiones percibidas, y estas surten como efecto un mejor comportamiento medioambiental (Darnall et al., 2010). Con respecto a la teoria de Stakeholders, Gadenne et al. (2009) observaron que a pesar de encontrar empresas con accionistas / gerentes con actitudes “verdes”, sin embargo el nivel de implementación de prácticas medioambientales en dichas empresas era pobre

Es necesario mirar dentro de la empresa, para comprender mejor cuales son las capacidades que apoyan la aparición de estrategias sostenibles con éxito, considerando fundamental el concepto de capacidad de absorción (Delmas et al., 2011). Así mismo, no siempre el hecho de mostrar actitudes favorables hacia el medioambiente está asociado con la toma de acciones para mejorar el impacto medioambiental de la empresa, por lo que se recomiendan los estudios empíricos. (Gadenne et al. 2009)

Existen estudios en los que se relaciona la proactividad medioambiental de la empresa con la obtención de diferentes beneficios. Por ejemplo, Aragón-Correa (1998), define los efectos positivos de la proactividad medioambiental como una nueva área de ventaja competitiva. Hay situaciones en las que el comportamiento proactivo produce beneficios tanto para el medio ambiente como para la empresa (King y Lenox, 2001). Los estudios cada vez van concretando y analizando cada uno de los beneficios obtenidos, como la mejora en la reputación de la empresa (Buysse y Verbeke, 2003), la obtención de efectos positivos tanto en el propio desempeño de la empresa y en sus las actividades de marketing (González-Benito, 2005). En la misma línea, Gadenne et al. (2009) añaden y detallan más beneficios para las empresas, entre los que se encuentran: reducción de desechos, ahorro de costes, aumento de la satisfacción de los clientes, mejoras en los productos y en las relaciones públicas de las empresas. Los estudios más recientes en este campo añaden que la proactividad medioambiental es una ayuda para los procesos de internacionalización (Martín-Tapia et al, 2010) e incluso para mejorar en los recursos financieros (Clarkson et al., 2011).

La relación entre mejora continua e innovación es una cuestión que goza de aceptación en la literatura. Siguiendo a Martín Castilla (2007) la innovación se ha impuesto como la única vía de desarrollo organizativo para la gestión del cambio a lo largo del tiempo y la formulación de soluciones de mejora creativas en respuesta a los retos que crea el entorno, enlazando ambos términos con la teoría de la contingencia aplicada por Gertsen (2001) para analizar los aspectos contingentes de la mejora continua con la evolución empresarial.

Actualmente resulta habitual asociar la mejora continua como una forma de innovación incremental (Marín-García et al. 2008, Bessant, 1998). Incluso también ha sido definida como un proceso de toda la organización de innovación incremental (Bessant y Francis, 1999) cuyos miembros suelen implicarse en los procesos de innovación. Si bien existen diferentes enfoques que discrepan de esta consideración y dudan que la mejora continua pueda identificarse como innovación (Cilleruelo et al. 2008)

Relacionando el concepto de mejora continua con la gestión medioambiental proactiva Hart (1995) indica que el concepto de mejora continua es incluido entre los recursos relacionados con la gestión medioambiental proactiva. En el trabajo de Darnall et al. (2006), se subraya que los sistemas de gestión medioambiental están basados en el modelo de mejora continua e incluso se indica que para mantener un sistema de gestión medioambiental se necesitan las capacidades de la mejora continua y es a través de ellas como se consigue facilitar los programas de reducción de residuos medioambientales. En su estudio sobre la norma ISO 14001 Morrow y Rondinelli (2002) indican esta misma relación. Otros autores destacan que la producción sostenible es el resultado último de la mejora continua (De Ron, 1997). Delmas et al. (2011) afirman que la estrategia para implementar programas de mejora medioambiental necesita de la implicación de mucha gente realizando esfuerzos de mejora continua. En su trabajo sobre la gestión medioambiental, Gupta (1994), indica que esta requiere de la evaluación completa de todos los procesos, y se esfuerza por lograr una mejora continua en ellos.

La relación entre innovación y gestión medioambiental es señalada por muchos autores. Por ejemplo Angell y Klassen (1999) relacionan las innovaciones tecnológicas como una de las bases sobre la que se sustentan las mejoras medioambientales. El interés combinado en competitividad y responsabilidad ecológica lleva con frecuencia a innovaciones en productos, procesos y políticas que de otro modo no se realizarían (Bansal, Roth, 2000). Las prácticas medioambientales proactivas son innovaciones de gestión que necesitan del compromiso de la organización hacia la mejora del medioambiente (Darnall et al. 2010), este mismo autor indica que las empresas pequeñas suelen ser innovadoras más eficaces y por lo tanto tiene una mayor inclinación a invertir en cambios proactivos medioambientales. Delmas et al. (2011) basan su investigación en tres estrategias que reconcilian competitividad y proactividad medioambiental: reducción de costes, creación de valor animando a la diferenciación de producto e innovación, y la mejora de la reputación. Para ello es un factor fundamental a tener en cuenta la capacidad de absorción de la empresa. Una de las motivaciones por la cual las empresas adoptan sistemas de gestión medioambiental es para promover innovaciones tanto de procesos como de productos (Morrow y Rondinelli, 2002, Hemmelskamp, 2007). Uno de los aspectos tenidos en cuenta para medir la proactividad medioambiental de una empresa es su tendencia a la innovación (Murillo et al. 2008).

Se ha observado cómo se relacionan entre sí los conceptos objetos de este trabajo, mejora continua con innovación, mejora continua con proactividad medioambiental e innovación con proactividad medioambiental. Sin embargo no se ha encontrado en el ámbito académico literatura empírica que relacione los tres conceptos a la vez. Esta es la razón principal que ha motivado este estudio, y la exploración a través del análisis cuantitativo de dichos tres conceptos a la vez y lo que nos lleva a plantear la siguiente hipótesis:

H1: Las empresas cuya gerencia impulsa programas de mejora continua e innovación muestran interés en mejorar su gestión medioambiental.

3. MUESTRA Y METODOLOGÍA.

Para el estudio se han utilizado datos provenientes del panel de innovación tecnológica PITEC (2009) que monitorean las actividades de innovación de las empresas españolas. La base de datos depende del INE (Instituto Nacional de Estadística) y se estructuro con el asesoramiento de académicos y expertos. Los primeros datos disponibles son de 2004 y se actualiza anualmente. Incluye un total de 255 variables.

Con anterioridad se ha utilizado para avanzar en la comprensión de la innovación en las empresas y las diferentes estrategias implementadas (Vega-Jurado et al., 2009), y también para identificar los factores que influyen en la orientación sostenible de las empresas (Segarra et al., 2011).

La muestra está compuesta por 8038 empresas españolas. Se han seleccionado las variables relacionadas con la mejora continua y la innovación de acuerdo con la teoría previamente expuesta. La preocupación medioambiental al innovar (denominado Objetivo 11 en la base de datos PITEC) determinada por la importancia de la reducción del impacto medioambiental en las actividades de innovación, muestra la proactividad medioambiental de la empresa y se considera la variable dependiente para poder analizar la influencia que la mejora continua y la innovación tienen sobre ella.

Las variables seleccionadas de acuerdo a la revisión de la literatura efectuada se presentan en la tabla 1.

VARIABLE	DEFINICION	CODIGO RESPUESTA
OBJET1	Importancia objetivo innovación tecnológica: Gama más amplia de bienes o servicios	1,2 3,4,Blanco
OBJET2	Importancia objetivo innovación tecnológica: Sustitución de productos o procesos anticuados	1,2 3,4,Blanco
OBJET3	Importancia objetivo innovación tecnológica: Penetración en nuevos mercados	1,2 3,4,Blanco
OBJET4	Importancia objetivo innovación tecnológica: Mayor cuota de mercado	1,2 3,4,Blanco
OBJET5	Importancia objetivo innovación tecnológica.: Mayor calidad de los bienes o servicios	1,2 3,4,Blanco
OBJET6	Importancia objetivo innovación tecnológica: Mayor flexibilidad en la producción o la prestación de servicios	1,2 3,4,Blanco
OBJET7	Importancia objetivo innovación tecnológica: Mayor capacidad de producción o prestación de servicios	1,2 3,4,Blanco
OBJET8	Importancia objetivo innovación tecnológica: Menores costes laborales por unidad producida	1,2 3,4,Blanco
OBJET9	Importancia objetivo innovación tecnológica: Menos materiales por unidad producida	1,2 3,4,Blanco
OBJET10	Importancia objetivo innovación tecnológica: Menos energía por unidad producida	1,2 3,4,Blanco
OBJET11	Importancia objetivo innovación tecnológica: Menor impacto medioambiental	1,2 3,4,Blanco
OBJET14	Importancia objetivo innovación tecnológica: Aumento del empleo total	1,2 3,4,Blanco
OBJET15	Importancia objetivo innovación tecnológica: Aumento del empleo cualificado	1,2 3,4,Blanco
OBJET16	Importancia objetivo innovación tecnológica: Mantenimiento del empleo	1,2 3,4,Blanco
FACE1	Importancia factores: falta de fondos dentro de la empresa o grupo	1,2 3,4,Blanco
FACE2	Importancia factores: falta de financiación externa a la empresa	1,2 3,4,Blanco
FACE3	Importancia factores: costes de innovación elevados	1,2 3,4,Blanco
FACI1	Importancia factores: falta de personal cualificado	1,2 3,4,Blanco
FACI2	Importancia factores: falta de información sobre tecnología	1,2 3,4,Blanco
FACI3	Importancia factores: falta de información sobre mercados	1,2 3,4,Blanco
FACI4	Importancia factores: dificultad en encontrar socios para la cooperación en innovación.	1,2 3,4,Blanco
OTROFAC1	Importancia factores: Mercado dominado por empresas establecidas	1,2 3,4,Blanco

OTROFAC2	Importancia factores: demanda incierta de bienes y servicios innovadores	1,2 3,4,Blanco
OTROFAC3	Importancia factores: no necesitadas por innovaciones previas	1,2 3,4,Blanco
OTROFAC4	Importancia factores: no necesitadas por falta de demanda de innovaciones	1,2 3,4,Blanco
INORGN1	Innovación organizativa de (t-2) a t: Nuevas prácticas empresariales en la organización	1,0,Blanco
INORGN2	Innovación organizativa de (t-2) a t: Nuevos métodos de organización de los lugares de trabajo en su empresa con el objetivo de un mejor reparto de responsabilidades y toma	1,0,Blanco
INORGN3	Innovación organizativa de (t-2) a t: Nuevos métodos de gestión de las relaciones	1,0,Blanco
INCOMN1	Innovación comercialización de (t-2) a t: Modificaciones significativas del diseño del	1,0,Blanco
INCOMN2	Innovación comercialización de (t-2) a t: Nuevas técnicas o canales para la promoción	1,0,Blanco
INCOMN3	Innovación comercialización de (t-2) a t: Nuevos métodos para el posicionamiento del	1,0,Blanco
INCOMN4	Innovación comercialización de (t-2) a t: Nuevos métodos para el establecimiento de los	1,0,Blanco

Variables binarias: 1=Sí; 0=No; Blanco=No información

Variables categoriales con cuatro estados: 1=Alta; 2=Media; 3=Baja; 4=No relevante/no empleada; Blanco=No información

Se ha realizado un Análisis factorial exploratorio para determinar las medidas para cada uno de los constructos teóricos subyacentes (Johnson y Wichern, 2001 Hair et al., 1998). Para cada grupo, se realizo un análisis factorial (método Varimax) para descubrir la estructura latente de cada conjunto de preguntas. El análisis factorial permite reducir un gran número de variables a un número menor de factores para modelizar los efectos (Hair et al., 1998).

Las variables fueron asignadas a los factores en los que tuvieron la mayor carga. La Tabla 3 presenta la rotación Varimax de componentes principales resultado del análisis. Para mayor claridad, las puntuaciones de los factores inferiores a 0,5 no se muestran en la Tabla 1.

Tabla 2. Análisis factorial

	Componente							
	1	2	3	4	5	6	7	8
OBJET1			,789					
OBJET2			,614					
OBJET3			,795					
OBJET4			,805					
OBJET5			,710					
OBJET6	,709							
OBJET7	,744							
OBJET8	,812							
OBJET9	,809							
OBJET10	,800							
OBJET14				,843				
OBJET15				,837				
OBJET16				,739				
INORGN1							,803	
INORGN2							,816	
INORGN3							,675	
INCOMN1					,632			
INCOMN2					,785			
INCOMN3					,804			
INCOMN4					,704			
FACE1						,840		
FACE2						,840		
FACE3						,745		

FACI1		,798						
FACI2		,864						
FACI3		,841						
FACI4		,612						
OTROFAC1		,575						
OTROFAC2		,565						
OTROFAC3								,888
OTROFAC4								,888

(Varimax rotado)

KMO 0,893 Variabilidad explicada 76,37% Análisis de Componentes principales con rotación Varimax.

El análisis factorial muestra que los datos se agrupan en 8 factores que denominaremos:

Factor 1: Calidad interna relacionada con la mejora continua. Unas de los principales objetivos de la mejora continua consiste en la obtención de "ceros", cero stock, cero desperdicio,.. Alineada con esta filosofía se encuentra las acciones de mejora o de innovación destinadas a la mejora de la flexibilidad productiva, mejora de la capacidad, reducción de costes y de consumo de materiales y energía (Papadopoulos, 2011).

Factor 2: Barreras internas que afectan a la innovación y mejora continua. Este factor recoge aquellas barreras de carácter interno que están afectando a los procesos de mejora continua. Se recogen los aspectos como la falta de personal cualificado o de información. La falta de información relativa a la innovación conforma la llamada capacidad de absorción. (Hervás-Oliver, Albors-Garrigós, 2009) (Delmas et al., 2011) que junto a la mejora de las capacidades y habilidades de los trabajadores son elementos fundamentales e imprescindibles para que mantener un proceso de mejora continua sostenido en el tiempo. Por otra parte, se recoge en este factor las incertidumbres internas recogidas respecto a la información de los mercados, lo que en conjunto está determinando la visión interna de la empresa respecto a la utilización de sus habilidades para afrontar el cambio que supone el enfoque de mejora continua.

Factor 3: Calidad externa relacionada con la mejora de la calidad percibida por el cliente. Este factor recoge aspectos de innovación o mejora que pretenden mejorar la posición competitiva de la empresa recogiendo aquellas innovaciones y mejoras orientadas a mejorar la parte final de la cadena de valor de la empresa, complementando así la búsqueda de la mejora operativa productiva que recoge el factor 1. Son objetivos de la iniciativa innovadora (Davenport, 1993).

Factor 4: Mejora de la calidad laboral. Este factor recoge objetivos de mejora de la estabilidad y calidad laboral de los trabajadores como uno de los objetivos deseados del proceso de innovación (Pianta, 2003).

Factor 5: Mientras los factores anteriores recogen actitudes, este factor determina el **grado de innovaciones de tipo comercial** que efectivamente se han llevado a cabo en los últimos 2 años. Esta dinámica de adopción de innovaciones es estudiada por (Damanpour, 2001).

Factor 6: Factores externos que afectan a la innovación. Recoge los aspectos, principalmente la falta de financiación, que pueden lastrar el proceso de innovación. Al igual que ocurre en la innovación, la mejora continua requiere del apoyo de la dirección mediante la aportación de los recursos necesarios para las actividades de mejora continua: tiempo, personal y recursos económicos para realizar las mejoras. (Segarra et al., 2011).

Factor 7: Este factor determina el grado de **innovaciones de tipo organizativo** que efectivamente se han llevado a cabo en los últimos 2 años. Damanpour (2001) explica como son adoptadas las innovaciones organizativas y su relación con las innovaciones de producto.

Factor 8: Otros factores que dificultan los procesos de innovación. Refleja la actitud de la empresa respecto del proceso de cambio a través de la innovación o proceso de mejora continua. La percepción de la no necesidad de cambio, es una reconocida barrera a actividades de innovación o mejora continua y, por tanto, es un factor a tener en cuenta, ya que las innovaciones comerciales dependen también de las fuerzas del mercado (Kline, Rosenberg, 1986)

Para el análisis, teniendo en cuenta los resultados previos obtenidos en otros estudios se distinguió entre 3 grupos. Altamente orientados, medianamente orientados y poco o nada orientados. De forma que se creó una variable modificada sobre la variable objetivo11 que representa la proactividad medioambiental en la base de datos PITEC. De esta forma, la nueva variable toma el valor de 1 si es altamente proactiva (objetiv11 =1), 2 si es medianamente proactiva (objet11=2) y 3 si se trata de una empresa con baja proactividad o no proactiva (objet11=3 o 4). Estudios anteriores (Segarra et al., 20011b, Peiró-Signes et al., 2011) han demostrado que existen pocas diferencias entre los grupos 3 y cuatro y puesto que lo que se pretende es destacar cuales son las características entre las empresas que optan por una actitud proactiva y no proactiva o poco proactiva, la separación de estas dos categorías no aporta información adicional para las conclusiones de este estudio.

4. ANÁLISIS Y RESULTADOS.

Se ha realizado un test ANOVA de los factores calculados para cada una de las categorías del Objetivo11modificado antes descrito para determinar si existen diferencias significativas entre cada una de las categorías.

Los resultados muestran diferencias significativas entre los grupos para cada uno de los 8 factores extraídos. De la observación de los resultados podemos intuir que los factores con un valor de F mayor van a ser determinantes a la hora de establecer las diferencias entre los grupos, ya que este parámetro indica un mayor grado de diferenciación entre los grupos.

Por otra parte, podemos observar que el grupo 1, empresas altamente orientadas medioambientalmente, puntúan más bajo en los factores 1, 3, 4 que son factores relacionados con la proactividad y cuya codificación de respuestas (alto=1, medio=2, bajo=3, no relevante=4) permite decir que tienen un mayor grado de proactividad, ya que cuanto menor sea el valor en la respuesta (mayor proactividad) menor es el valor de la puntuación del factor, al ser ésta la representación de la posición de la observación tras normalizar la muestra según una normal de media 0 y desviación típica 1. Por otra parte, puntúan más alto en los factores 5 y 7, lo que indica que llevan a cabo un mayor número de innovaciones de tipo organizacional o comercial, es decir, que no sólo son más proactivas sino que también son más activas en la realización de innovaciones o mejoras.

Tabla 3. Análisis de medias (Anova)

		Media	Desviación típica	F	Sig.
Factor 1	Grupo 1	-0,678	0,923	1171,308	,000
	Grupo 2	-0,365	0,835		
	Grupo 3	0,417	0,881		
Factor 2	Grupo 1	0,059	0,963	20,389	,000
	Grupo 2	-0,128	0,909		
	Grupo 3	0,031	1,045		
Factor 3	Grupo 1	-0,223	0,815	198,210	,000
	Grupo 2	-0,257	0,779		
	Grupo 3	0,195	1,100		
Factor 4	Grupo 1	-0,500	1,096	658,113	,000
	Grupo 2	-0,331	0,957		
	Grupo 3	0,333	0,838		
Factor 5	Grupo 1	0,057	1,148	12,012	,000
	Grupo 2	0,064	1,103		
	Grupo 3	-0,049	0,884		
Factor 6	Grupo 1	-0,065	0,945	5,060	,006
	Grupo 2	0,000	0,942		
	Grupo 3	0,025	1,042		
Factor 7	Grupo 1	0,080	1,059	14,447	,000
	Grupo 2	0,053	1,068		
	Grupo 3	-0,053	0,942		
Factor 8	Grupo 1	0,055	0,937	3,813	,022
	Grupo 2	0,005	0,972		
	Grupo 3	-0,023	1,034		

A continuación, se desarrollo un modelo discriminante sobre la base de las ocho dimensiones relacionadas con la innovación y mejora continua y asumiendo que las empresas fueron clasificadas originalmente en tres grupos (variable dependiente) de acuerdo con la variable Objet11 modificada. La ventaja de esta técnica sobre otras como la regresión es que no realiza un ajuste de los datos para obtener la variable dependiente y, por tanto, no asume que existe una relación entre las independientes y la dependiente. De esta forma, la agrupación se realiza para incrementar el grado de varianza explicada, permitiendo la determinación de grupos diferenciados y cuales son las características que permiten diferenciar estos grupos. Posteriormente comparamos los grupos obtenidos en el análisis con la clasificación que hemos realizado en función de su proactividad medioambiental, de manera que si el grado de aciertos es suficientemente elevado, podemos concluir que las funciones y, consecuentemente, los factores que la componen, están influyendo en esta clasificación y, por tanto, en la proactividad medioambiental. La tabla muestra los coeficientes para cada una de las dos funciones discriminantes, así como lambda de Wilk y las puntuaciones medias para cada uno de los tres grupos (Hair et al., 1998).

Tabla 4. Coeficientes estandarizados de las funciones discriminantes canónicas

	Función	
	1	2
Factor 1	,846	-,271
Factor 2	,048	,752
Factor 3	,419	,510
Factor 4	,705	,050
Factor 5	-,108	-,124
Factor 6	,063	-,187
Factor 7	-,121	-,007
Factor 8	-,057	,134
Wilk's lambda	0,576 p<0,05	0,992 p<0,05
Mean scores		
Cluster 1	-1,148	,121
Cluster 2	-,732	-,144
Cluster 3	,754	,013
Varianza explicada	98,9%	1,1%

Tabla 5. Clasificacion de los resultados.

Resultados de la clasificación[a,c]

obj11mod			Grupo de pertenencia pronosticado			Total
			1	2	3	
Original	Recuento	1	**964(55,79%)**	328(18,98%)	436(25,23%)	1728
		2	604(32,39%)	**529(28,36%)**	732(39,25%)	1865
		3	210(4,72%)	363(8,17%)	**3872(87,11%)**	4445
	%	Total	1778	1220	5040	8038
Validación cruzada	Recuento	1	**956(55,32%)**	335(19,39%)	437(25,29%)	1728
		2	610(32,71%)	**522(27,99%)**	733(39,3%)	1865
		3	210(4,72%)	363(8,17%)	**3872(87,11%)**	4445
	%	Total	1776	1220	5042	8038

Clasificados correctamente el 66,7% de los casos agrupados originales.

Clasificados correctamente el 66,6% de los casos agrupados validados mediante validación cruzada.

Criterio de máxima probabilidad = 55,3%. Criterio de probabilidad proporcional= 40,58%

Como se muestra en la tabla, las funciones discriminantes fueron estadísticamente significativas basadas en lambda de Wilk ($p < 0,05$). El coeficiente para el factor 1, que se encuentra fuertemente relacionado con los procesos de mejora continua como se ha demostrado anteriormente, y el coeficiente para el factor 4, que representa uno de los objetivos fundamentales de los procesos de mejora continua, la viabilidad de la empresa y del empleo, fueron los más altos y sustancialmente más altos que los otros coeficientes de la función discriminante 1.

Después de los anteriores el objetivo de búsqueda de la calidad externa se estableció como el tercero en importancia en dicha función.

Por otro lado, la segunda función discriminante viene determinada fundamentalmente por el factor 2 y el 3, pero la variabilidad explicada por la misma es mínima 1,1% por lo que podemos concluir que los dos factores de los estudiados que influyen significativamente en la proactividad medioambiental al innovar son, la búsqueda de innovaciones internas, que está estrechamente relacionada con las actividades de mejora continua y, la búsqueda de una mejora en la estabilidad y calidad del empleo, que es un objetivo que subyace en cualquier programa de mejora continua, ya que se busca garantizar la viabilidad y la competitividad de la empresa en el largo plazo.

La Fig. 2 muestra la posición relativa de cada cluster a lo largo de los dos ejes discriminantes.

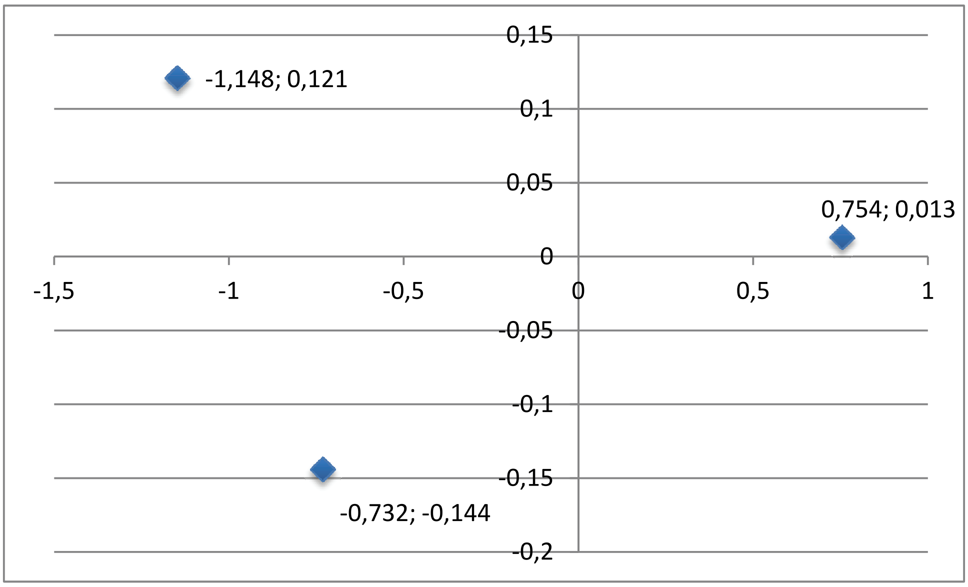

Fig. 2. Cluster a lo largo de los dos ejes discriminantes.

Además, el grupo de centroides (medias de conglomerados) para cada uno de los tres grupos difieren sustancialmente. Las puntuaciones de la función discriminante fueron estandarizadas para que la totalidad de la muestra tuviera una media de 0,00 y una desviación estándar de 1,00. Esta comparación permite diferenciar fácilmente los grupos. Por ejemplo, la media para el Grupo 1 se encuentra en el segundo cuadrante (-1.148, 0.121), para el Grupo 2 la media se encuentra en el tercer cuadrante (-0,732, -0.144), y para el Grupo 3 la media se encuentra en el primer cuadrante (0.754, 0.013).

Los centroides de grupo nos indican que el grupo 1 puntúa de media más de una desviación típica respecto de la media del conjunto de datos, lo que implica que puntúa más bajo en los factores 1, 4 y 3. Teniendo en cuenta como se construyen estos factores y que las preguntas relacionadas con los mismos tienen la siguiente codificación 1=Alta, 2=Media, 3=Baja y 4=No relevante/no empleada, resulta que las empresas del grupo 1 y 2 muestran una mayor orientación hacia las actividades de mejora continua el grupo 3. Lo anterior que queda reflejado gráficamente en la gran distancia entre los centroides de los citados grupos en el eje discriminante 1.

A pesar de que es sumamente importante contar con funciones estadísticamente significativas, también es muy importante que las funciones discriminantes tengan un buen desempeño en la clasificación de las empresas en sus grupos originales para la calibración y validación de las muestras.

En la tabla 4 se presentan los resultados de la clasificación basada en las dos funciones discriminantes. Las filas de la tabla 5B muestra la clasificación actual basada el nivel de proactividad medioambiental que muestran las empresas (objetiv11), mientras que las columnas muestran el grupo que se predijo sobre la base de las dos funciones discriminantes. Las empresas en la diagonal principal tienen predicciones correctas (en negrita), mientras que las otras celdas representan las empresas mal clasificadas.

Si cada grupo está compuesto por igual número de respuestas sin ninguna información previa adicional, uno puede asignar al azar las empresas en los tres grupos con una probabilidad de asignación correcta del 33%. En nuestro caso, puesto que las proporciones de cada grupo no son iguales, un criterio de selección proporcional se puede utilizar para evaluar la capacidad predictiva de un modelo discriminante (Morrison, 1969, Huberty, 1984, Perreault et al, 1979) y (Hair et al., 1998). El criterio selección proporcional para un modelo discriminante se puede definir como $\Sigma_i = {}_{1, K} (p_i)^2$ donde, p_i representa la probabilidad de clasificar correctamente una empresa elegida al azar se clasifican en el grupo i. Las probabilidades (p_i) se puede calcular simplemente haciendo una relación del número de observaciones por grupo con respecto al tamaño de la muestra total. Las probabilidades esperadas para los tres grupos son el 21,5%, 23,2% y 55,3% respectivamente. Por lo tanto, el criterio de selección proporcional para la muestra total permitiría acertar el 40,58% de las veces. Hair et al. (1998) recomiendan, para considerar el modelo discriminante como bueno, que la clasificación debe ser de al menos un 25% más alto que el criterio de probabilidad proporcional (1,25 x 40,58% = 50,72%). Como se muestra en la tabla 5, la exactitud de la clasificación para el modelo estimado fue de 66,7%, lo que es considerablemente superior a la directriz propuesta de Hair et al. (1998). Hay que destacar que la exactitud de la clasificación del modelo discriminante estimado es también mayor que el criterio de máxima probabilidad (la probabilidad de estar en el grupo con el mayor tamaño, grupo 3, de la muestra que es del 55,3%) (Hair et al., 1998).

Es una práctica común para validar los modelos discriminantes estimados mediante la técnica de validación cruzada (por ejemplo, U-Method o jackknifing). La principal diferencia es que el U-Method se centra en la precisión de la clasificación, mientras que jackknifing se centra en la estabilidad de las funciones discriminantes. En nuestro estudio, el propósito del análisis discriminante fue demostrar la exactitud de la clasificación y por lo tanto, se utilizó el U-Method de validación cruzada de los resultados. Los resultados se presentan en la Tabla 5 y muestran que la validación cruzada clasifica con bastante precisión y supera de nuevo el criterio de probabilidad proporcionalidad y el criterio de máxima probabilidad.

5. CONCLUSIONES

Se puede concluir que se verifica la hipótesis planteada, ya que los resultados del análisis empírico demuestran la existencia de una relación directa entre las empresas clasificadas en el grupo 1 y 2 (Alta y media proactividad medioambiental) y las actividades de mejora continua e innovación. Los factores estudiados que con influencia más directa en la proactividad medioambiental son por una parte la búsqueda de innovaciones internas y la búsqueda de una mejora en la estabilidad y calidad del empleo. El primero está estrechamente ligado con las actividades de mejora continua: actividades de reducción de consumo energético, de consumo de materiales, reducción de costes, incremento de flexibilidad y capacidad. De esta forma las empresas orientadas a realizar actividades de mejora continua muestran también una mayor orientación medioambiental, verificando la hipótesis planteada.

El segundo factor es un objetivo que subyace en cualquier programa de mejora continua. Las empresas destinan recursos a mejora continua con el objetivo de ganar competitividad y así garantizar la viabilidad de la empresa en el largo plazo. A su vez, el mantenimiento de acciones de mejora continua requieren de personal estable que conozca en profundidad los procesos y que adquiera cada vez más habilidades y competencias, siendo estas características indisolubles de cualquier sistema de mejora continua. Por tanto, en este estudio se ha comprobado que las empresas que tienen entre sus objetivos a la hora de realizar innovaciones o mejoras, el desarrollo y estabilidad de sus trabajadores, también se preocupan más por los aspectos medioambientales, verificando de nuevo la relación existente entre las actividades de mejora continua y la orientación medioambiental de las empresas.

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HOW EXPLOITATIVE AND EXPLORATIVE ALLIANCES BETWEEN FAMILIAR PARTNERS SUCCEED? REAL OPTIONS REASONING AND KNOWLEDGE-SHARING ROUTINES REDEPLOYMENT

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ABSTRACT

Existing research has not clarified *how* familiar partners can realize joint value by either exploring or exploiting technological opportunities in R&D alliances. To cover this research gap, we conduct a comparative case study on two R&D alliances, adopting a process-oriented perspective and focusing on the *redeployment* of *inter-organizational knowledge-sharing routines.* Integrating real options reasoning into the context of inter-organizational routines redeployment, this study provides some major theory-building contributions. First, familiar partners may realize joint value in both exploiting and exploring technological opportunities by abstractly conceptualizing (and thus redeploying) their routines as ambidextrous mechanisms. Second, this redeployment strategy in turn may allow them to successfully deal with the flexibility-uncertainty trade-off over time. Furthermore, heterogeneity in managerial cognition may explain heterogeneity in routines redeployment and success across alliances.

Keywords:

R&D alliances; familiar partners; exploration; exploitation; knowledge-sharing routines; redeployment

1. INTRODUCTION

R&D alliances have become essential strategic tools for firms to bring about innovation in complex environments, by providing opportunities either to leverage existing capabilities (exploitative R&D alliances) or to discover new technological opportunities (explorative R&D alliances) (Lavie, Rosenkopf 2006, Koza, Lewin 1998). By their very nature, however, R&D alliances entail high level of risk, not only concerning performance but also in relational terms (Das, Teng 1998). This situation magnifies the gap between the value potential offered by R&D alliances and the effective realization of value, being this last in turn contingent upon the capability of the partners to collaborate together (Madhok, Tallman 1998). Therefore, R&D alliances between familiar partners- those counting on a prior history of mutual interactions (Granovetter 1973, Beckman, Haunschild & Phillips 2004)- seems to offer some potential advantages. In this context, many firms resort to familiar partners for R&D collaboration, as observed in empirical literature (Hoang, Rothaermel 2005, Hoang, Rothaermel 2010, Gulati, Lavie & Singh 2009).

Due to the importance of the phenomenon, value dynamics in R&D alliances have received great scholarly attention. In the particular setting of R&D alliances formed by familiar partners, scholars have traditionally extended the conceptual arguments of the 'paradox of embeddedness' (Uzzi 1997). Thus, it has been argued that R&D collaboration between familiar partners is likely to succeed when it is exploitation-oriented, whereas familiar partners are likely to fail at exploration. On the one hand, familiar partners develop patterns of interaction out of accumulative mutual experiences which, when iteratively implemented and refined, end up in a set of shared routines that allow effective exchange of knowledge, joint work, coordination, and problem solving (Zollo, Reuer & Singh 2002). If exploitation has to do with "refinement, choice, production, efficiency, selection, implementation, execution" and involves "using currently available information to improve present returns" (March 1991: 71-72), then the stronger the routinization of inter-partner interactions, the higher the likelihood to succeed. On the other hand, scholars have argued that knowledge embodied in routines of familiar partners becomes redundant over time, hindering the flow of novel ideas and perspectives into the collaboration (Goerzen 2007). If exploration has to do with "search, variation, risk taking, experimentation, play, flexibility, discovery" (March 1991: 71) and requires "gaining new information about alternatives and thus improving future returns" (March 1991: 71-72), the stronger the routinization of inter-partner interactions, the lower the likelihood to succeed.

These arguments, so established in the theoretical literature, have not been always corroborated from an empirical standpoint. On a broad context, studies like Goerzen (2007) find that repeated alliances with the same partner decrease firm's economic performance, whereas other like Reuer, Zollo and Singh (2002) show that prior partner-specific experience increased the performance of subsequent alliances with the same partner. In the context of R&D alliances, Tiwana (2008) demonstrate that strong ties among partners facilitate knowledge integration, which in turn furnishes likelihood of successful alliance ambidexterity (i.e., concurrence of exploration and exploitation). Other studies conclude that likelihood of R&D alliance success is enhanced when novelty of resources and partners' familiarity are balanced (e.g., Gulati, Lavie & Singh 2009), whereas it has been also found that prior experience between alliance partners simply is not relevant in explaining innovation success (Hoang, Rothaermel 2005, Phelps 2010).

We argue that prior research into R&D alliances formed by familiar partners has provided such ambiguous evidence mainly because it has not directly looked at the *processes* of collaboration (Ring, Van de Ven 1994, Salk 2005). In particular, existing research has not unveiled *how* familiar partners, having already created the capability to collaborate together, leverage their mutual collaborative experience when they form new R&D alliances. As a result, it is still unknown *how* they can realize joint value in either exploring or exploiting technological opportunities. Seeking to elucidate the value dynamics of R&D alliances formed by familiar partners, this study adopts a marked process-oriented perspective and focuses on the *redeployment* of *inter-organizational knowledge-sharing routines*. Inter-organizational knowledge-sharing routines are one of the most important constituent elements of the partners' capability to collaborate together (Zollo, Reuer & Singh 2002) and can be defined as *recurrent patterns of inter-partner interactions that, when effective, permit the mutual transfer, recombination and/or creation of specialized knowledge in the alliance* (Dyer, Singh 1998, Dyer, Nobeoka 2000). Adapting the concepts of bilateral resource redeployment (Capron, Mitchell 1998) and capability redeployment (Helfat, Peteraf 2003) to our research context, we define redeployment as *the process by which familiar partners jointly transfer the inter-organizational knowledge-sharing routines they have created through their accumulated mutual experiences into a new joint collaborative scenario*. Therefore, we formulate our research question in the form of *how familiar partners realize joint value by redeploying their knowledge-sharing routines in both exploitation- and exploration-oriented alliances?* To address this research question, we conduct a longitudinal comparative case study on two successful R&D alliances, both formed by familiar partners with long histories of prior interactions but with different formal innovation-seeking orientation (one exploitation-oriented and the other exploration-oriented).

Adopting an inductive theory-building approach (Eisenhardt 1989), our data shows that familiar partners redeploy their knowledge-sharing routines following real options reasoning (Kogut, Kulatilaka 2001, Myers 1984). This study thus contributes to elucidate the value dynamics of R&D alliances formed by familiar partners by bridging the literatures of inter-organizational routines redeployment and real options. To that end, we conceive R&D alliances between familiar partners as platforms of embedded collective real options (Kogut 1991, McCarter, Mahoney & Northcraft 2011), relying on the conceptualization of strategy as a chain of real options (Bowman, Hurry 1993) and tracing the analogy between the exploration-exploitation of collaborative opportunities and the acquisition-exercise of collective real options. As Kogut and Kulatilaka (2001) stress, framing capabilities (and thus routines) as real options, guides the interpretation of the learning balance between exploitation and exploration. Our study shows that familiar partners may realize joint value in both exploiting and exploring technological opportunities by abstractly conceptualizing (and thus redeploying) their routines as ambidextrous mechanisms, allowing them to deal with the flexibility-uncertainty trade-off over time. Furthermore, our study points to managerial cognition as the root of heterogeneity in both routines redeployment and realization of joint value across alliances.

The remainder of the study is organized as follows. Next section presents the research design and methodology of the study, providing a description of the two alliances under study. We then moved on to the analysis of the cases, presenting quantitative and qualitative evidence. Then, we elaborate further on this evidence and discuss the theory-building contributions of the study. Finally, we present the main conclusions, implications and limitations of the study, as well as some avenues for further research.

2. RESEARCH DESIGN AND METHODOLOGY

2.1. Research Design and Cases

This study aims at inductive theory-building to explain how familiar partners can successfully realize joint value in both exploitative and explorative R&D alliances. To that end, we study longitudinally and comparatively two real-life R&D alliances developed in the course of a larger R&D consortium (i.e., The Acuisost Consortium), labeled CAH-LF and MAR-LF alliances (see Table 1).

This research design can be considered appropriate for two main reasons. First, existing evidence is contradictory and ambiguous (Eisenhardt 1989) and, in particular, it is still unknown how familiar partners can successfully redeploy their knowledge-sharing routines in the different context of innovation-seeking collaboration. Second, case study matches the nature of our 'how' research question, which deals with links between collaborative processes and its context (Yin 2003), mobilizing multiple observations on complex relational processes which need to be traced longitudinally over time (Langley 1999).

The two studied alliances were selected as our research setting following *theoretical sampling criteria* (Eisenhardt 1989, Yin 2003). First, both of them are R&D alliances formed by familiar partners, thus they are representative of the phenomenon under consideration. As explained by LF's R&D Manager in several interviews, the CAH (Center for Animal Health) and the MAR (the Research group on Marine Resources) were, at the inception of the Acuisost Consortium, the main "lifelong technological partners" of the LF. Second, both studied alliances were formed within the same larger context (i.e., The Acuisost Consortium) by the same firm- the lead firm of the consortium (LF) - and two different research organizations (RO) -the CAH and MAR. That allows reliability in comparison, minimizing the risk of extraneous variation (Eisenhardt 1989, Yin 2003). For example, the formal contracts in the two alliances were highly similar. Furthermore, firm-RO alliances between familiar partners offer an adequate setting for studying not only exploitation but also exploration (i.e., applied technological capabilities *vs*. basic science capabilities, property intellectual protection *vs*. open science philosophy, short-term problem-solving *vs*. long-term curiosity-driven research) (Lacetera 2009, Bercovitz, Feldman 2007).

Table 1. Main characteristics of the CAH-LF and MAR-LF alliances

	CAH-LF Alliance	**MAR-LF Alliance**
Familiar partners	• Center for Animal Health (CAH) • Lead firm of the A.Consortium (LF) • Collaboration from 1990	• Research group on Marine Resources (MAR) • Lead firm of the A.Consortium (LF) • Collaboration from 2000
Innovation-seeking orientation (formal contract) **Technical objectives** **Horizon, Budget**	• Exploitation • Developing on an industrial scale a (previously explored) new pathogen-detection methodology • 4 years, 220.000€	• Exploration • Obtaining vegetable proteins from macro-algae and analyzing their applicability for fish feed production (new research line for the partners) • 4 years, 159.236€
Joint realization of value	Success	Success
Key informants (partners' representatives)	• CAH's Head (Head researcher of the alliance) • LF's R&D Manager (responsible for the alliance)	• MAR's Head (Head researcher of the alliance) • LF's R&D Manager (responsible for the alliance)

To ensure rich variability in the phenomenon of interest, we followed the criterion of 'polar cases' (Eisenhardt 1989) concerning the formal (contractual) innovation-seeking orientation of the alliances (exploitation in the CAH-LF alliance and exploration in the MAR-LF alliance). Existing literature suggests that the process of knowledge-sharing routines redeployment may vary according to the innovation-seeking orientation: "The mindsets and organizational routines needed for exploration are radically different from those needed for exploitation" (Gupta, Smith & Shalley 2006).

We follow the recommendations of Pettigrew (1990) and Pentland (1999), structuring our research efforts on two subsequent phases that went from surface to deeper levels of data collection and analysis. During the first phase (April 2008- October 2010), we collected overall information. This study emerged from a larger ongoing research project on the Acuisost Consortium. Although the first phase of data collection was not aimed specifically to compare the CAH-LF and MAR-LF alliances, it provided large corpora of relevant data to that end. For example, in this phase we obtained access to both primary and secondary data sources, which provided information about objectives and actors involved in all the firm-RO alliances of the consortium (e.g., consortium's report, consortium agreement). Similarly, interviews with the LF and direct observation in some consortium committees, informed us about the ongoing evolution of these alliances. All this information led us to consider inter-organizational knowledge sharing as an important explanatory factor of the rate of success of the firm-RO alliances of the consortium.

During the second phase (October 2010-September 2011), to confirm our first impressions, we started with exploratory interviews with the LF's R&D Manager, as well as with several partner firms and ROs involved in the consortium (October 2010). On the basis of this information, we selected the CAH-LF and MAR-LF alliances, following criteria above explained. At the same time, we reviewed relevant literature to decide the theory-driven variables on which the study would focus (i.e., inter-organizational knowledge-sharing routines and joint realization of value, whose operationalization is explained below). After one more exploratory interview with the LF's R&D Manager (February 2011), we started collecting specific information about the CAH-LF and MAR-LF alliances. In particular, data was collected retrospectively through semi-structured interviews in the form of face-to-face surveys (Yin, 2003), conducted between May and July of 2011 with key informants of both partners in each alliance (i.e., two interviews with the LF's R&D Manager, one interview with the CAH's Head and one interview with the MAR's Head). Interviews had an average length of 1.5 hours, were recorded and then transcribed by the two interviewers involved, and were not conducted under a rigid question-answer format. Informants were also asked to provide information about the longitudinal evolution of the alliance (e.g., details, anecdotes, milestones, and examples) as well as to justify their responses. This retrospective data collection strategy allowed us to deal with data-reduction dilemmas, generate 'customized' items, collect process data and avoid self-respondent biases by fulfilling the principle of triangulation (Yin 2003, Langley 1999).

Data analysis started with the reconstruction of the history of the two studied alliances, combining information from interviews and other data sources. Next, an extensive case study report for each alliance was wrote, containing a lot of citations from interviews and documents to stay very close to the original data and thus achieve accuracy (Langley 1999). Subsequently, we analyzed data through an inductive approach (Rerup, Feldman 2011), involving iterative discussions between the three researchers of the study. Based on the case study reports, we moved from raw data to first-order constructs (see narratives in next section) and subsequently from them to second-order constructs, linking data with theoretical concepts, arriving at comprehensive explanatory framework for addressing the research question of the study (see discussion of findings).

2.2. Operationalization of Theory-Driven Variables[32]

2.2.1. Inter-organizational Knowledge-Sharing Routines

The literature into organizational routines offers few clues as to how to operationalize properly the concept of routines (Becker 2004, Becker 2005). This deficiency extends to the inter-organizational context. In particular, knowledge-related issues in alliances not always have been addressed explicitly from a routines-based perspective (e.g., Mowery, Oxley & Silverman 1996) and, even when this has been the case (e.g., Zollo, Reuer & Singh 2002), not all employed measures can be considered appropriate[33]. In this context, we come back to the concepts of organizational and inter-organizational routines (Zollo, Reuer & Singh 2002, Zollo, Winter 2002), as well as those available empirical measures that better suit our research purposes.

We identify three dimensions to characterize the process of redeployment in each alliance, and asked informants about them: *frequency* [frequency of contact maintained between the firm and

[32] Further details on operationalization of variables are available upon authors' request.

[33] For example, Zollo et al. (2002) 'deduce' the existence and magnitude of inter-organizational routines by demonstrating a link between prior collaborative experience between partners and alliance superior performance. Other attempts to capture knowledge sharing or knowledge- related issues in collaborative settings range from dummy variables capturing whether knowledge flows exist between two actors (e.g., Tsai, 2002; Hansen, Mors & Lovan et al. 2005) through quantitative measures reflecting the costs associated to the search and transfer of knowledge from the partner (e.g., Hansen et al., 2005).

the RO during the development of the alliance, both face-to-face and by email and phone, as well as formal and informal (Sarkar, Aulakh & Madhok 2009, e.g., Becerra, Lunnan & Huemer 2008)], *intensity* [extent to which both knowledge in-flows and out-flows occurred between the firm and the RO, including technological, managerial and market knowledge (e.g., Simonin 1997, Sammarra, Biggiero 2008)], and *willingness* [extent to which involved actors proved themselves willing to engage in knowledge sharing, including flexibility to facilitate knowledge sharing and proactiveness to both transfer and receive knowledge (e.g., Hamel 1991, Simonin 2004)]. Furthermore, to capture whether redeployment of knowledge-sharing routines proved effective, we asked informants about their *effectiveness* [perceived relative absorptive capacity or extent to which the firm and the RO were increasingly able to recognize and value, assimilated, and apply new knowledge from the other party (e.g., Lane, Lubatkin 1998, Dyer, Hatch 2006)].

2.2.2. Alliance Success (Joint Value Realization)

Based on prior literature into strategic alliances in general (Parkhe 1993, Ariño 2003, Glaister, Buckley 1998) we identify several dimensions of value creation that accommodates the value-creation dynamics of R&D alliances (e.g., Gulati, Lavie & Singh 2009) and firm-RO alliances (e.g., Mora-Valentín, Montoro-Sánchez & Guerras-Martín 2004). To capture joint realization of value at the technological level, we asked informants to rate on a five-point Likert scale (1) the *degree of fulfillment of the technical objectives* of the alliance and (2) the extent to which a *full innovation* had been achieved, as well as to clarify (3) whether a *patent* has been achieved, and/or (4) whether scientific *publications* had been developed focusing on the results/processes of the focal project. To capture joint realization of value at the relational level, we asked informants to rate on a five-point Likert scale the extent to which the alliance had provided them with (1) *new collaborative opportunities* and/or (2) *new business opportunities*, the extent to which the alliance had enhanced (3) their *image and reputation* and (4) their *organizational capability to collaborate* with other organizations, as well as (5) to value their agreement/disagreement with several assertions about the *continuity of the relationship* with the partner of the focal alliance. In particular, (a) whether new join collaborations had been agreed, and (b) if not, whether future collaboration was perceived as probable/improbable; (c) if so, whether future collaboration would address the same or new research lines). Furthermore, as an integrative dimension capturing value at both relational and technological levels (Ariño 2003), we asked informants to rate on a five-point Likert scale the degree of *overall satisfaction* they had gained with the focal alliance (explicitly asking them to consider both the achieved outcomes and the relationship developed between the partners).

3. ANALYSIS OF THE CASES: THE CAH-LF AND MAR-LF ALLIANCES

In this section, we provide a detailed description of the two alliances under study. For each of them, we first describe the history of the relationship between the two familiar partners (represented in Figure 1 and Figure 2, respectively). Subsequently, we present their collaboration under the Acuisost Consortium and provide quantitative and qualitative data on the process of redeployment of their knowledge-sharing routines and joint realization of value.

3.1. The CAH-LF Alliance

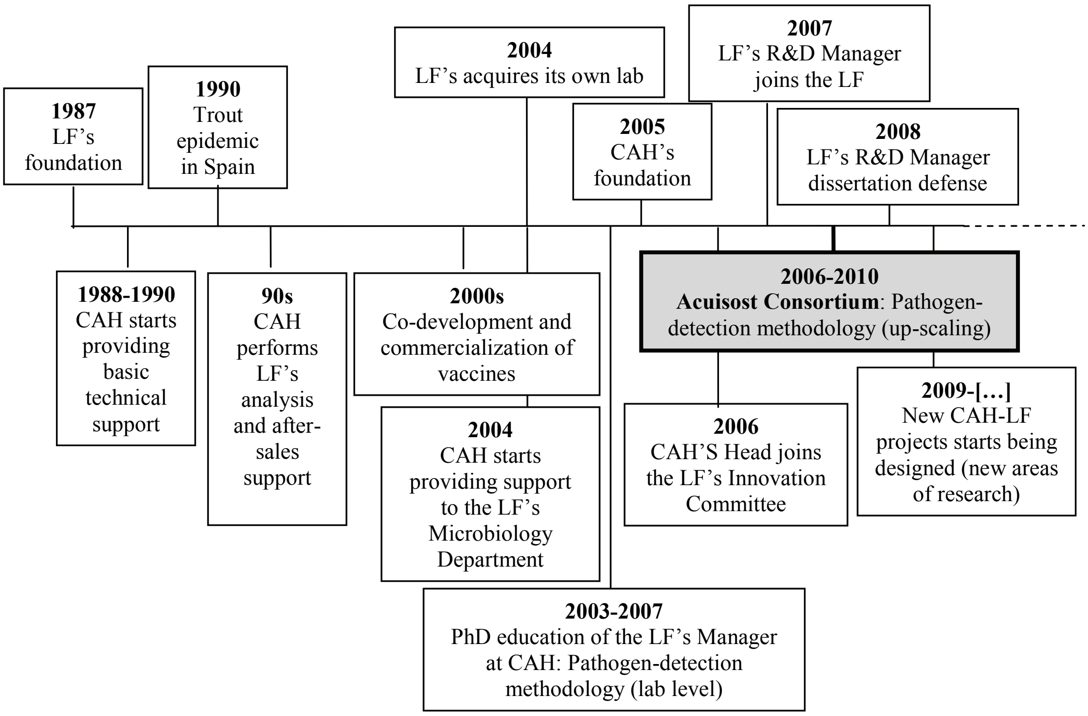
3.1.1. The History of the CAH-LF Relationship

The relationship dates back to late 80's, when the LF was still a start-up (it was formally founded in 1987) and the CAH did not exist as such (it was formally founded in 2005). Contact started on a personal level between the current Head of the CAH (who had been appointed full professor in 1988 and was leading the research group germ of the center) and two current executives and founders of the LF, who had obtained their degree in veterinary medicine in the school to which CAH is affiliated:

> "…the firm had recently been brewed, they needed basic technical support and started looking for it in our School […] Empathy emerged between us and we start collaborating together, at first in a very modest way" (CAH's Head)

In the 90's, an epidemic arose devastating the trout production of the country (the main aquaculture species at that time), becoming endemic from them. At that time, the LF did not possess its own microbiological laboratory yet, CAH conducting all microbiological analysis of the LF and providing support and after-sales services to the LF's clients. This working methodology paved the way to co-develop a strong vaccine, which the LF successfully sold to their clients during subsequent years, involving important financial flows for both partners and the institutionalization of their collaborative relationship.

Figure 1. Main milestones in the CAH-LF relationship



From then on, the partners continued collaborating together, tying different kind of projects over time and gradually increasing the complexity of their collaborative initiatives. In the words of the LF's R&D Manager "CAH played the role of R&D unit" of the LF during those years. As the LF's technological infrastructure consolidated, the services provided by CAH became "more sophisticated". For example, once the LF built its own microbiological analysis in 2004, CAH started providing technical support to the LF's Department of Microbiology and Illness Diagnosis in all those themes which the firm was not able to do by itself, as explained by the CAH's Head, due to "technological complexity or excessive costs".

In explaining the CAH-LF collaborative relationship the PhD education of the LF's Manager should be mentioned. Having obtained his degree in the School of Veterinary Medicine to which CAH is affiliated, the current LF's R&D Manager occupied a PhD position in the CAH (period 2003-2007) under the supervision of the CAH's Head (dissertation defense in 2008). From the interviews we identify to reasons underlying the importance of this milestone. First, the doctoral dissertation is directly related with the CAH-LF collaboration under the Acuisost Consortium. When the opportunity to lead the consortium came to the LF (November 2006) it offered CAH to collaborate, and both partners agreed extending the research undertaken in the doctoral dissertation of LF's R&D Manager into the industrial level. Second, the LF is a family-owned enterprise and the LF's R&D Manager, as a family member, always wanted to work in the LF. His PhD education thus was understood as a "training period prior to joining the firm" (starting in 2007 as manager of the Acuisost Consortium and getting promoted to R&D Manager in 2009). In particular, the doctoral dissertation of the LF's R&D Manager focused on developing, based on the knowledge created in reaction to the above mentioned epidemic, a new pathogen-detection methodology at the lab level. Indeed, as can be read in the dissertation acknowledgment writings of LF's R&D Manager, arguing that aquaculture would be the LF's business area of strongest development:

> "… (the CAH's Head) changed my vocation and convinced me to specialize in the exciting field of aquaculture"

In parallel to other specific research projects, including thus the collaboration under the Acuisost Consortium, the CAH's Head played the role of external technical advisor in the LF's Innovation Committees which, implemented in 2006 as a part of the technological sophistication process in the LF, were held yearly to design the firm's innovation strategy for next year. Furthermore, concurrently to the Acuisost Consortium, the partners started to design new joint projects extending their collaboration, which had focused on aquaculture biosecurity so far, into the areas of aquaculture nutrition and pet biosecurity.

Both the CAH's Head and the LF's R&D Manager stress during the interviews that the CAH and the LF had developed along their collaborative trajectory a strong value-creating relationship characterized by the values of mutual benefit, trust and long-term orientation. Likewise, these values extended to the relationship between the CAH's Head and the LF's R&D Manager on a personal level[34]:

> "The relationship is strategic […] it has allowed us to link our scientific area of expertise with the aquaculture field in the academic arena […] CAH became a center of reference in research […] the LF has become an important multinational company, CAH has had to do in this process […] I directly supervised all the projects with the LF, they have priority […] we strive to preserve the relationship […] my personal relationship with the LF's R&D Manager is simply excellent […] he is an important asset of the LF (CAH's Head)

> "The CAH is and will remain our *star* research center […] the CAH and the LF have grown together […] The CAH's Head is a leading scientific in Spain, he was appointed professor at his 29! […] he is a friend of the LF in general and of mine in particular" (LF's R&D Manager, interview) "….I would like to thank the CAH's Head for his encouraging friendly orientation […] I hope our collaboration continue in this new

[34] We directly observed some conversations between the CAH's Head and the LF's R&D Manager, finding clear indicators of their good relationship (e.g., relaxed tone, jokes, and questions about personal life).

stage, it is not easy to find people like you" (Acknowledge writings, LF's R&D Management Doctoral Dissertation)

3.1.2. CAH-LF Collaboration under the Acuisost Consortium

The CAH-LF project extended an existing research line in aquaculture biosecurity by "developing on an industrial scale a new pathogen-detection methodology" (Source: alliance's report). The CAH-LF alliance thus was markedly exploitation-oriented. From the interviews we know that, in parallel with this project, partners started preliminary experiments in other areas, which ended up in two new joint projects.

The following two tables summarize our quantitative and qualitative data on knowledge-sharing redeployment (Table 2) and joint realization of value (Table 3) in the CAH-LF collaboration under the Acuisost Consortium.

Table 2. Redeployment of the CAH-LF's knowledge-sharing routines

Knowledge-sharing dimension		LF	CAH	Aggregated (1-3 Scale)	Illustrative interview quotes
Frequency of contact	• Frequency of contact (e-mail, phone)	5	5	5 (High)	"… contact by email and phone almost on a daily basis, meetings are also held when needed" (LF's R&D Manager)ñ "…communication flows fluently in the two directions, especially by email and phone, once a week at a minimum" (CAH's Head)
	• Frequency of contact (face-to-face)	4	5	4.5 (High)	
Willingness to share knowledge	• Flexibility	5	5	5 (High)	"… they are more flexible than us, they adapt to our agenda" (LF's R&D Manager) "…the LF's availability has reduced as it has grown, but what is important always fits in their schedule […] we meet wherever, even in the LF's clients facilities if needed " (CAH's Head)
	• Proactiveness to share knowledge	5	4	4.5 (High)	"… when we pose a problem, they study it and always offer us a solution" (LF's R&D Manager) ...we adapt to the LF's necessities and the LF's adapt to ours [...] they rely on our expertise and follow our advice […] when an information need arises, we ask them openly [...] we discuss a question as much as needed until consensus is reached, if one party disagrees, it is not carried out (CAH's Head)
	• Proactiveness to receive knowledge	5	4	4.5 (High)	
Intensity of knowledge sharing	• Technological knowledge in-flows	5	5	5 (High)	"… they put all their technological knowledge at our disposal […] Sometimes they have provide us relevant market knowledge, for example, about new product development trends […] The transfer of managerial knowledge is not relevant (LF's R&D Manager) "…technological information flows have been and still are highly intense in both directions […] LF's technological process […] this technical knowledge has allowed us to know the national aquaculture market […] it is not possible to extrapolate a firm's managerial model to our context" (CAH's Head)
	• Market knowledge in-flows	3	4	3.5 (High)	
	• Managerial knowledge in-flows	1	2	1.5 (Medium)	
Effectiveness in knowledge sharing	• Value and recognize new knowledge	5	5	5 (High)	"…we use the same language. After all, *I come from* CAH […] mutual understanding allows us to arrive at important achievements […]research at the CAH reflects into our activities" (LF's R&D Manager) "…We are a *tool* of the LF. We acquire knowledge from the LF to find out its necessities, then we assimilate and apply this knowledge into our research […] we in turn transfer knowledge we generate to the LF, which finally applies it in its products and processes […] " (CAH's Head)
	• Assimilate new knowledge	5	5	5 (High)	
	• Apply new knowledge	5	5	5 (High)	

Note: Highlighted in grey values for subsequent cross-case comparison. Percentage of agreement [calculated as % of (Rates of Informant $_{LF}$ = Rates of Informant $_{CAH}$)/ Total No. rates] = 55%. Average disagreement [calculated as |(Rates of Informant $_{LF}$- Rates of Informant $_{CAH}$|)/ Total No. different rates]= 1

Table 3. Joint value realization between the CAH and the LF

Join value dimensions		LF	CAH	Aggregated (1-3 Scale)	Illustrative interview quotes/data
Innovation	• Degree of fulfillment of technical objectives	4	4	4 (High)	"… initial technical objectives have been fulfilled to a 80% degree, the main part of the process was completed earlier than planned and then because we started doing other interesting things" (LF's R&D Manager) "… the objectives that we initial considered for this project have been met to a 80% degree, some tasks have been changed, others removed […] changes are needed in any R&D project, working in something that will not be useful for the firm does not make sense for us" (CAH's Head)
	• Full innovation	3	3	3 (Medium)	[Both informants agreed that a full innovation occurs when results are "industrially applied to commercial ends"] "… it is not a full innovation because we have not already started commercializing it, but we consider to do it in the near future […] it is not worth patenting it" (LF's R&D Manager) "…results achieved are included in the category of 'results that are not worth patenting' […] many times firms prefer not patenting as a mean of protection or simply because it is not a profitable investment" (CAH's Head)
	• Patent	1	1	1 (Low)	
	• Publications	3	4	3.5 (High)	"… we have developed important academic results, some publications are co-authored by the LF's R&D Manager, but it is difficult to say that they came strictly from the Acuisost Consortium, maybe come from our relationship with the LF in general" (CAH's Head)
Other goals	• New collaborative opportunities	5	2	3.5 (High)	"…CAH have provided us many new opportunities overtime, and I am sure CAH will remain providing them to us […] if they cannot provide us a solution, they search among its network of contacts and remit us to another research center […] they have put us in contact with some organizations of other fields with which they previously collaborated and with which we currently collaborate too […] CAH is key to us because its multidisciplinary activity " (LF's R&D Manager) "… our relationship with the LF is strategic and the aquaculture sector knows it […] it has provided a lot of opportunities overtime […] we collaborate with most of the LF's client firms but none of the LF's competitors has asked us our services […] advantages outperform disadvantages" (CAH's Head)
	• New business opportunities	5	2	3.5 (High)	

Join value dimensions		LF	CAH	Aggregated (1-3 Scale)	Illustrative interview quotes/data
	• Image and reputation	3	2	3 (Medium)	[Both informants considered that the Acuisost Consortium in general has been a more important source of image and reputation than the CAH-LF collaboration in the Acuisost Consortium in particular]
	Satisfaction	5	4	4.5 (High)	"… highly satisfactory, as usual" (LF's R&D Manager) "… we can say 'total satisfaction', concerning not the Acuisost Consortium but our relationship in general" (CAH's Head)
Continuity	• No join projects, but probable	1	1	1 (Low)	The MAR and the LF decided not to commit more resources by the moment in the industrial implementation (up-scaling) of this methodology. Before their collaboration under the Acuisost Consortium finished, the two partners started experimenting in new areas (aquaculture nutrition and pet biosecurity) and agreed two new joint projects for future (, one of them with MAR). Both informants took for granted the continuity of their collaboration beyond the Acuisost Consortium and considered that "this research line is exhausted, nothing else can be get from it" (LF's R&D Manager)
	• No join projects, and improbable	1	1	1 (Low)	
	• New join projects, the same lines	1	1	1 (Low)	
	• New join projects, different lines	5	5	5 (High)	

Notes: Highlighted in grey values for subsequent cross-case comparison. Percentage of agreement [calculated as % of (Rates of Informant $_{LF}$ = Rates of Informant $_{CAH}$)/ Total No. rates] = 58%. Average disagreement [calculated as |(Rates of Informant $_{LF}$- Rates of Informant $_{CAH}$|)/ Total No. different rates]= 1.8

3.2. The MAR-LF Alliance

3.2.1. The History of the MAR-LF Relationship

Although the MAR and the LF started collaborating together in 2000s, the origins of the relationship date back to late 80's, when the MAR's Head held the position of Production Manager at an aquaculture company. As a result of their respective professional activities (e.g., business associations meetings, trade fairs, the Annual National Conference on Aquaculture), he entered into personal relationships with several current LF's actors (i.e., the General Managers of Iberian Eels and Mediterranean Aquaculture- two fish producer firms affiliated to the LF's corporate group-, as well as with the of the LF themselves). Indeed, the Iberian Eels' General Manager and the MAR's Head described each other in the interviews as his "best (personal) friend"[35]. Subsequently, the MAR's Head changed its career towards the academic world, founding the MAR research group. Shortly after, MAR started collaborating with Iberian Eels

[35] We interviewed the Iberian Eels' General Manager in other data collection stages of this doctoral dissertation.

and Mediterranean Aquaculture, providing them technical support to extend their production facilities and to achieve official environmental accreditations.

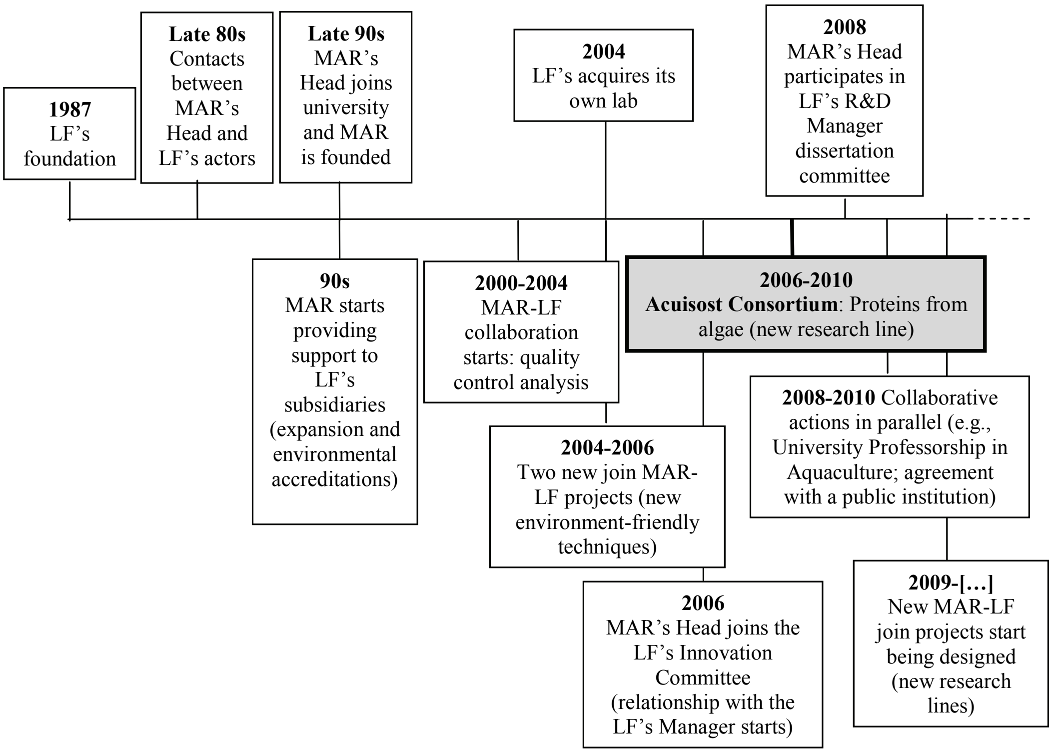
In 2000, direct collaboration between the MAR and the LF started in the area of quality control. At that time, the LF did not possess yet its own quality control equipment and thus MAR performed the related analysis. Such a collaborative scope remained like that until 2004 when, following the advice of the MAR's Head, the LF invested in its own quality control equipment:

> "… a firm like the LF, at that time in process of technological growth, needed its own quality control equipment […] one may think that it would damage the MAR's interests in the short term but the fact is that the long-term effects would be rather the opposite: it opened us the opportunity to address together many other areas" (the MAR's Head)

Indeed, our data confirm the reasoning of the MAR's Head. In the following two years (2004-2006), the MAR and the LF undertook two new research projects to experiment with new environmental-friendly techniques, denoting increasing sophistication in the collaboration. In addition, the MAR's Head started acting as external technical advisor in the LF's Innovation Committees in 2006. Furthermore, when the opportunity to lead the Acuisost Consortium came to the LF (November 2006) and it offered MAR to collaborate, MAR proposed taking the leap in aquaculture nutrition, experimenting with algae that represented potential sources of proteins new for both organizations. Sounding appealing to the LF, the two organizations jointly elaborated further on this idea until arrive at the definitive research proposal:

> "….proteins from algae may represent a nutritionally viable less costly and sustainable alternative for fish-based proteins […] There are a lot of scientific studies and there are also some established commercial products […] the most innovative aspect (of the MAR-LF project in the Acuisost Consortium) is its focus on macro-algae available in the domestic market (farmed in Spain, instead of imported)" (Source: alliance's report)

Figure 2. Main milestones in the CAH-LF relationship



In parallel with the development of the Acuisost Consortium, the MAR and the LF engaged in some other collaborative actions. In December 2009, both organizations launched a University Professorship in Aquaculture, managed by the MAR's Head and sponsored by the LF. Also in 2009, both organizations signed a collaboration agreement with the Spanish Ministry of Environment and Rural and Marine Affairs to develop a guide for aquaculture practices (published by the public institution in 2010).

Similar to the CAH- LF case, both the MAR's Head and the LF's R&D Manager stress during the interviews that both organizations had developed along their collaborative trajectory a strong value-creating relationship characterized by the values of mutual benefit, trust and long-term orientation:

> "… they know we will not cheat and vice versa […] Perhaps I am not an Einstein but the LF's R&D Manager knows that I will make all effort to provide them useful results […] derived benefits are reciprocal […] all of this keeps up together […] the LF's R&D Manager possess important technical capacities […] it is easy for both of us to collaborate together" (MAR's Head)

> "… he is a good technician and a better strategist, simply a business man […] we really get on well with each other MAR provided us interesting business opportunities […]

> the MAR's Head have launched many initiatives with an important impact on the image of the firm" (LF's R&D Manager)

Unlike what occurred in the CAH-LF case, the professional collaboration between the MAR's Head and the LF's R&D Manager started with the Acuisost Consortium. However, the first contacts between them took place in 2006. The LF's R&D Manager, still holding a PhD position in the CAH, was also invited to the 2006 LF's Innovation Committee as external advisor (in view of his forthcoming incorporation in 2007). Subsequently, the MAR's Head was also invited to participate as external examiner to the defense of the LF's R&D Manager doctoral dissertation (July 2008). Informants confirmed that the strong bonds existing between their organizations acted as an important starting point to gradually build a harmonious, empathy- and trust-based relationship on a personal level.

3.2.2. MAR-LF Collaboration under the Acuisost Consortium

As advanced, the MAR-LF project addressed a research line totally new for both organizations related to the improvement of aquaculture nutrition. In particular, it aimed at "obtaining vegetable proteins from macro-algae and analyzing their applicability for fish feed production" (Source: alliance's report). Therefore, it can be said that the MAR-LF collaboration under the Acuisost Consortium clearly was exploration-oriented. However, the LF's R&D Manager explained in an interview that a shift towards exploitation was envisaged by both partners:

> "…it was not about to discover new knowledge for the sake of discovering, but for extending it into the industrial front someday" (LF's R&D Manager)

The following two tables summarize our quantitative and qualitative data on knowledge-sharing redeployment (Table 4) and joint realization of value (Table 5) in the MAR-LF collaboration under the Acuisost Consortium.

Table 4. Redeployment of the MAR-LF's knowledge-sharing routines

Knowledge-sharing dimension		LF	MAR	Illustrative interview quotes
Frequency of contact	• Frequency of contact (e-mail, phone)	4	5	"… contact by email and, particularly, by phone is quite frequent […] we meet together whenever possible " (LF's R&D Manager)
	• Frequency of contact (face-to-face)	4	3	"…communication with the LF's Manager is effective and fluent, by phone and email, and phone once a week at a minimum […] we have also meetings, quite but obviously less frequently " (MAR's Head)
Willingness to share knowledge	• Flexibility	5	5	"… MAR shows total flexibility in this regard " (LF's R&D Manager) "...we must adapt to the LF's necessities [...] try to be totally flexible […] meetings whenever and wherever they can (MAR's Head)
	• Proactiveness to share knowledge	4	4	"… MAR's Head shows always proactive to give us information […] important decisions by consensus" (LF's R&D Manager) "...we listen the LF's necessities that act as the guide for our actions to try to provide them a solution […] the LF's R&D Manager know that if I recommend him something is thinking in the firm's interests, it is also beneficial for the MAR in the long-term […] the LF's is always transparent with us, providing all the information we require to provide them solutions" (MAR's Head)
	• Proactiveness to receive knowledge	4	4	
Intensity of knowledge sharing	• Technological knowledge in-flows	3	3	"… they especially provided us relevant market knowledge […] technological knowledge generated in this project has been relatively simple […] exchange of managerial knowledge is not significant" (LF's R&D Manager) "…technical knowledge always flows without obstacles between the two parties […] intensity depends on the characteristics of the project at hand […] I already knew the aquaculture market when we started with algae […] our experience in the consortium has served us to confirm our ideas on how to collaborate with firms: flexibility and useful solutions" (MAR's Head)
	• Market knowledge in-flows	5	3	
	• Managerial knowledge in-flows	2	4	
Effectiveness in knowledge sharing	• Value and recognize new knowledge	4	4	"…the LF resort to us because it needs solutions […] we understand it and do real applied research […] if the LF do not develop new products from the consortium, it will make no sense […] the most important thing in collaboration is always the personal relationship, and we understand each other perfectly" (MAR's Head)
	• Assimilate new knowledge	4	4	
	• Apply new knowledge	4	4	

Notes: Highlighted in grey values for subsequent cross-case comparison. Percentage of agreement [calculated as % of (Rates of Informant $_{LF}$ = Rates of Informant $_{MAR}$)/ Total No. rates] = 55%. Average disagreement [calculated as |(Rates of Informant $_{LF}$- Rates of Informant $_{MAR}$|)/ Total No. different rates]= 1.17

Table 5. Joint value realization between the MAR and the LF

Joint value dimension		LF	RO	Illustrative interview quotes/data
Innovation	• Degree of fulfillment of technical objectives	5	4	"…although at the beginning we had some unexpected problems delaying the project, we rapidly solved them and from then on the project progressed at a quite good pace, the whole project being completed earlier than planned" (LF's R&D Manager) "…the objectives initially established to this project has been met to an acceptable degree, there have been some deviations but be expected in any R&D project. On a technical level, results are very interesting: we have confirmed the viability of algaes ("MAR's Head)
	• Full innovation	3	3	[Both informants agreed that a full innovation occurs when results are "industrially applied to commercial ends"] "… (to achieve full innovation) it would be required to build a new production plant (to avoid transportation costs) […] the current economic situation discourages the LF from investing in it now" (LF's R&D Manager) "… a full innovation has not been achieved insofar the costs of the last step (transportation) render the whole process unviable" (MAR's Head)
	• Patent	1	1	"… it is not worth to patent the results we have achieved […] results are very interesting but the process is relatively simple […] if a competitor started experimenting and arrived at the same results, we would be ready to invest immediately" (LF's R&D Manager) "… it is not about patenting for the sake of patenting […] you can invent something totally new but totally useless" (MAR's Head)
	• Publications	1	1	"… MAR never publishes results from ongoing projects. Now that the project is finished, we start considering with the Lf if we can published something […] I will supervise the doctoral dissertation of a employee of the LF's marketing staff" (MAR's Head)
Other goals	• New collaborative opportunities	4	5	Both informants described other results that they perceived to be mutual benefits coming from their collaboration under the Acuisost Consortium, even though these results were not directly related to their project under the Acuisost Consortium: • New lines of research • Creation of an university professorship in aquaculture sponsored by the LF and managed by the MAR Head • A collaboration agreement with the Spanish Ministry of Environment and Rural and Marine Affairs

Joint value dimension		LF	RO	Illustrative interview quotes/data
	• New business opportunities	5	5	• Creation of a new aquaculture business non-profit association • Creation of a university laboratory with cut-edge environment-friendly technology • Actions of occupational integration of people with disability in aquaculture firms "… the MAR's Head has launched several initiatives like the professorship or the new lab enhancing the image of our firm […] the LF profits from the important network of institutional contacts of the MAR's Head […] (he) put me in contact with an Egyptian firm with which we have signed a collaboration agreement" (LF's R&D Manager)
	• Image and reputation	5	5	"…the Acuisost Consortium has provided us important opportunities in terms of growth […] it has been an important milestone for MAR's image […] we have extended our network of contacts with new firms and colleagues […] first step towards future collaborations" (MAR's Head)
	Satisfaction	5	4	"…. I am very satisfied with how we have collaborated and with what we have obtained with MAR from the Acuisost Consortium" (LF's R&D Manager) "…our collaboration in the Acuisost Consortium has proved highly satisfactory in relational and technical terms" (MAR's Head)
Continuity	• No join projects, but probable	1	1	The MAR and the LF decided not to invest by the moment in the production plant required to extend the research line of the focal alliance to the industrial scale. Before their collaboration under the Acuisost Consortium finished, the two partners agreed two new joint projects for future (addressing two new lines of research, one of them with CAH)
	• No join projects, and improbable	1	1	
	• New join projects, the same lines	1	1	
	• New join projects, different lines	5	5	

Notes: Highlighted in grey values for subsequent cross-case comparison. Percentage of agreement [calculated as % of (Rates of Informant $_{LF}$ = Rates of Informant $_{MAR}$)/ Total No. rates] = 75%. Average disagreement [calculated as |(Rates of Informant $_{LF}$- Rates of Informant $_{MAR}$|)/ Total No. different rates]= 1

4. DISCUSSION: REAL OPTIONS IN CAH-LF AND MAR-LF ALLIANCES

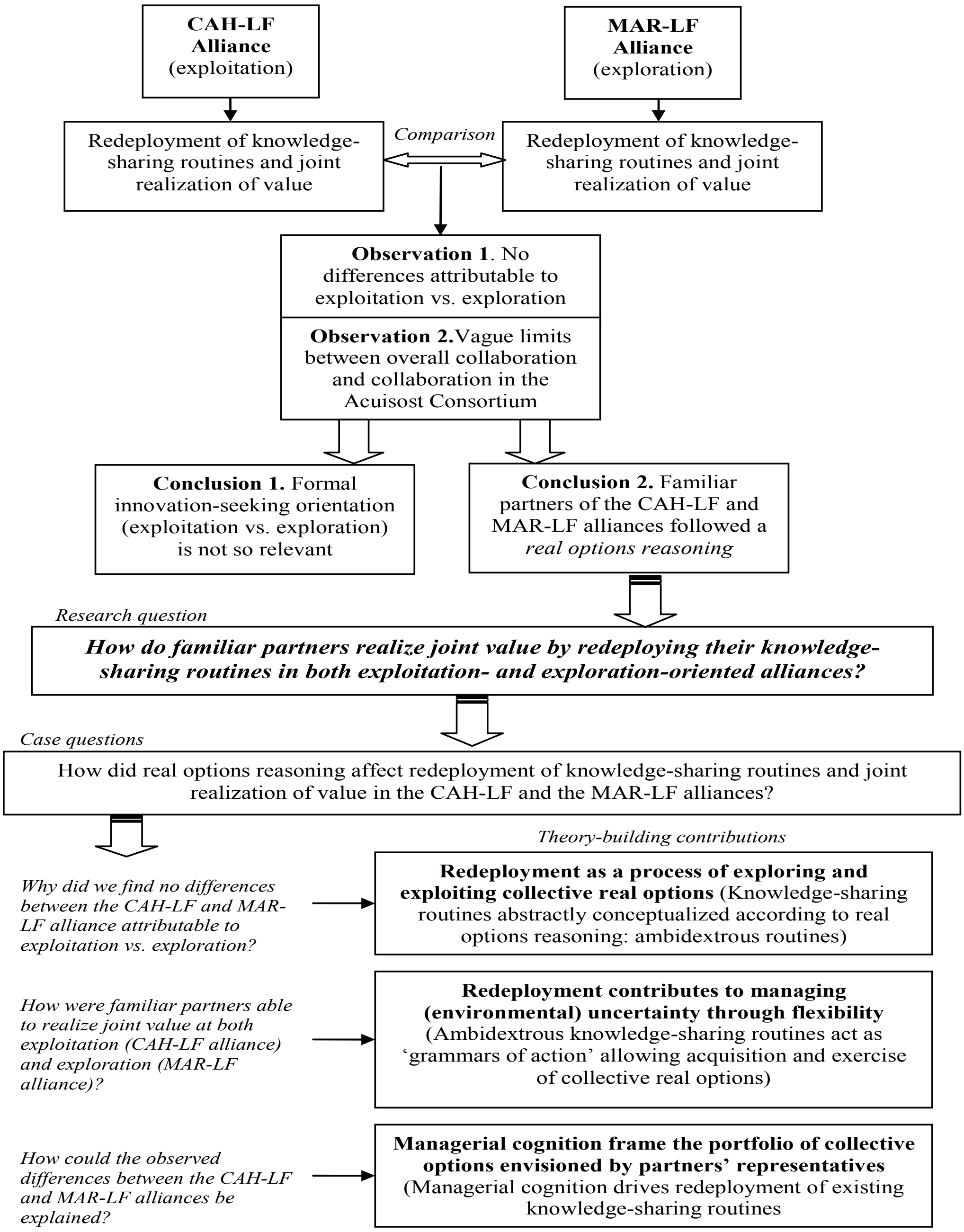
In this section, we link our findings to relevant theoretical concepts, addressing our research question. Figure 3 displays the theory-building process we followed, from observations, through specific questions arising from case data to the theory-building contributions covering the research question of the study.

4.1. Towards Theory-Building: Main Observations and Conclusions

From the in-depth analysis and comparison of the CAH-FL and the MAR-LF alliances, we first derived an important conclusion for our research purpose: Whether a focal R&D alliance between familiar partners aims at exploitation or exploration is not such a key factor suggested by prior literature (e.g., Gupta, Smith & Shalley 2006) in explaining how they redeploy their existing knowledge-sharing routines and thus realize joint value.

This conclusion in turn is rooted in the following two broad observations. First, we did not observe differences between the two studied alliances in terms of knowledge-sharing routines redeployment and joint realization of value **that can be clearly attributed** to their different innovation-seeking orientation (exploitation vs. exploration). Second, in both alliances under study it is difficult to discern between the part of the processes of redeployment and value realization between each pair of partners that corresponded to the *collaboration in the Acuisost Consortium* from the part that corresponded to their *overall collaboration*. In fact, informants themselves stressed repeatedly during the interviews ideas like “it is difficult to isolate what happens in the Acuisost Consortium from *our* relationship in general” or “the Acuisost Consortium has not created a before and after in *our* relationship” (CAH’s Head).

Figure 3. Theory-building process



Searching for a comprehensive explanation, we observed that the innovation-seeking orientation of the focal R&D alliances between the familiar partners was not important because they in practice applied *real options reasoning* in redeploying their existing knowledge-sharing routines. Real options reasoning is a conceptual approach to strategic investment that, relying on the fundamentals of financial options theory, emphasizes the value of undertaking sequential investment strategies, preserving the right to make future choices under uncertain conditions (McGrath, Nerkar 2004). Therefore, it potentially offers a dynamic perspective to strategic analysis that fits the process nature of inter-organizational collaboration ((Kogut 1991, Faems, Madhok 2009). Accordingly, we conceive alliances between familiar partners as platforms of embedded collective real options (Kogut 1991, McCarter, Mahoney & Northcraft 2011). Following McCarter et al. (2011), a collective real option[36] is an action undertaken jointly by alliance partners when they agree to make a small initial investment of resources to uncover additional information about the possible success of a subsequent larger-scale alliance initiative. Furthermore, integrating arguments from the literatures on routines and real options (Myers 1984, Kogut 1991, Bowman, Hurry 1993) may allow us to arrive at a compelling conceptual framework to address our research question, disentangling commonalities and differences between the two cases under study. We thus take a step further to bridge the literatures on routines and real options (Kogut, Kulatilaka 2001) extending the conceptualization of strategy through the option lens (Bowman and Hurry, 1993) into the context of inter-organizational knowledge-sharing routines redeployment. Such an extension makes strong conceptual sense taking into account prior important antecedents. First, Bowman and Hurry (1993: 760) motivate their conceptualization of strategy through the option lens by arguing that “over time, the organizational process of sequential choice yields a pattern of resource *deployment* (emphasis added) that is termed *strategy* (emphasis in original)”. In this regard, redeployment of knowledge-sharing routines can be viewed as a join incremental strategy of familiar partners to leverage their mutual collaborative experience into a new collaborative scenario. Second, Kogut and Kulatilaka (2001) conceptualize capabilities in terms of real options and, as stated, knowledge-sharing routines are important constituent elements of the capability of partners to collaborate together (Zollo, Reuer and Singh, 2002; Dyer and Nobeoka, 2000). Therefore, we frame redeployment of familiar partners’ routines in terms of *acquisition* of new collective real options (exploration) and *exercise* (exploitation) of previously activated collective real options [also *abandonment* if it is perceived low likelihood of success or *delay* if it is perceived that further information is needed to take a decision] (Kogut, Kulatilaka 2001, McGrath, Nerkar 2004, Vassolo, Anand & Folta 2004).

To further elaborate on these ideas, we follow a two-step process. We first discuss why we observed that the two pairs of familiar partners followed a real options reasoning. Subsequently, we address the research question of the study by discussing how such a real options reasoning affected the processes of knowledge-sharing routines redeployment and joint value realization in the two alliances under study.

[36] Broadly speaking, a real option is “the investment in physical assets, human competence, and organizational capabilities that provide the opportunity to respond to future contingent events” (Kogut & Kulatilaka, 2001: 745).

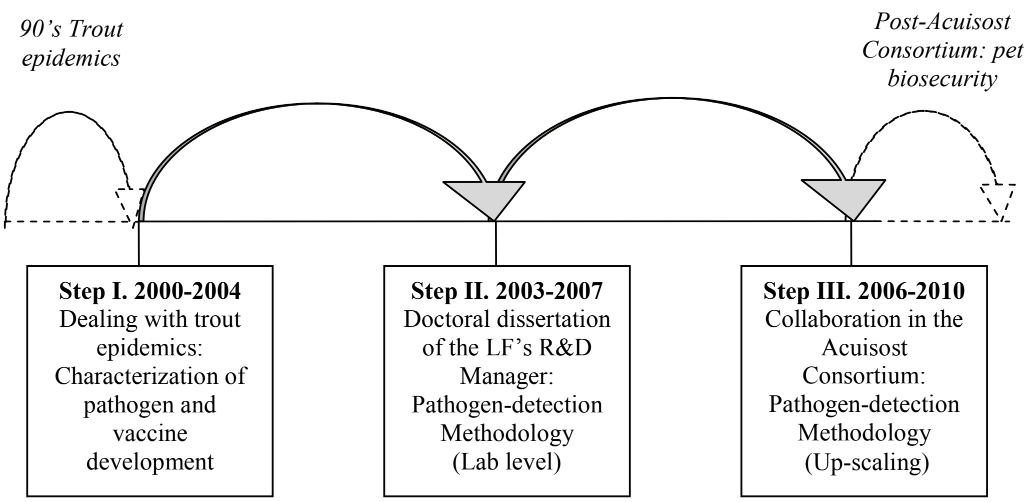
4.2. Why did Partners follow Real Options Reasoning in CAH-LF and MAR-LF alliances?

We observe two interrelated conditions in the CAH-LF and MAR-LF alliances clearly echoing real options reasoning in collaboration. First, in the two studied alliances, each pair of familiar partners understood that their collaboration did not confine to the alliance under the Acuisost Consortium. Rather, informants referred to a larger inter-organizational picture, bringing together the (a) the *shadow of the past* or their history of prior interactions- e.g., vaccines against the trout epidemic in the CAH-LF alliance; quality-control analysis in the MAR-LF alliance- (Poppo, Zhou & Ryu 2008), (b) the *shadow of the future* or expected future alliances- e.g., new CAH-MAR-LF project- (Parkhe 1993), and (c) the *shadow of the present* or other concurrent relationships- e.g., Heads of CAH and MAR external advisors in the LF's Innovation Committee (Gulati, 1998). To deepen such ideas, we adapt the 'locus of innovation' notion (Powell, Koput & Smith-Doerr 1996) and introduce the concept of *locus of collaboration,* defined as the 'scenario' in which collaboration between partners is perceived to take place. Accordingly, our data shows that the locus of collaboration between familiar partners is not the focal alliance itself but an inter-temporal and multi-fold collaborative scenario, resembling the long-term and composite vision of strategy through the option lens (Bowman, Hurry 1993).

Second, our data on the CAH-LF and MAR-LF alliances confirm that the two pairs of familiar partners under study had built a collaborative relationship of ambidextrous nature over time (Tiwana 2008) insofar they balanced along their continuum of collaboration the tension between exploitation and exploration (Lavie, Rosenkopf 2006, Koza, Lewin 1998, March 1991). As mentioned in the narratives, the collaborative relationship between each pair of familiar partners started at the origin with exploitation-oriented projects (e.g., microbiological analysis quality control analysis) and, once the technological infrastructure of the LF was built (e.g., the LF's had its won laboratory and equipments), partners started searching new technological alternatives through exploration-oriented alliances.

Given these observations, and viewing strategy through the option lens (Bowman, Hurry 1993), we argue that partners of the CAH-LF and the MAR-LF alliances conceived their collaboration as *a long-term chain (or portfolio) of embedded collective real options* and that they thus followed a join incremental strategy of investment along their continuum of collaboration. For example, as Figure 4 shows, the CAH-LF alliance under the Acuisost Consortium sought to exploit a pathogen-detection methodology (through up-scaling) which partners had previously explored together (by means of a doctoral dissertation developed by the LF's R&D Manager and supervised by the CAH's Head) and which in turn was related to a previous collaborative initiatives (i.e., when dealing with a trout epidemic). At the same time, partners started exploring new future opportunities, and collaboration continued after the Acuisost Consortium with new agreed joint R&D projects addressing new research lines (e.g., biosecurity in the pet nutrition field).

Figure 4. The chain of collective real options in the CAH-LF alliance



Real options reasoning allows us to explain the above mentioned vagueness we observed between 'collaboration under the Acuisost Consortium' and 'collaboration between the partners as a whole' by interpreting it as an indicator of interaction within the portfolio of collective real options. In this regard, McGarth and Nerkar (2004: 4) argue that "because options interact […] subsequent option investments in R&D arenas can increase the value of options opened earlier" and Vassolo et al. (2004: 1046) add that "in the presence of interactions, the valuation of a portfolio of related options is not straightforward. Failure to consider the effect of interactions […] would lead to misleading explanations".

4.3. How did Real Options Reasoning affect Redeployment of Knowledge-Sharing Routines and Joint Value Realization in the CAH-LF and MAR-LF Alliances?

To address this question, we structure our subsequent theory-building efforts in three sections. First, we discuss how real options reasoning influenced partners' abstract conceptualization of the knowledge-sharing routines and, consequently, how it determined the redeployment actions undertook in the studied alliances. Next, we discuss how the redeployment pattern was tied to the management of uncertainty through flexibility and thus how partners were able to realize joint value in both alliances. Finally, we invoke the role of managerial cognition to explain observed differences in terms of redeployment and value realization between the two cases.

4.3.1. Redeployment: A process of Exploring and Exploiting Collective Real Options. Based on the above observations and the conceptualization of redeployment followed in this study[37], we argue that the locus of collaboration is a core concept to explain how partners of the studied alliances redeployed their existing routines.

The dual ontology of organizational routines proposed by Feldman and Pentland (2003) is central to this reasoning[38]. Extending it into our empirical context, the *ostensive* aspect of the inter-organizational knowledge-sharing routines refers to the partners' interpretation of what these routines are and what they stand for. Concerning the *performative* aspect, we focus on the specific actions during the redeployment process (or redeployment investments) undertaken by the partners' representatives (i.e., who are the routines actors here). Relying on this literature, we argue that the ostensive aspect of the inter-organizational knowledge-sharing routines is akin to the locus of collaboration envisioned by each pair of familiar partners. As explained, familiar partners of each studied alliance perceived the locus of collaboration according to their real option reasoning. Therefore, the abstract conceptualization of the knowledge-sharing routines contains the envisioned platform of collective real options. It thus follows that familiar partners of the alliances under study abstractly conceptualized their knowledge-sharing routines as mechanisms to both explore and exploit collective real options over time[39]. Furthermore, existing literature stresses that the subjective understandings of the routine actors, reflected in the ostensive aspect, serve as a guide both for ongoing performance of the routines (Feldman, Pentland 2003). Consequently, we claim that the redeployment investments taken by the familiar partners in both alliances under the Acuisost Consortium (or performative actions we observed) incorporated the abstract conceptualizations of the knowledge-sharing routines and thus were inexorably imbued with a real options spirit.

Given the above observations, we could consider that each studied pair of familiar partners, by accumulating explorative and exploitative collaborative experiences over time, had developed

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[37] We have described redeployment as the process by which familiar partners jointly transfer the inter-organizational knowledge-sharing routines they have created through their accumulated mutual experiences to a new joint collaborative *scenario*.

[38] According to this framework, organizational routines consist of two interrelated aspects: the *ostensive* and the *performative*. Broadly speaking, "the ostensive aspect is the idea; the performative aspect is the enactment" (Feldman and Pentland, 2003: 102). More specifically, the ostensive aspect is the abstract schematic conceptualization of a routine, whereas the performative aspect concerns the specific actions taken by the specific actors involved in the routine (See also Becker, 2004)

[39] Notice that implicit in these arguments is the assumption that the two familiar partners in each studied alliance shared the same abstract conceptualization of their knowledge-sharing routines. Although this question is beyond the interest of this study, it can be argued that this assumption makes sense, both theoretically and empirically. Relying on existing literature and the findings of Study II.1 of this doctoral dissertation, we found indicators from our data on the CAH-LF and MAR-LF alliances that each pair of familiar partners had already developed a shared psychological contract.

ambidextrous knowledge-sharing routines (Filippini, Güttel & Nosella 2011). This evidence resembles the conceptualization of inter-organizational routines as 'grammars of (collaborative) action' which define a set of possible patterns of interaction between the partners, rather than prescribing a single pattern (Zollo, Reuer & Singh 2002, Pentland, Rueter 1994). Importantly, we did not observed that partners retrieved from their inter-organizational memory only a specific part of their knowledge-sharing routines (Cohen, Bacdayan 1994) and thus redeployed them in a pure exploitation or exploration mode (Gupta, Smith & Shalley 2006), *according to* the formal orientation of the focal alliance. Rather, our data on the CAH-LF and the MAR-LF alliances suggest that, as a consequence of their real options reasoning, each pair of familiar partners simultaneously explored and exploited collective options by redeploying their knowledge-sharing routines, *regardless* the formal orientation of the focal alliance. Our evidence thus challenges inertia arguments usually associated to collaboration between familiar partners (Kogut, Kulatilaka 2001, Schreyögg, Kliesch-Eberl 2007). The redeployment stories of the CAH-LF and MAR-LF alliances show how familiar partners can possess well-established patterns of interaction which are, however, of flexible nature. This reasoning is in line with the above- mentioned conceptualizations of routines: 'grammars of action' (Pentland, Rueter 1994) and dual (ostensive-performative) phenomena (Feldman, Pentland 2003)[40]. Our study also illustrates how inter-organizational routines can evolve over time, even though once a high level of functionality has been achieved, as the capabilities lifecycle approach suggests (Helfat and Peteraf, 2003)[41].

The above reasoning has allowed us to explain why we found no differences between the two studied alliances **that can be clearly attributed** to their different innovation-seeking orientation (exploitation vs. exploration). On a broader level, these findings represent a major theory-building contribution since they provide a compelling explanation to some existing contradictory evidence on the role that partner-specific experience may play in alliance exploration success: familiar partners may redeploy ambidextrous knowledge-sharing routines and thus explore and exploit technological opportunities in a simultaneous fashion even if the

[40] Pentland and Feldman (1994) develop the framework of routines as 'grammars' in an attempt to integrate flexibility in the conceptualization of patterned activity. Feldman and Pentland (2003) also recognize flexibility of routines by emphasizing that the performative aspect is not an invariant reflection of the ostensive aspect: routine actors may react to the outcomes of prior routine iterations and thus rebuild the initial abstract conceptualization (See also Feldman, 2000).

[41] In fact, we explicitly asked our informants about the extent to which they have noticed improvement in their patterns of interaction. We found some indicators of such improvement, although exhibiting dismissing learning rates due to the high levels of accumulated mutual experiences.

alliance formally aims at exploration. The above discussion gives rise to the following proposition:

***Proposition 1**. In the setting of R&D collaboration between familiar partners, redeployment entails exploring and exploiting collective real options, as long as partners have developed knowledge-sharing routines of ambidextrous nature and regardless the formal seeking-orientation of the alliance (exploitation vs. exploration).*

4.3.2. Redeployment and the management of uncertainty through flexibility.

To explain how real options reasoning affected knowledge-sharing routines redeployment and joint value realization in the studied alliances, we can further integrate arguments from the routines and real options literatures by focusing on the flexibility-uncertainty relationship. These two literatures offer different perspectives on the phenomenon that, however, result complementary to each other when extended into the context of inter-organizational routines redeployment. Drawing on these two literatures (e.g., Kogut 1991, McCarter, Mahoney & Northcraft 2011, Pentland, Rueter 1994, Feldman, Rafaeli 2002), a distinction can be made between two broad types of uncertainty in the inter-organizational context- *social uncertainty* (endogenous to the collaborative relationship) and *environmental uncertainty* (exogenous to the collaborative relationship). This distinction echoes the alliance risk-based view (Das, Teng 1998) and allows us to explain how partners in the two studied alliances were able to realize value. In particular, our data on the CAH-LF and MAR-LF alliances confirm that each pair of familiar partners were able to realize joint value because they (1) had already overcome social uncertainty when they initiated their collaboration under the Acuisost Consortium and (2) managed collectively environmental uncertainty over time by applying a flexible redeployment strategy. We elaborate further on these two points below.

Social uncertainty already overcome. Well-grounded in alliance research is the idea that collaborative efforts of familiar partners are likely to succeed because, along their history of prior interactions, they have developed trust and overcome suspicious about the intentions of each other and have established effective interaction patterns to integrate their different knowledge resources (Dyer, Singh 1998). Inter-organizational routines act as sources of connections and understandings among the routine actors, providing a guide to partners on how to develop their patterns of interaction (Feldman, Rafaeli 2002). By a similar logic, partners can manage the *social dilemma* inherent to alliances by acquiring collective real options, and thus increasing simultaneously mutual trust, cooperation, and exposure (McCarter, Mahoney & Northcraft 2011, Faems, Madhok 2009). Our study contributes to this understanding by showing that partners were able to concentrate their routine-redeployment investments on the management of one unique uncertainty front (i.e., environmental uncertainty), given that social uncertainty between the partners had already been overcome. These arguments are corroborated by some statements, arising recurrently in the interviews, such as "the LF knows that we will not cheat and vice versa" and "we know how to do things well when collaborating with each other" (MAR's Head). Therefore, likelihood of knowledge-sharing effectiveness was no longer a *volatility* variable in the collaborative equation, but a kind of *intercept* for which it was thus no needed to consider different possible scenarios and that gave meaning to the continuity of the CAH-LF and MAR-LF relationships. Lack of social uncertainty and trust thus rendered the collaborative scenarios in a state of stability, in turn reducing complexity and thus enhancing likelihood of joint realization of value (Kumar, Nti 1998). In this regard, our data on the CAH-LF and the MAR-LF alliances study extends the framework developed by McMacter et al. (2011) for partners lacking a long history of prior interactions.[42]. In the context of familiar partners, collective real options resulting from the redeployment of their routines represent an otherwise inconceivable portfolio of value-creating opportunities, rather than provide them "the opportunity to first try and then trust each other" (McCarter, Mahoney & Northcraft 2011: 635)".

Environmental-uncertainty and flexibility. Concerning environmental uncertainty, in the learning routines literature, scholars have emphasized the necessity of firms to balance the tension between exploration and exploration over time (Lavie, Rosenkopf 2006, March 1991). In the real options literature, this *ambidextrous flexibility* has been framed in terms of acquisition of new real options and exercise of previously acquired real options (e.g., Kogut 1991, McGrath, Nerkar 2004, Vassolo, Anand & Folta 2004). Therefore, both literatures converge in the importance of balancing exploration and exploitation (put differently, the importance of following a real options strategic reasoning) to create value in uncertain environments.

Previously, we have comprehensively argued that the two studied pairs of familiar partners had developed and then redeployed ambidextrous knowledge-sharing routines along their collaboration. Partners of the CAH-LF and MAR-LF alliances therefore faced environmental uncertainty by flexible redeploying of their knowledge-sharing routines, and thus were able to

[42] In fact, our data on the CAH-LF and the MAR-LF alliances suggest that the 'testing the waters' strategy emphasized by these authors can perhaps take place during the capability-building process (i.e., as partners develop their capabilities to collaborate together they acquire collective real options to deal with social uncertainty). The examination of this question goes beyond our interest, since the present study focuses on the capability-redeployment process that comes once the partners' capabilities are already in place, yet it sounds as an interesting avenue for further work.

realize joint value. Inter-organizational routines, understood as 'grammars of actions', allow partners to choose the most adequate pattern of interaction from all the possible ones to deal with exogenous contingencies (Zollo, Reuer & Singh 2002, Pentland, Rueter 1994, Teece, Pisano & Shuen 1997). More specifically, strategic alliance scholars (e.g., Kogut 1991, Estrada, de la Fuente & Martín-Cruz 2010) have emphasized that applying real option reasoning is an effective alliance strategy, since it allows them to maintain flexibility in uncertain environments. The underlying logic is that alliance partners can explore simultaneously a wide range of technological alternatives by forming multiple alliances concurrently and over time, deterring full commitment of resources until corroborating which one/ones is/are the most favorable. We observed precisely this strategic behavior in the alliances under study. For example, in the CAH-LF alliance, partners decided not to continue with that line of research (considering it to be 'exhausted') and started exploring new technological opportunities. In the MAR-LF alliance, partners explored a new technological opportunity. Potential was confirmed so, instead of totally abandon the idea, partners decided to wait before committing more resources due to the global economic crisis, starting exploration of new technological opportunities. In this regard, our study extends to the inter-organizational context the argument that real option reasoning in strategic decision-making allows firms not only to protect from environmental uncertainty but to profit from it (Kogut, Kulatilaka 2001, Kogut 1991).

The above reasoning has allowed us to explain how both pairs of familiar partners under study were able to realize joint value by redeploying their knowledge-sharing routines, regardless the different innovation-seeking orientation of the alliances (exploitation vs. exploration). On a broader level, these findings represent a major theory-building contribution, challenging prior research that, relying on the 'paradox of embeddedness' arguments (Uzzi 1997), argues that explorative alliances between familiar partners are not likely to succeed. Emphasizing that knowledge of familiar partners become redundant over time (e.g., Goerzen 2007), these studies have denied two important realities: (1) familiar partners may follow a real options reasoning and thus develop inter-organizational routines of flexible nature that allows them to simultaneously explore and exploit technological opportunities (or ambidextrous inter-organizational routines according to Filippini et al., 2011) and (2) under these circumstances, familiar partners together can not only apply existing knowledge but also generate new one by redeploying their existing knowledge-sharing routines. Based on the above discussion, we propose:

Proposition 2. *In the setting of R&D collaboration between familiar partners, redeployment of ambidextrous knowledge-sharing routines triggers realization of joint value by allowing* *management of environmental uncertainty through flexibility, as long as social uncertainty has been overcome and regardless the formal seeking-orientation of the alliance (exploitation vs. exploration).*

4.3.3. Managerial Cognition and the Identification of Collective Real Options.

Both the routines and real options literatures recognizes that managerial cognition acts as a driver of strategic action. From a dynamic capabilities view, cognition drives opportunity sensing and seizing and changes in routines, by enabling some developmental trajectories and constraining others (Rerup, Feldman 2011, Tripsas, Gavetti 2000, Teece 2007). Similarly, the real options approach envisions an active role for management over time: managers scan, map and track the environment on an ongoing basis, deciding what options should be acquired and continuously rethinking strategic implications of such decisions in terms of exercise (further commitment), waiting for more information (delay of further commitment) or abandonment (Bowman, Hurry 1993). Extending these arguments to our inter-organizational context, we argue that managerial cognitive schemata frame the portfolio of collective options partners' representatives envision and thus contains answers to questions such as 'what are the potential applications of *our* existing knowledge-sharing routines?'. This brings us to the critical role that managerial cognition plays in the routine-redeployment process.

Our data on the CAH-LF and the MAR-LF alliances allow us to identify some distinctive features of the professional backgrounds and profiles of the partners' representatives. As can be deduced from the previous narratives, the CAH's Head profile was more academic oriented than the MAR's Head and the LF's held a more profiles, which integrated managerial and academic experiences. Given these observations, and considering that cognitive schema form mainly through experiences (Tripsas, Gavetti 2000), we argue that combination of different professional profiles resulted in a different cognitive infrastructures sustaining the redeployment processes of knowledge-sharing routines in each studied alliance. Furthermore, such heterogeneity in cognition led the partners of both studied alliances to envision idiosyncratic collaborative scenarios, containing thus different portfolios of collective real options. Therefore, the collaborative efforts of each pair of familiar partners or, put differently, their redeployment investments, aimed at exploring and exploiting different bundles of opportunities. Adopting the idea of dynamic capabilities as 'best practices' (Eisenhardt, Martin 2000), we observed that the redeployment strategies undertaken by each pair of familiar partners possessed general commonalities (i.e., managing uncertainty through flexibility) but were idiosyncratic in details, since the envisioned targets of collective real options giving meaning to the strategies were idiosyncratic. Put differently, although in both alliances under study partners held an options-based locus of collaboration, we observed different *attention focus* of collaboration. As a result, the different subjective representations of each pair of familiar partners led them to establish different collaborative agendas (Nadkarni, Barr 2008) and, thus, they realize joint value in different ways. As Bowman and Hurry (1993) argue, opportunities for strategic action (or real options) come into being only when managers recognized them through retrospective sensemaking, remaining until that in the form of *shadow options*. Indeed, the LF's R&D Manager explained that the CAH and the MAR provided two different kinds of opportunities for innovative strategic action to the firm, emphasizing different kind of shadow options derived from the *CAH's network of scientific contacts* versus *the MAR's network of institutional contacts*[43].

The above reasoning has allowed us to explain the differences we identified between the two studied alliances in terms of knowledge-sharing routines redeployment and joint realization of value. On a broader level, these findings represent an important theory-building contribution, extending prior literature linking cognition and organizational capabilities and routines, into the particular context of inter-organizational routines redeployment. In doing so, our study shows the important role that heterogeneity in managerial cognition can play in explaining heterogeneity in alliance success, by affecting the redeployment of inter-organizational knowledge-sharing routines and not only the creation and change of organizational capabilities (Rerup, Feldman 2011, Tripsas, Gavetti 2000). The above discussion supports the following proposition:

Proposition 3*. In the setting of R&D collaboration between familiar partners, heterogeneity in managerial cognition leads to heterogeneous envisioned portfolios of collective real options thus triggering heterogeneity in joint realization of value across alliances.*

5. CONCLUSION AND IMPLICATIONS

This study provides a process-oriented perspective on the value-creation dynamics of R&D alliances formed by familiar partners, studying how they are able to realize joint value in both exploring and exploiting technological opportunities by redeploying their inter-organizational knowledge-sharing routines. By comparing two successful alliances (one oriented at exploitation and the other oriented at exploration)our study concludes that (1) familiar partners with long history of prior interactions apply a real options reasoning in defining the *locus of their collaboration* as a multi-fold longitudinal collaborative scenario that entails *a portfolio of*

[43] See comparatively Table 3 and Table 5, to find out more indicators of these arguments (e.g., results in terms of publications).

embedded collective real options over time, (2) familiar partners may have already overcome social uncertainty and created *ambidextrous knowledge-sharing routines* whose redeployment allows them to realize joint value by *managing environmental uncertainty through flexibility*, and (3) *heterogeneity in managerial cognition* is a more relevant factor in explaining heterogeneity in value realization rates in R&D alliances formed by familiar partners, than the innovation-seeking orientation included in the formal alliance contracts. Consequently, this study yields some important implications.

5.1. Implications for Research

This study extends prior scholarly efforts to bridge the literatures of strategic management and real options (Myers 1984, Bowman, Hurry 1993, McGrath, Nerkar 2004, Vassolo, Anand & Folta 2004). Broadly speaking, this study adds important insights to the research tradition explaining strategic alliances phenomena through the option lens (Kogut 1991, Vassolo, Anand & Folta 2004, Estrada, de la Fuente & Martín-Cruz 2010). More specifically, this study extends the conceptual literature linking the fields of capabilities and real options (Kogut, Kulatilaka 2001), focusing on one important constituent element of the dynamic capability to collaborate (i.e., inter-organizational knowledge-sharing routines (Zollo, Reuer & Singh 2002)) and opening the *black box* of redeployment. In doing so, this study contributes to existing literature in several important ways.

In light of our data, we have conceptualized collaboration between familiar partners in terms of portfolios of embedded collective real options that are explored and exploited iteratively in a multi-fold longitudinal scenario. Thus, our study extends through the option lens well-ground alliance research arguments that past interactions, concurrent relationships between partners, as well as mutual expectations about future cast a shadow upon the present (Parkhe 1993, Poppo, Zhou & Ryu 2008, Gulati 1998), explaining how it may affect current redeployment behavior.

As argued by Kogut and Kulatilaka (2001), studying capabilities as real options allows a more comprehensively interpretation of the learning balance between exploitation and exploration. In this regard, integration of routines literature and real options reasoning has elicited a comprehensively conceptualization of inter-organizational knowledge-sharing routines, bridging together the perspectives of routines as 'grammars of action' (Pentland, Rueter 1994), 'dual phenomena' (Feldman, Pentland 2003), and 'ambidextrous' mechanisms (Filippini, Güttel & Nosella 2011). Our study thus endows the notion inter-organizational knowledge-sharing routines with deep theoretical underpinnings, broadening existing understanding (Zollo, Reuer & Singh 2002, Dyer, Nobeoka 2000, Dyer, Hatch 2006). Similarly, relying on the dynamic perspective offered by real options reasoning, our conclusions enrich the broader field of research into resources and capabilities redeployment, which has traditionally focused on acquisitions instead of alliances and has usually adopted a structure-oriented approach (Capron, Mitchell 1998, Capron, Dussauge & Mitchell 1998, Anand, Singh 1997). In this regard, our study extends the bilateral perspective proposed by Capron and Mitchell (1998) by shifting attention focus on redeployment from *resources individually developed by targets and acquirers* to *knowledge-sharing routines jointly developed by familiar partners*. Taking into account that routines are the constituent elements of capabilities (Zollo, Winter 2002), real options reasoning also provides a compelling empirical illustration of how the capability lifecycle evolves across the *maturity* stage when the trajectory branches into redeployment (Helfat, Peteraf 2003).

As a whole, real options reasoning allows a more fine-grained perspective to addresses the value-creation dynamics of R&D alliances formed by familiar partners, contributing thus to resolve existing ambiguous evidence. We find that familiar partners may be able to successfully balance the tension between exploration and exploitation over time as long as they have developed ambidextrous routines, in line with Tiwana (2008) and Filippini et al. (2011). Therefore, our conclusions provide an interesting counterpoint to the predictions, inspired by 'paradox of embeddedness' (Uzzi 1997), that explorative R&D alliances formed by familiar partners are likely to fail. Furthermore, our data on the CAH-LF and the MAR-LF alliances reveals that whether an alliance between familiar partners is formally oriented to exploration or exploitation may be not as relevant as presumed. As long as familiar partners frame their collaboration in terms of collective real options, differences in the interpretive schemata of managers may lead them to consider different opportunities (in the form of collective real options), thus explaining heterogeneous rates of alliance success and joint realization of value. All these arguments may comprehensively complement discussion of findings of studies like Hoang and Rothaermel (2005) and Phelps (2010) concluding that partner-specific alliance experience is not always a relevant determinant of innovation success in alliances.

5.2. Implications for practice

Real options approach applied to strategic management may allow scholars to "develop ideas that are relevant to the problems facing decision-makers" (McGrath, Nerkar 2004: 19). Indeed, the routines and learning literatures proved much more convincing to address the two real-life alliances under study when combined with real options arguments. Accordingly, we offer some recommendations for managers involved in the management of R&D alliances with familiar partners. Our study shows that redeployment of inter-organizational routines may be consistently analyzed from a real options approach (Adner, Levinthal 2004) and that following a real options reasoning could be a successful strategy for alliance ambidexterity (Tiwana 2008). We thus strongly recommend managers to explicitly organize the collaborative behaviors of their organizations around such a real options philosophy. Looking at alliances through the option lens may promote (1) development of ambidextrous knowledge-sharing routines, (2) reduction of uncertainty and complexity in collaboration, and (3) likelihood of innovation success. Furthermore, given the importance of managerial cognition, we recommend to search for an adequate cognitive structure by placing special attention to the professional backgrounds of the individuals managing the alliances. This strategic decision could be particularly useful for firms-research organization collaboration, due to differences in institutional missions and perspectives (Lacetera 2009).

5.3. Limitations

Our findings are based on an in-depth longitudinal study of two R&D alliances formed by the same firm and two different research organizations within the context of a larger R&D consortium (i.e., the Acuisost Consortium). This research design has allowed us to minimize the risk of extraneous variation and thus to make a reliable comparison of the two alliances (e.g., formal contracts were very similar in both cases and both pairs of partners had a long history of prior interactions). However, our findings are clearly contextualized, and consequently they need to be taken with caution in other research settings. For example, our data on the CAH-LF and MAR-LF alliances reveal that both pairs of partners over time had successfully overcome social uncertainty, have balanced the exploitation-exploration tension, and have developed ambidextrous knowledge-sharing routines. However, inheritance from history of interactions may be different. Partners may have not build such harmonious relationship -and continue collaborating together out of inertia (Gulati 1995) - or simply they have only accumulated experiences in either exploitation or exploration. Under any of these circumstances, familiar partners may not have in place effective knowledge-sharing routines that allow them to successfully exploit and explore technological opportunities.

5.4. Future research

Based on the above discussion, we identify some interesting avenues for further research, beyond the large-sample test of our theoretical conclusions. In line with the limitations of the study, it could be interesting to compare the processes of redeployment of of knowledge-sharing routines and joint value realization in R&D alliances formed by different kinds of familiar partners (e.g., firm-firm vs. firm-research organization alliances; familiar partners with and without harmonious histories of interactions), as well as between different collaborative settings (e.g., R&D alliance within a larger consortium vs. an 'independent' alliance).

Furthermore, our data suggest several conclusions that, even though beyond the interest of this study, may inspire some lines of further work. First, our data suggest that familiar partners may have already overcome social uncertainty when they engage in a new joint alliance. In this regard, it could be interesting to frame 'the testing the waters' strategy proposed by McCarter et al. (2011) in terms of 'building process of the capability of partners to collaborate together' and thus study the creation of alliance capabilities as real options (Kogut, Kulatilaka 2001). Second, our data reflects debate around the 'paradox of embeddedness' at the network level. On the one hand, embeddedness may constraint network opportunities [*"... our relationship with the LF is strategic and the aquaculture sector knows it ... we collaborate with most of the LF's client firms but none of the LF's competitors has asked us our services"* (CAH's Head)]. At the same time, an advantageous balance may be achieved in network composition [*"...the LF profits from the important network of institutional contacts of the MAR's Head ... if they (CAH) cannot provide us a solution, they search among its network of contacts and remit us to another research center (LF's R&D Manager)*]. Therefore, our data suggest that revisiting the concept of alliance portfolio capabilities (Sarkar, Aulakh & Madhok 2009, Hoffmann 2007) adopting a real options approach may be an interesting line for further work.

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COMPETENCIA EN TECNOLOGÍA DE LA INFORMACIÓN Y RESULTADOS EN INNOVACIÓN DE PRODUCTO[44]

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RESUMEN

Muchas compañías han desarrollado estrategias que incluyen fuertes inversiones en tecnologías de la información con el objetivo de mejorar sus resultados en innovación de productos. Sin embargo, ciertos trabajos cuestionan incluso su relación positiva con los resultados empresariales y sugieren la mediación de otros aspectos. Este estudio propone al éxito comercial de la innovación como una variable dependiente de la competencia en tecnología de la información. Basándonos en la literatura sobre la perspectiva de capacidades dinámicas proponemos que las competencias de aprendizaje interno y externo juegan un papel clave en la relación entre las competencias en tecnología de la información y el éxito comercial de la innovación. Utilizamos ecuaciones estructurales para testar las hipótesis en una muestra de 186 empresas azulejeras de la industria cerámica. Los resultados sugieren que las competencias en tecnología de la información mejoran el éxito comercial de la innovación y que esta relación está totalmente mediada por las competencias de aprendizaje interno y externo.

Palabras claves:

Competencia en tecnología de la información, capacidades dinámicas, éxito comercial, aprendizaje interno, aprendizaje externo.

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1. INTRODUCCIÓN

La tecnología de la información (TI) permite ahorrar tiempo, hacer una gestión más eficaz y mejorar la información, dado que es un facilitador de la información sobre conocimientos clave (Phiri, 1999). Por ello, avances recientes en tecnologías de la información han creado cambios sustanciales en los entornos de negocios y especialmente cambios en las prácticas de negocios; acortando los ciclos productivos, permitiendo el rápido desarrollo tecnológico y originando finalmente, entornos hiper-competitivos (Wind y Mahajan, 1997; Segars y Grover, 1999; Segars y Dean 2000).

Las empresas que son capaces de realizar cambios de forma rápida y adaptarse a las nuevas tecnologías pueden poseer una ventaja competitiva frente al resto de competidores que sean más lentos y estén peor informados (Barney et al., 2001). Sin embargo, existen estudios que no muestran una relación positiva entre la TI y el resultado de la compañía (Devaraj y Kohli, 2003). Una explicación para esto es que la TI es necesaria pero insuficiente para conseguir una ventaja competitiva (Clemons y Row, 1991), por lo que existen investigadores de gestión estratégica que la relacionan con otros componentes específicos de la estrategia de la empresa (Rivard et al., 2006), así como con componentes derivados de la perspectiva de recursos y capacidades (Tippins y Sohi, 2003; Lin et al., 2008). Éstos últimos afirman que no sólo es importante la inversión realizada por parte de la empresa en tecnologías de la información, sino que también será clave el aprendizaje organizativo y el conocimiento poseído por la compañía.

El concepto de “conocimiento como recurso” de la compañía sugiere que el conocimiento puede ser transmitido, recombinado, y utilizado para crear valor (Grant, 1996a). Por lo tanto, gracias a la creación y transferencia efectiva del conocimiento se pueden crear ventajas competitivas (Alavi, 2000), especialmente gracias al conocimiento tácito colectivo (Brown y Eisenhardt, 1997; Orlikowski, 2002; Nonaka, 1994). El concepto de reconfiguración de recursos es esencial en la habilidad dinámica de coordinar, expandir y reconfigurar los recursos de conocimiento en la construcción de nuevas competencias funcionales (Iansiti y Clark, 1994; Pisano, 1994; Teece y Pisano, 1994; Eisenhardt y Brown, 1999).

Debido a que las capacidades dinámicas surgen del aprendizaje (Zollo y Winter, 2002; Marsh y Stock, 2006; Easterby-Smith y Prieto, 2008) es muy fácil conectar al conocimiento con las capacidades dinámicas de la compañía, ya que podemos entender la capacidad de reconfiguración de conocimiento como una capacidad dinámica. El aprendizaje interno se refiere al nuevo conocimiento creado por la propia acumulación de experiencia utilizando sus recursos mientras que el aprendizaje externo se refiere al nuevo conocimiento creado e integrado dentro de la empresa a través de la interacción con el entorno y otras organizaciones (Kessler et al.,2000; Chang, 2003; Bapuji y Crossan, 2004).

La creación y uso del conocimiento está asociada con la innovación, ya que esta consiste en la explotación exitosa de nuevas ideas (Amabile et al., 1996). Podemos considerar que el éxito comercial de la innovación es una aproximación de los resultados generales de la compañía, ya que existen estudios que afirman que aquellas empresas con mayores resultados de la innovación obtienen mayor desempeño general (Darroch, 2005).

Aunque recientemente se ha probado la relación entre competencia en tecnología de la información, conocimiento o aprendizaje y resultados de la compañía (Tippins y Sohi, 2003; Lin et al., 2008) algunos estudios no han sido concluyentes (Powell y Dent-Micalef, 1997; Devaraj y Kohli, 2003). Por este motivo, en el presente trabajo proponemos que es necesario profundizar en el entendimiento de esta relación. Para ello establecemos una nueva variable dependiente muy ligada a los resultados empresariales, el éxito comercial de la innovación. Estudios anteriores consideran que el resultado innovador tiene un efecto directo en el resultado general de la compañía (Wheelwright y Clark 1992; Renko et al. 2009; Baker y Sinkula 2009).

Además, algunos trabajos que tratan de explicar la existencia de una relación entre TI e innovación, tanto de forma teórica (Davenport, 1993; Holsapple y Singh, 2003, Davenport et al., 2008) como empírica (Sabherwal and Sabherwal, 2005), obtienen resultados contradictorios (Joshi et al., 2010), sobre todo en lo que se refiere al éxito en la comercialización de los productos. En el presente estudio proponemos que dos variables intermedias ayudan a explicar esta relación y posibilitan el entendimiento de por qué en ocasiones las inversiones en tecnología de la información no generan mayores resultados innovadores. Estas variables son las competencias de aprendizaje interno y externo. La competencia en tecnología de la información reforzará las competencias de aprendizaje interno y externo y serán estas las que afectarán al éxito comercial de la innovación.

Utilizamos ecuaciones estructurales para testar las hipótesis en una muestra de 186 empresas italianas y españolas del sector azulejero cerámico. Estas empresas representan el 50% del total del target objetivo. Los resultados proporcionan evidencia empírica de que la competencia en TI está positivamente relacionada con el aprendizaje interno y externo. Y en segundo lugar, las competencias en aprendizaje interno y externo juegan un rol importante en determinar los efectos de la TI en el éxito comercial de la innovación.

En las secciones siguientes revisamos la literatura sobre competencia en TI, competencia en aprendizaje interno y externo y capacidades dinámicas. Seguidamente, presentamos las hipótesis, describimos la metodología utilizada en el estudio empírico, detallamos las medidas de las variables dependientes e independientes y analizamos los principales resultados alcanzados en el estudio. El trabajo concluye con las implicaciones académicas y prácticas de la investigación.

2. COMPETENCIA EN TECNOLOGÍA DE LA INFORMACIÓN

Antes de 1990 mucha de la literatura sobre TI se basaba en su potencial para alterar todo un conjunto de variables estratégicas y de estructura industrial, incluyendo las posiciones en costes, economías de escala y poder de mercado (Cash y Konsynski, 1985; Porter, 1985; Clemons, 1986). Posteriormente, la literatura se ha interesado por la relación entre la TI y componentes específicos de la estrategia empresarial, como la exploración del entorno (Maier et al., 1997), las ventajas competitivas (Mata et al., 1995), los resultados empresariales (Dollinger, 1984; Powell y Dent-Micallef, 1997; Bharadwaj, 2000), la acumulación de conocimiento (Grant, 1996), el aprendizaje organizativo (Tanriverdi, 2006) y la innovación abierta (Huang, 2011).

Las estrategias en TI pueden ser clasificadas en dos categorías generales: (1) las TI de exploración del entorno y (2) las estrategias de uso de la TI (Bergeron et al., 2004). (1) Las estrategias de TI de exploración del entorno suelen implementarse a través de herramientas de compartición de conocimiento tácito. Por otro lado, (2) las estrategias de la empresa en TI suelen poner más atención en las estrategias de uso de la TI y consecuentemente invierten más recursos en estas. Esto es debido al énfasis que se le otorga a la conversión de conocimiento explícito en documentos para que se puedan compartir electrónicamente a través de intranets. Sin embargo, para compartir el conocimiento tácito se suelen utilizar estrategias que requieran de relaciones interpersonales y por lo tanto no es necesaria tanta inversión en TI. Éstas pueden incluir redes de discusión online, videoconferencias, e-mail, así como otras herramientas de colaboración (Scheepers et al., 2004).

Por el momento existen muchos estudios que hacen referencia a la inversión en TI (Sircar et al., 2000; Thatcher y Oliver, 2001), dando por hecho que una mayor inversión mejorará el valor de la TI en la compañía. Este enfoque subestima cuestiones como la obsolescencia de los equipos o el rápido decrecimiento del precio del hardware, que provoca que mucho del material que tiene la compañía pierda su valor de forma rápida. Por ello, en el presente estudio asumimos un enfoque de competencia. Consideramos que lograr la competencia con respecto a las herramientas y procesos utilizados para gestionar la información ha adquirido mucha importancia dado el importante incremento de información en el mercado actual.

Existen diversos autores que han aportado una definición al concepto "Competencia en TI" (CTI). Si los clasificamos de forma cronológica destacaríamos en primer lugar la aportación de Ross et al., (1996) que define a esta competencia como la habilidad de controlar los costes relacionados con TI, ofrecer los sistemas cuando sea necesario, y afectar a los objetivos de negocio mediante la aplicación de TI. Seguidamente, Sambarmurthy y Zmud (1997) y Feeny y Wilcocks (1998), se refieren a la competencia en TI como los activos distintivos, competencias, conocimientos, procesos y relaciones que permiten a las empresas adquirir, desplegar y gestionar los productos y servicios de TI en la configuración de las innovaciones y las estrategias empresariales. Bharadwaj (2000) la entiende como la habilidad de la empresa de movilizar y desplegar la base de recursos de TI en combinación o co-presencia con otros recursos y capacidades. Nosotros nos quedamos con la definición de Tippins y Sohi (2003), en la que se define como el grado en que la empresa es conocedora de la forma de gestionar efectivamente la TI para gestionar la información dentro de la empresa. Estos autores clasifican la TI en distintas categorías (Bharadwaj, 2000) sugiriendo tres dimensiones para la medición del concepto. En este trabajo asumimos esta medición de Tippins y Sohi (2003) en la que el concepto es valorado como un constructo de segundo orden compuesto por tres factores de primer orden. Estos factores tienen un nivel de importancia similar; representan recursos co-especializados que proporcionan una medida de la habilidad de la organización para comprender y utilizar herramientas TIC y procesos necesarios para gestionar el mercado y la información de los clientes.

Conocimiento en TI

Dado que el conocimiento es información combinada con experiencia, contexto, interpretación y reflexión, representa un componente tácito que es difícil de cuantificar (Davenport et al., 1998:43). Como con otros dominios específicos del conocimiento, el conocimiento en TI se distingue por ser una selección de otras concepciones más generales del conocimiento (Capon y Glazer, 1987). El conocimiento técnico ha sido descrito como contexto basado en el saber hacer. Es decir, dadas ciertas circunstancias específicas, la correcta secuencia de acciones y administración de reglas de decisión apropiadas puede conducir a resultados predecibles. En este estudio, al igual que en el estudio de Tippins y Sohi (2003) el conocimiento en TI se conceptualiza como el grado en que una empresa posee un conjunto de conocimientos técnicos acerca de los objetos, tales como sistemas computarizados.

Operaciones en TI

Las operaciones técnicas comprenden actividades llevadas a cabo para conseguir un fin específico (Mitcham y Mackey, 1983). Pueden ser consideradas como los métodos, técnicas y requerimientos para completar una tarea específica (Granstrans, 1982). Consisten en procesos heterogéneos que son dirigidos a la producción de bienes y servicios económicos (Nelson et al., 1967). Esta conceptualización se corresponde con la idea de proceso tecnológico de Capon y Glazer (1987), que es un set de ideas y pasos utilizados para conseguir un objetivo (por ejemplo, un producto terminado). Las operaciones técnicas también son pensadas como una manifestación del conocimiento técnico cuya implementación resulta en operaciones técnicas o capacidades. Las capacidades no sólo representan una comprensión profunda de los dominios de conocimiento interno, sino que también reflejan una habilidad de exportar el conocimiento a otras operaciones incongruentes (Leonard-Barton, 1995). En este estudio seguiremos a Tippins y Sohi (2003) que conceptualizan las operaciones en TI como una extensión a través de la cual la empresa utiliza la TI para gestionar el mercado y la información del cliente.

Elementos de TIC

Los elementos de las TIC son fácilmente medibles (Reardon et al., 1996), actúan como facilitadores y son responsables del actual incremento de producción y difusión de la información (Glazer, 1991). Como herramienta, los objetos técnicos se refieren a los artefactos que ayudan en la adquisición, procesamiento, almacenamiento y uso de la información (Martin 1988:24). Para este estudio la conceptualización de elementos de la TI representan el hardware, software y personal de apoyo.

3. APRENDIZAJE ORGANIZATIVO

En este trabajo seguimos a aquellos trabajos que indican que una futura línea de investigación del aprendizaje organizativo debería ser estudiar como éste es afectado por los desarrollos tecnológicos (Argote, 2011). Dentro de esta nueva corriente encontramos estudios como el de Antonelli y Ferraris (2011) el cual destaca que para la introducción de innovaciones tecnológicas y organizativas se requiere de la generación de nuevos conocimientos. Esta generación de conocimiento se caracteriza por atributos específicos: el conocimiento es un output específico de la actividad y al mismo tiempo un imput para la generación de nuevo conocimiento. Debido a la indivisibilidad del conocimiento, el acceso al conocimiento existente en cada momento del tiempo es una condición necesaria para la generación de conocimiento nuevo. Sin embargo, ninguna empresa puede disponer de todo el conocimiento existente, por lo tanto, las empresas no generan el nuevo conocimiento tecnológico de forma individual. El carácter doble del conocimiento como resultado de un proceso de investigación y la entrada en la generación de conocimiento destaca además la complementariedad básica y la interdependencia de los agentes en el proceso de innovación: la innovación es en sí el resultado colectivo de la acción intencional e interactiva de los agentes económicos (Blume y Durlauf 2001 y 2005).

3.1 Competencia de aprendizaje externo

Se refiere a la habilidad de la empresa de crear e integrar nuevo conocimiento a través de la interacción con el entorno y con otras organizaciones (Bapuji y Crossan, 2004). Es decir, la empresa reconfigura las prácticas a través de la transformación de conocimiento. Un ejemplo de esto puede ser la combinación de conocimiento corriente con conocimiento nuevo proveniente de la adquisición de tecnología y de la interacción con el entorno y otras organizaciones (Ettlie y Pavlou, 2006). El nuevo conocimiento proveniente del aprendizaje externo se incluye en la base de conocimiento de la empresa y representa un imput importante para el proceso de innovación (Chang, 2003). Este aprendizaje será más rápido si se sustenta en la experiencia acumulada y la base de conocimiento presente en la empresa (Malerba, 1992; Levinthal y March, 1993).

Una forma de interaccionar con el entorno externo puede ser mediante las alianzas en I+D Quintana y Benavides (2011). El acceso al conocimiento diverso pero a la vez relacionado con la base tecnológica de la empresa beneficia, por un lado, su absorción mediante aprendizaje asociativo, y por otro, permite incrementar las posibilidades de desarrollar innovaciones tecnológicas en áreas familiares, así como de mejorar de forma continua y aplicar con nuevos propósitos las tecnologías centrales (Knudsen, 2007; Zhang et al., 2007, Vanhaverbeke et al, 2009).

3.2 Competencia de aprendizaje interno

Se refiere al conocimiento creado por la propia acumulación de experiencia de la empresa a través del uso de sus propios recursos. El aprendizaje interno se desarrolla principalmente a través de las actividades de investigación y el desarrollo e implementación de mejores prácticas. Es algo que se incluye en la base de conocimiento de la empresa y juega un rol importante en el proceso de innovación (Cohen y Levinthal, 1990; Kessler et al.2000).

El personal de la empresa puede crear y diseminar nuevo conocimiento dentro de los límites de la organización, requiriendo de la existencia de procesos de explotación. Desde las teorías evolutivas, esto implica un aprendizaje acumulativo que permite incrementar las capacidades corrientes de la empresa. Esta acumulación de aprendizaje interno juega un rol crucial para la empresa en términos de creación de valor, ya que permite incrementar su habilidad de explotar nuevas oportunidades (Penrose, 1959: Spender y Grant, 1996). En este sentido, la capacidad de absorción es una clara capacidad de aprendizaje, basada en el conocimiento previo (Cohen y Levinthal, 1990).

Nuestra medición de las **competencias en aprendizaje externo e interno** está basada en un enfoque de doble circuito de aprendizaje o doble bucle, ya que supone la modificación de las prácticas, objetivos y normas implícitas de la organización (Argyris y Schön, 1978). La característica de este tipo de aprendizaje es que se asume que los trabajadores y mandos intermedios transmiten la información sobre sus opiniones acerca de si se debería de cambiar alguna de las prácticas de la empresa que implica a su vez cambios en la estrategia que se está implementando.

4. HIPÓTESIS

La cuestión del tiempo en el proceso de innovación se convierte en el parámetro más difícil en el mercado competitivo. Cuanto más rápido se desarrolle un producto más probabilidades de conseguir una ventaja competitiva (Filippini et al., 2004). Por lo tanto, en un departamento de investigación y desarrollo se debe aplicar una técnica de desarrollo de productos rápida. El desarrollo rápido de productos requiere de sistemas de equipo orientados a la comunicación, que abran nuevas vías de cooperación. Mediante la utilización eficaz de competencias en TI dentro del departamento de investigación y desarrollo de una organización, el tiempo de desarrollo de producto se puede reducir (Bullinger et al., 2000). Además, la tecnología de la información es un buen instrumento para construir un entorno de colaboración, tales como el boletín electrónico o el portal de intercambio de conocimientos. Estos entornos pueden llevar a cabo el pensamiento creativo y agilizar la eficiencia y la eficacia de un proceso de innovación (Li et al., 2006) afectando favorablemente a la innovación de producto.

La competitividad y supervivencia de la compañía depende cada vez más de su capacidad de conocimiento para producir innovaciones continuamente (Cohen y Levinthal, 1990). Por ello, dado que la creación, diseminación y uso del conocimiento es facilitada por la tecnología de la información (Davenport et al., 1998), si esta tecnología aumenta permitirá la existencia de capacidades de conocimiento críticas para el sostenimiento de iniciativas de gestión del mismo que posibiliten la innovación (Alavi y Leidner, 2001). Por lo que;

H1: La competencia en tecnología de la información afecta de forma positiva al resultado de la innovación de producto.

Joshi et al. (2010) explican que existe mucha TI que puede ayudar a mejorar la capacidad de adquisición del conocimiento de dentro de la compañía; como por ejemplo los directorios de empleados que llevan a identificar en qué empleados clave reside el conocimiento o los sofisticados mecanismos inteligentes integrados en las tecnologías de búsqueda, recuperación y estructuración de datos. Alavi y Leidner (2001) proponen a la TI como herramienta para la mejora de la capacidad de asimilación de conocimiento de la compañía. Esta se produce mediante la creación de memoria organizativa en forma de repositorios de conocimiento. A partir del aprendizaje organizativo, las empresas pueden acumular conocimiento valioso para su almacenamiento y posterior uso por parte de los empleados (Tippins y Sohi, 2003) y las herramientas de TI ayudarán a que se produzca este almacenaje.

La TI refuerza el aprendizaje interno de la compañía (Joshi et al., 2010). A su vez, desde la perspectiva de recursos y capacidades, la capacidad de aprender se define como la habilidad de la empresa de desarrollar o adquirir nuevos recursos y habilidades basados en el conocimiento que sean útiles para ofrecer nuevos productos (Hull y Covin, 2010). En concreto, definimos al aprendizaje interno como la adquisición de nueva información y conocimiento por parte de los miembros de la organización gracias a la interacción con otras unidades o miembros de dentro de la organización (Schroeder et al., 2002). Esta interacción se verá reforzada por la TI. Hao-Chen Huang, (2011) sugieren que el aprendizaje interno incrementa la capacidad de innovación tecnológica de un equipo de investigación y desarrollo y esto podrá resultar en un incremento en innovación de producto. Por lo que nosotros esperamos que la competencia de aprendizaje interno sea el link que puede ayudar a la empresa a canalizar su competencia en TI hacia la mejora de sus resultados en innovación de producto. Consecuentemente, proponemos la siguiente hipótesis:

H2: La competencia de aprendizaje interno actúa como variable mediadora entre las competencias en TI y el resultado de la innovación de producto.

Shneiderman (2007), nos habla de herramientas que ayudan a que se produzca interacción social gracias a que facilitan la conexión entre los grupos e individuos. Un ejemplo de éstas podrían ser los tablones de anuncios, software de mensaje electrónico, salas de chat, tecnologías RSS para sintetizar y compartir información desde múltiples fuentes y los wikis y los blogs para la integración de conocimiento e ideas. Todo esto acelera el conocimiento por descubrimiento y la innovación (Shneiderman, 2007). Este tipo de herramientas será muy útil para la generación de competencias de aprendizaje externo.

La habilidad para adquirir, asimilar y explotar conocimiento externo está relacionada con el conocimiento previo de la empresa, que incluye habilidades básicas como el uso de un lenguaje común (Faems et al., 2007). Por lo que debemos de tener en cuenta la homogeneización del lenguaje que se produce mediante la utilización de TI como un factor que ayudará a que se produzca este tipo de conocimiento. Esta tecnología de la información aumenta la participación y el diálogo entre los individuos con el propósito de aumentar el desarrollo de conocimiento y la integración. Así, las herramientas de TI pueden fomentar y proveer la capacidad de integración social formal e informal, gracias al soporte de varios mecanismos de integración social (Joshi et al. 2010). Por ejemplo, el uso de video conferencias y trabajo en grupo facilita la integración formal, mientras varias herramientas como las prácticas de e-community y los blogs, crean oportunidades para la integración informal.

Dewet y Jones (2001) sugieren que la aplicación de TI aumenta la capacidad de hacer frente a los socios externos, clientes y partes interesadas a través de la expansión de los límites de las actividades que realiza la organización. Del mismo modo, la fortaleza del conocimiento retenido en una organización mejora con la calidad de las interacciones y colaboración de los grupos de individuos que lo utilizan, con la mejor comprensión acerca de cómo codificar el conocimiento y las fuentes disponibles para su actualización. Ese proceso de refuerzo del conocimiento promueve la capacidad de innovación (Subramaniam y Youndt, 2005). Por lo que podemos esperar que la competencia de aprendizaje externo sea el link que facilita que la empresa pueda canalizar su competencia en TI hacia la mejora de sus resultados en innovación de producto. Por ello proponemos que;

H3: La competencia de aprendizaje externo actúa como variable mediadora entre las competencias en TI y el resultado de la innovación de producto

5. METODOLOGÍA

5.1 Muestra

Dada la naturaleza de la investigación y la consecuente inexistencia de fuentes de datos secundarios, recurrimos a encuestas para obtener la información necesaria para la realización de este estudio. Utilizamos compañías industriales, ya que en este tipo de compañías la adquisición de conocimiento externo es complementaria a la I+D interna, lo que contribuye al desarrollo de conocimiento tecnológico previo (Cassiman y Veugelers, 2006). Esto será importante para poder observar tanto la competencia de aprendizaje interno como externo.

Nos centramos en una única industria, debido a que el aprendizaje que participa en los procesos de innovación probablemente será más homogéneo (Santarelli y Piergiovanni, 1996). En concreto, examinamos las industrias de cerámica italiana y española del azulejo, ya que es una población bastante homogénea y ello nos permite controlar ciertos factores de contingencia como el tamaño y la industria (Bonavia y Marin, 2006; Oltra y Flor, 2010).

La industria de producción de azulejo se encuentra en gran medida globalizada. En el momento de obtención de la muestra, la producción de cerámica italiana y española representaba el 77% de la producción de la UE (Ascer 2006). Siendo el 44% producido en España (ITC 2004).

Los productores de azulejo de cerámica italiana y española se organizan de manera similar. La mayoría de ellos son considerados como PYMEs, ya que por lo general no exceden de un promedio de 250 trabajadores y tienden a concentrarse geográficamente en distritos industriales: Sassuolo en el norte de Italia y Castellón en el este de España (Valencia, Cámara de Comercio de 2004).

En la producción de azulejo de cerámica, la acumulación tecnológica se genera principalmente por (1) el diseño, construcción y operación de sistemas de producción compleja (trayectoria escala intensiva), y (2) conocimientos, habilidades y técnicas emergentes de investigación académica química (trayectoria basada en la ciencia). Estudios previos proporcionan pruebas convincentes de que los productores de azulejo de cerámica italiana y española muestran una conducta significativa hacia la innovación (Enright y Tenti 1990; Oltra et al., 2002).

La encuesta se realizó entre octubre y diciembre de 2006 (anexo). Para garantizar que los ítems del cuestionario fueran plenamente comprensibles en el contexto de la industria cerámica se llevó a cabo un pre-test con cuatro técnicos del Centro Español de Innovación y Tecnología en Diseño Industrial Cerámico (ALICER). El cuestionario se construyó mediante escalas Likert de 7 puntos y fue dirigido a los directivos de las empresas. Los directores de Recursos Humanos contestaron a las preguntas referentes a la gestión del conocimiento (Wang 2008) y tecnología de la información mientras los directores de producción a las preguntas de resultado en la innovación, ya que es el director de producción la persona de la empresa con más conocimiento en las actividades en materia de innovación (Calantone et al., 2002). Las encuestas se hicieron mediante entrevista personal a cada uno de los encuestados. Para favorecer el ratio de respuesta ofrecimos un informe con los resultados extraídos a las empresas participantes.

Finalmente, obtuvimos un total de 186 cuestionarios, 97 de las empresas italianas y 89 de las empresas españolas. La muestra obtenida representó alrededor del 50% de la población objetivo. Tanto el número de respuestas como la tasa de respuesta puede considerarse satisfactoria (Spector, 1992; Williams et al., 2004). El sesgo de no respuesta se evaluó a través de una comparación de las estadísticas de la muestra con valores de la población conocida como el volumen de ventas anuales o el número de empleados. Existen páginas web pertenecientes a las asociaciones de productores de azulejos de cerámica que ofrecen esta información para la mayoría de las empresas de la industria; tanto en Italia (Assopiastrelle 2006) como en España (Ascer 2006).

5.2. Medida de las variables

Para medir el *resultado en innovación de producto* utilizamos la escala propuesta por Gatignon et al. (2002) que está compuesta por 3 items. Esta escala ha sido utilizada satisfactoriamente por un número considerable de estudios empíricos (Mu y Di Benedetto, 2011). El instrumento de medida utilizado fue una escala likert de 7 puntos que variaba desde totalmente en desacuerdo a totalmente de acuerdo.

La *competencia en tecnologías de la información y comunicación* fue medida utilizando la escala de medida propuesta por Tippins y Sohi, (2003). Esta escala está compuesta por 3 dimensiones: conocimiento de las TIC, operaciones en TIC y elementos de TIC. La escala likert de 7 puntos variaba desde nada de acuerdo a muy de acuerdo.

La *competencia en aprendizaje extern*o está compuesta por 5 items relacionados con la habilidad de la empresa para adquirir y crear conocimiento colaborando con otros agentes externos a la empresa. Y la *competencia en aprendizaje interno* está compuesta por 6 ítems relacionados con las habilidades de la empresa para ayudar a crear y gestionar el desarrollo de conocimiento interno (ver anexo). Para medir ambas competencias de aprendizaje se ha utilizado una escala likert de 7 puntos que señala el grado de acuerdo y desacuerdo del entrevistado con las afirmaciones propuestas. Estas escalas han sido utilizadas satisfactoriamente en estudios anteriores (Alegre et al., 2011).

Fue tenida en cuenta la variable de control; *poder de mercado*. Se pretende controlar si el poder de mercado tiene un impacto significativo en los resultados en innovación. Para ello se preguntó por la cuota de mercado y el incremento de las ventas (escala likert de 7 puntos).

5.3 Análisis estadísticos

Para el análisis empírico se realizaron modelos de ecuaciones estructurales con indicadores robustos. Este tipo de análisis multivariado de segunda generación puede resolver varios problemas que pueden ocurrir en el análisis de regresión múltiple (Dhanaraj y Beamish, 2003), y sobre todo permite analizar las relaciones al mismo tiempo, incluidas las mediciones de error en el modelo, por lo que es posible identificar una posible sobreestimación o subestimación de la fuerza de las relaciones entre los constructos. Desde el punto de vista teórico, esta técnica confirma las medidas de fiabilidad y validez de los constructos. Nuestro modelo de investigación se estimó utilizando el software EQS 6.1. La muestra está compuesta por 186 empresas; por lo tanto está muy por encima del límite mínimo de 100 sujetos que se considera para realizar los análisis de modelos de ecuaciones estructurales (Williams et al., 2004).

5.4. Propiedades psicométricas de las escalas de medición

Las propiedades psicométricas de las escalas de medida fueron evaluadas de conformidad con las prácticas aceptadas (Gerbing y Anderson, 1988; Tippins y Sohi, 2003), incluyendo la validez de contenido, fiabilidad, validez discriminante, validez convergente y dimensionalidad de la escala.

La validez de contenido se establece a través de una revisión de la literatura existente y por medio de entrevistas personales con expertos del sector industrial azulejero de cerámica (cuatro técnicos del área de diseño y arquitectura del Instituto Tecnológico de Cerámica. Esta área tiene el nombre de ALICER). Hemos calculado el coeficiente alfa y el indicador de fiabilidad compuesta para evaluar la fiabilidad de la escala (Fornell y Larker 1981; Bou-Llusar et al., 2009). Todas las escalas poseen un coeficiente alfa aceptable y fiabilidad de los indicadores compuestos de al menos 0,70.

Tabla 1. Media, desviación típica, Alpha Reliabilities, correlaciones y Alpha de Cronbach

	Mean	s.d.	CR	1	2	3	4	5	6	7
1.- CTI	4,72	1,46	0,91	(0.88)						
2.-OTI	4,54	1,48	0.71	0,65**	(0.92)					
3.-ETI	4,12	1,59	0.67	0,58**	0,64**	(0.83)				
4.-CAI	3,97	1,61	0.95	0,21**	0,11	0,21**	(0.94)			
5.-CAE	3,96	1,42	0.94	0,09	-0,03	0,13	0,74**	(0.88)		
6.-ECI	5,26	1,51	0.94	0,30**	0,12	-0,06	0,22**	0.00**	(0.90)	
7.-PM	4,53	1,50	0.89	-0,09	0,03	0,04	0,52**	0.48**	0.09	(0.82)

NOTA: ** Coeficiente de correlación estadísticamente significativo ($p<0.01$). El Alpha de Cronbach se muestra en la diagonal. Composite reliabilities se muestra en la columna CR Para calcular los coeficientes de correlación trabajamos con las medias de los items que construyen cada dimensión.

NOTA 2: CTI: Competencias en Tecnologías de la Información. OTI: Operaciones en Tecnologías de la Información. ETI: Elementos en Tecnologías de la Información. CAI: Competencia de Aprendizaje Interno. CAE: Competencia de Aprendizaje Externo. ECI: Éxito Comercial de la Innovación. PM: Poder de Mercado.

La validez discriminante se evaluó mediante análisis factorial confirmatorio (AFC), comparando las diferencias de χ^2 entre un modelo factorial confirmatorio restringido con una correlación interfactor establecida en 1 (que indica que son la misma construcción) y un modelo sin restricciones con una correlación interfactor "set free". Todas las diferencias χ^2 fueron significativas, proporcionando evidencia de la validez discriminante (Anderson y Gerbing 1988; Gatignon et al 2002). También se utilizó el AFC para establecer la validez convergente mediante la confirmación de que todos los ítems de la escala cargaban significativamente en la construcción de sus factores (Anderson y Gerbing 1988). Adicionalmente, se confirmó la validez convergente mediante la comparación de las diferencias de χ^2 entre un modelo "constrained confirmatory" con una correlación interfactor establecida en 0 (que indica que no existe relación entre los dos constructos) y un modelo sin restricciones con una correlación interfactor "set free". Toda diferencia de χ^2 se consideraron significativas, proporcionando evidencia de la validez convergente (Gatignon et al., 2002).

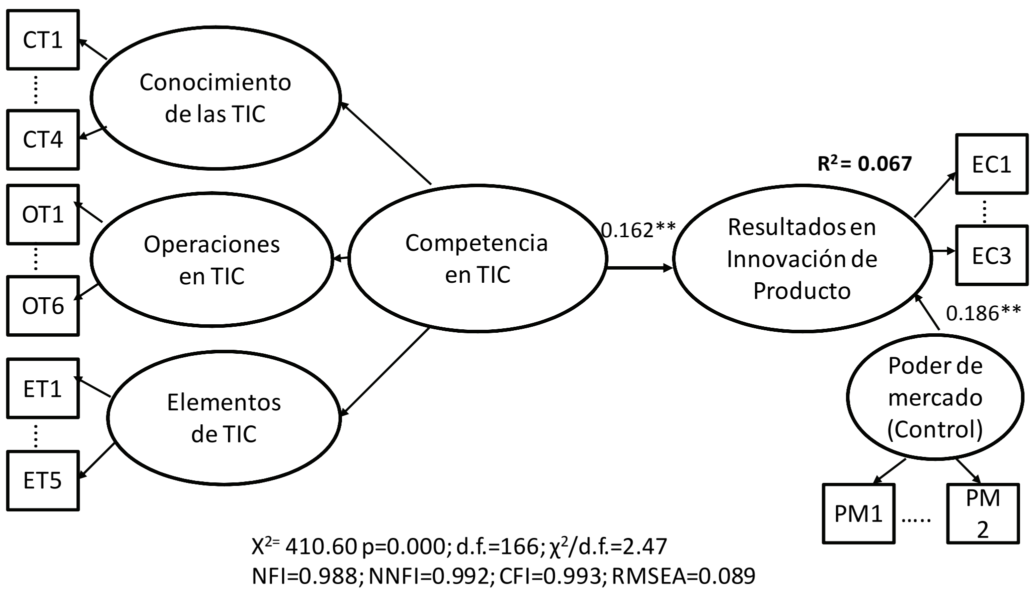
Se testó la dimensionalidad de los constructos a través de las cargas de los elementos de medición de los factores de primer orden y las cargas de los factores de primer orden en los factores de segundo orden. Todas las cargas fueron superiores a 0,40 y significativas ($p < 0.001$). No aparecieron cargas cruzadas.

Hemos utilizado diferentes informantes dentro de una misma empresa para evitar el problema de varianza común. En concreto, el director de Recursos Humanos contestó a las preguntas sobre competencias de conocimiento interno y externo y el director de Producción contestó a las preguntas sobre competencias en TI y resultados en innovación de productos.

6. RESULTADOS

El estadístico χ^2 es la herramienta más utilizada para medir el ajuste del modelo y es especialmente recomendado para probar efectos mediadores como el de este modelo. Como podemos ver en la figura 5.1, el estadístico χ^2 es significativo. Sin embargo, otros índices relevantes muestran un buen ajuste (Tippins y Sohi, 2003). En este primer modelo examinamos el efecto directo entre la competencia en TI y el resultado en innovación del producto. Este modelo se utiliza para testar la hipótesis 1 que sugiere una relación positiva y significativa entre la competencia en TI y el resultado en innovación de producto. Por lo que podemos indicar que nuestra primera hipótesis obtiene soporte.

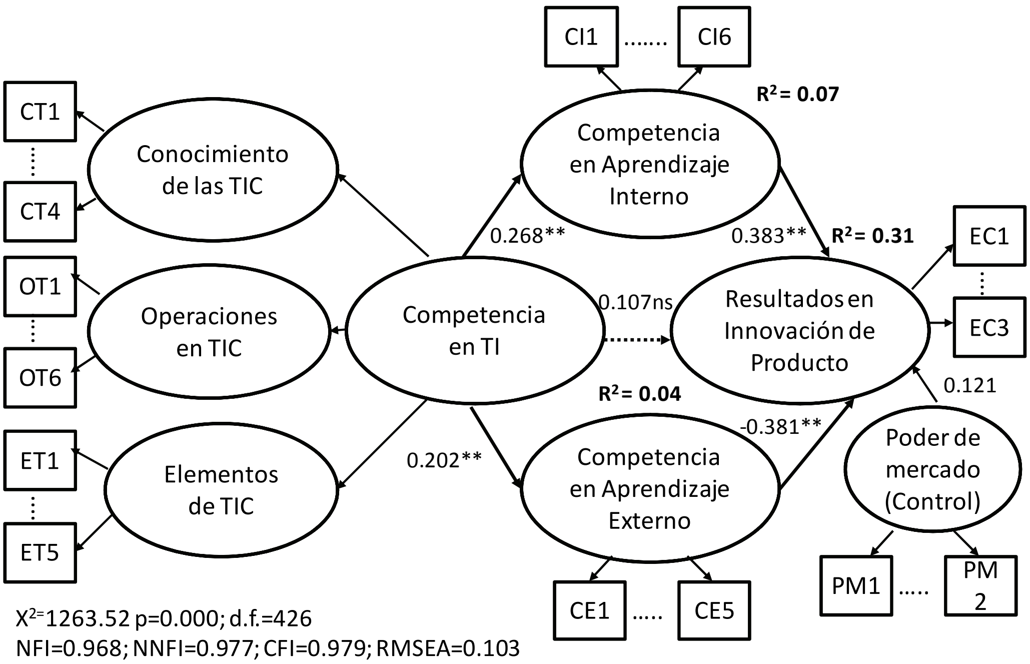
Figura 1. Modelo directo



En el segundo modelo mostramos la mediación parcial que examina la misma relación introduciendo las competencias en aprendizaje interno y externo como variables mediadoras.

La inclusión de estas variables en el análisis ayuda a proporcionar una explicación a la relación positiva entre la competencia en TI el éxito comercial de la innovación. La figura 5.2 muestra los resultados de los análisis. El estadístico χ^2 para cada modelo es significativo, sin embargo y los índices son superiores 0,90 por lo que sugieren un buen ajuste general (Tippins y Sohi, 2003).

Figura 2. Modelo Mediado



El efecto mediador de las competencias en aprendizaje interno y externo en la relación competencia en TI y resultados en innovación de producto es demostrado, tal como sugieren Tippins y Sohi (2003) por la secuencia siguiente: (1) Primero, la mediación parcial del modelo explica más varianza de la variable dependiente que el modelo directo (R2=0,31 vs. R2=0,06); (2) existe una relación significativa entre TI y las competencias en aprendizaje interno y externo; (3) existe una relación significativa entre competencias en aprendizaje interno y externo y el éxito comercial de la innovación, y (4) la relación significativa entre la competencia en TI y los resultados en innovación de producto se convierte en baja y no significativa en el modelo de mediación parcial. Esta secuencia proporciona pruebas convincentes de un claro efecto de mediación de las competencias de aprendizaje interno y externo en la relación. Así, a nuestro entender, el modelo de mediación parcial representa una contribución significativa de la influencia – la cual es apoyada tanto por la teoría como por algunas investigaciones empíricas anteriores - de la competencia en TI en el éxito comercial de la innovación. Por lo que nuestras hipótesis 2 y 3 obtienen soporte.

7. DISCUSIÓN

La posibilidad de que la competencia en tecnología de la información proporcione ventajas competitivas a la compañía ha recibido gran interés en los últimos años. A pesar de que se considera que la inversión en TI tendrá un impacto positivo en el resultado empresarial, parece ser que esta relación no se da en todos los casos. Tippins y Sohi (2003) intentan dar luz a esta controversia y para ello proponen al aprendizaje organizativo como variable intermedia en esta relación. El aprendizaje organizativo será necesario para que las inversiones en TI provoquen mayores resultados generales. Nosotros creemos que es necesario más esfuerzo para poder entender este fenómeno, por lo que establecemos una nueva variable dependiente muy ligada a los resultados empresariales, los resultados en innovación. Estudios anteriores demuestran que aquellas empresas con mayores resultados innovadores también obtienen mayor resultado general (Baker y Sinkula 2009). Además, incluimos dos variables intermedias, la competencia en aprendizaje interno y la competencia en aprendizaje externo.

Podemos resaltar que nuestro principal objetivo es examinar los efectos de la competencia en TI y del aprendizaje interno y externo en el éxito comercial de la innovación. Tratamos de explicar por qué los resultados en innovación de producto varían entre las empresas. Para ello nos centramos en una única industria, la cerámica italiana y española, caracterizadas por ser líder mundial en términos de tecnología, productividad, calidad y diseño y por tener unas características muy parecidas en ambos países, de forma conjunta. Observamos los efectos que pueden tener en los resultados en innovación producidos en esta industria la competencia en TI y el aprendizaje interno y externo de las compañías que la conforman. Si examinamos de forma conjunta los efectos directos e indirectos, comprobamos que los efectos indirectos prevalecen sobre los directos. Por lo que la competencia en TI puede mejorar las ventajas competitivas sostenibles en el rendimiento de la innovación de productos, pero lo hace de forma indirecta a través de las competencias de aprendizaje interno y externo. Por lo tanto, las ventajas competitivas sostenibles en la industria del azulejo cerámico requerirán de estrategias que enfoquen su atención en la competencia en TI. Sin embargo, éstas deberán prestar especial atención a las competencias de aprendizaje interno y externo, ya que el impacto de la competencia en TI en el resultado en innovación está mediado por ambas competencias. La innovación es un output importante dentro de los procesos empresariales siendo un factor crítico para el resultado económico de la compañía.

En segundo lugar, dado que las empresas están incrementado el uso de soportes de sistemas digitales e impulsando sus iniciativas de gestión del conocimiento, los investigadores de sistemas de la información resaltan la necesidad de estudios que nos ayuden a entender los roles de la TI en la gestión del conocimiento y la innovación de las empresas (por ejemplo, Alavi y Leidner, 2001; Sambamurthy y Subramani, 2005; Joshi et al., 2010). Por ello, nuestra conceptualización e investigación empírica ayuda a enriquecer esta literatura.

Sorprendentemente, pese a que la relación entre la competencia de aprendizaje interno y el éxito comercial de la innovación es positiva, nuestros resultados muestran una relación negativa entre el aprendizaje externo y el éxito comercial de la innovación. Para poder entender este resultado realizamos análisis adicionales para estudiar cómo se comportan cada una de las variables que componen el constructo. Tras observar las correlaciones de las variables que forman al aprendizaje externo con respecto al éxito comercial de la innovación, descubrimos que aquellas variables que muestran una fuerte relación negativa con respecto al éxito comercial son las relacionadas con la colaboración con asociaciones del sector (compuestas por las empresas de la industria y por lo tanto, empresas competidoras entre sí). La literatura nos indica que la cooperación con competidores es considerada por algunas industrias como peligrosa. A pesar de la ventaja de intercambiar el conocimiento tecnológico en la colaboración con los competidores, éstos son potencialmente peligrosos porque venden en mercados similares al de la empresa y supone un riesgo el que puedan acceder a los recursos en I+D de la empresa (Tsai 2009). Este riesgo se entiende por Veugelers y Cassiman (1999) como posibles efectos secundarios involuntarios "involuntary outgoing spillovers". Estos autores explican por qué el acceso al conocimiento del competidor es la fuente menos frecuente. Entendemos que este es el caso de la industria cerámica. No obstante, las variables “cooperación con las instituciones de investigación” y “adquisición de tecnología”, muestran una correlación positiva con respecto al éxito comercial de la innovación, por lo que en la industria cerámica será importante el aprendizaje que se obtiene a través de estas dos fuentes para alcanzar un mayor éxito comercial de la innovación.

Estos resultados tienen implicaciones importantes para la toma de decisiones sobre las competencias en TI y las competencias en aprendizaje interno y externo, sobre todo en el contexto de la innovación de productos. Con este estudio también reforzamos las nuevas tendencias en la investigación sobre la perspectiva de recursos y capacidades que buscan no sólo identificar los activos críticos específicos de una industria en particular, sino también mejorar nuestra comprensión de cómo esto ocurre en entornos cambiantes al considerar las capacidades dinámicas.

Desde un punto de vista práctico nuestros resultados muestran que la simple inversión en TI por sí misma no puede proveer valor estratégico, sino que ayudará al soporte y refuerzo de las capacidades organizativas claves para la innovación y las ventajas competitivas. Las empresas deben focalizar su atención en factores intermedios como las competencias en conocimiento interno y externo y los resultados en innovación de producto para determinar qué beneficios pueden derivarse de las inversiones en TI que favorecen la asunción de esta competencia. Los resultados sugieren que los gerentes no deberían dedicarse al análisis del impacto directo de las TI, sino que deberían encontrar maneras de mejorar la TI en su rol de captación y refuerzo de las competencias de aprendizaje de la empresa, que ayudan a que una empresa sea más innovadora. Es decir, no solo se trata de invertir en TI sino que se deben de realizar unas políticas adecuadas para la generación de competencias de aprendizaje interno y externo, posibilitando de este modo que las inversiones en TI se traduzcan en un mayor éxito comercial de la innovación.

Los resultados del presente estudio están sujetos a ciertas limitaciones. En primer lugar, los datos fueron recogidos de forma transversal, es decir, en un único momento del tiempo, por lo que no se puede demostrar de manera concluyente la causalidad ni descartar la causalidad inversa. Por otra parte, la población objetivo de este estudio se limita a un conjunto bastante homogéneo de empresas. Aunque esto aumenta la confianza de que los resultados se derivan de las hipótesis principales, no podemos generalizarlos.

Los resultados de este estudio proporcionan una guía para futuras investigaciones. El efecto mediador de las competencias de aprendizaje interno y externo debe tenerse en cuenta en la investigación sobre competencia en TI y resultados de la innovación de productos. La relación entre competencia en TI y resultados en innovación de producto necesita análisis adiciones desde una perspectiva longitudinal. Investigaciones futuras pueden distinguir entre innovación de producto radical e incremental.

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8. ANEXOS

Anexo 1)

Tabla 2. Ítems del cuestionario

A.- COMPETENCIA EN TECNOLOGÍAS DE LA INFORMACIÓN Y COMUNICACIÓN (TIC)

Por favor, indique el grado de acuerdo / desacuerdo con los siguientes aspectos relacionados con las TIC:

CONOCIMIENTO DE LAS TI	Tippins y Sohi (2003)
CT1. En general, nuestros empleados de apoyo técnico informático están al día en sus conocimientos.	
CT2. Nuestra empresa domina la tecnología informática.	
CT3. Estamos al día en cuanto a innovaciones informáticas	
CT4. Tenemos el conocimiento necesario para desarrollar y mantener conexiones informáticas de comunicación con nuestros clientes y proveedores	
OPERACIONES EN TI	
OT1. Nuestra empresa es experta en recoger y analizar información sobre nuestros clientes y nuestros proveedores via sistemas informáticos.	
OT2. De forma rutinaria utilizamos sistemas informáticos para acceder a información procedente de bases de datos externas	
OT3. Utilizamos sistemas informáticos para analizar la información de los clientes y de los proveedores	
OT4. Utilizamos sistemas de apoyo a la toma de decisiones frecuentemente cuando procesamos la información sobre nuestros clientes y proveedores.	
OT5. Nos basamos en sistemas informáticos para recoger, almacenar y procesar la información sobre nuestros clientes y proveedores.	
ELEMENTOS DE TI	
ET1. Nuestra empresa tiene un departamento formal de Sistemas de Gestión de la Información	
ET2. El directos de nuestra empresa incluye dentro de sus tareas principales la gestión de nuestra tecnología de la información	
ET3. Cada año presupuestamos una cantidad de fondos importante para nuevo hardware y software (de tecnología de la información).	
ET4. Nuestra empresa crea aplicaciones informáticas específicas cuando surge la necesidad.	

B.- CAPACIDADES DE GESTIÓN DEL CONOCIMIENTO

Nivel de desempeño de su empresa en comparación a la competencia en los siguientes aspectos (escala LIKERT de 7 puntos):

CONOCIMIENTO EXTERNO	
CE1. Capacidad para obtener información del estado y los progresos de la ciencia y las tecnologías relevantes mediante sistemas de prospectiva y vigilancia tecnológica	Fleisher (2001); Chang (2003)
CE2. Disponibilidad y eficacia de los sistemas de captación de información relevante, continua y actualizada sobre los competidores, mediante sistemas de inteligencia competitiva	Fleisher (2001); Myburgh (2004)
CE3. Habilidad para la creación de conocimientos mediante la cooperación con las asociaciones del sector	Chang (2003)
CE4. Habilidad para la creación de conocimientos mediante la cooperación con las instituciones de investigación	
CE5. Adquisición de tecnología	Jacobsson et al. (1996)
CONOCIMIENTO INTERNO	
CI1. Grado de cualificación académica del personal de I+D+I	Jacobsson et al. (1996)
CI2. Capacidad para mantenerse en la frontera tecnológica del negocio	Wheelwright y Clark (1992); Tidd, Bessant y Pavitt (1997)
CI3. Habilidad para organizar el esfuerzo de innovación e I+D+I	Takeuchi y Nonaka (1986); Tidd et al. (1997)
CI4. Eficacia en la definición de mecanismos de seguimiento y revisión de los proyectos de I+D+I	Wheelwright y Clark (1992); Tidd et al. (1997)
CI5. Eficacia en la asignación de recursos humanos al departamento de I+D+I	Jacobsson et al. (1996)
CI6. Capacidad para coordinar e integrar todas las fases del proceso de I+D+I y sus interrelaciones con las tareas funcionales de ingeniería, producción y marketing	Takeuchi y Nonaka (1986); Weelwright y Clark (1992)

E.- INNOVACIÓN TECNOLÓGICA

Con referencia a la innovación tecnológica más importante de los últimos tres años indique el grado de acuerdo o desacuerdo con respecto a las siguientes afirmaciones (escala LIKERT de 7 puntos)

ÉXITO COMERCIAL PERCIBIDO DEL PRODUCTO	
EC1. La innovación fue implantada con éxito en la empresa	
EC2. La innovación ha significado un éxito comercial para la empresa	
EC3. La innovación ha alcanzado las expectativas de la empresa en cuanto a impacto en las ventas	Gatignon, Tushman, Smith y Anderson (2002)

Anexo 2)

Figura 3. AFC de la Competencia en Tecnología de la Información y Comunicación

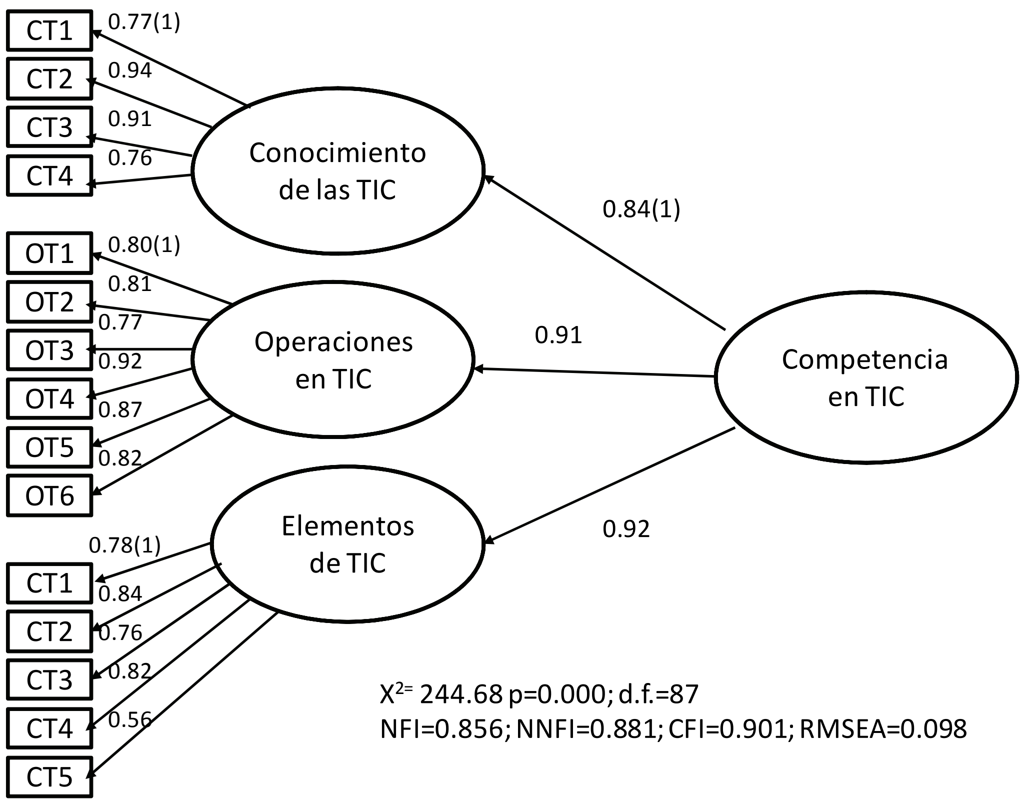
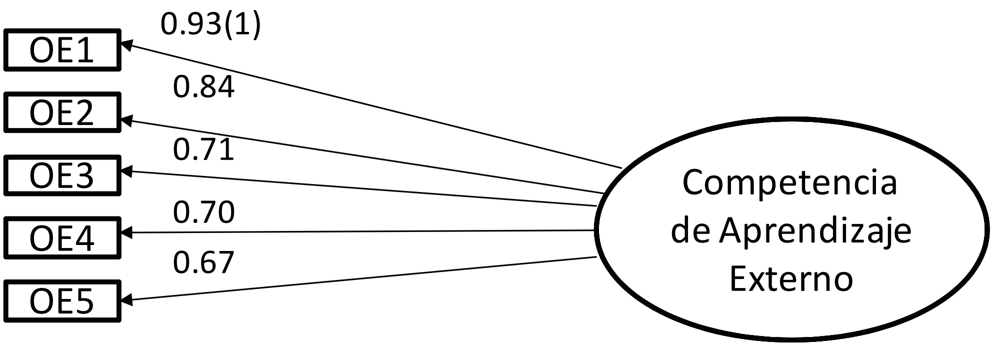
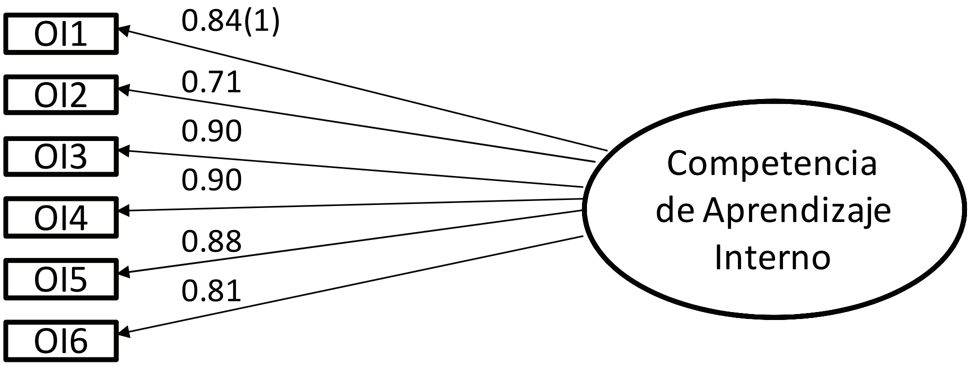


Figura 4. AFC de la Competencia de Aprendizaje Externo



$X^{2}=$ 22.77(p=0.000); d.f.=5
NFI=0.952; NNFI=0.923; CFI=0.962; RMSEA=0.139

Figura 5. AFC de la Competencia de Aprendizaje Interno



$X^{2}=$ 29.81(p=0.000); d.f.=9
NFI=0.966; NNFI=0.960; CFI=0.976; RMSEA=0.112

MODELOS Y CONSTRUCTOS DE MEDIDA DE LA CAPACIDAD DE ABSORCIÓN: ¿EXISTE UN CONSENSO EN SU DESARROLLO?[45]

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RESUMEN

A pesar del amplio crecimiento de la literatura sobre capacidad de absorción, aun existe cierto vacío teórico y metodológico respecto a su medición y a los dominios en los que se enmarca. Son varios los estudios que han revisado el concepto y que han contribuido a facilitar el entendimiento de los aspectos centrales del término. No obstante, son pocos los estudios que han llevado a cabo un análisis sistemático del nivel de apoyo empírico alcanzado en su estudio. Para dar respuesta a este gap fue examinada una muestra de 78 artículos empíricos, para los cuales se emplearon criterios de selección específicos y relevantes. Tras la revisión teórica, nuestros resultados resaltan que la validez del concepto varía considerablemente según el enfoque planteado y del tipo de variable independiente y dependiente estudiada. Asimismo, pocos académicos han incorporado en sus mediciones el aspecto multidimensional del concepto limitándose a medirlo a través de aproximaciones como son la I+D, el conocimiento previo y las patentes.

Palabras claves:

Capacidad de absorción; estudios empíricos; modelos; constructos

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1. INTRODUCCIÓN

El conocimiento ha sido reconocido como uno de los principales recursos que permite a las organizaciones obtener ventajas competitivas (Grant, 1996, Teece, 1997). Debido a ello, varias organizaciones centran su atención en el desarrollo de conocimiento interno a través de actividades como son la I + D (Laursen & Salter 2006). No obstante, dado los constantes cambios y dinamismo del entorno, una estrategia centrada únicamente en el conocimiento interno es limitada. Por ello es necesario que las organizaciones evolucionen a una estrategia que les permita obtener las ventajas de la integración del conocimiento interno y externo (Lichtenthaler 2009). En este marco la capacidad de absorber conocimiento externo se ha convertido un elemento crucial, ya que otorga a las organizaciones la habilidad para identificar, asimilar y explotar el conocimiento externo con fines comerciales (Cohen & Levinthal, 1990).

A partir de su introducción, el concepto ha sido utilizado en un centenar de publicaciones de diversos campos de la teoría sobre las organizaciones como son: dirección estratégica, gestión de las tecnologías, negocios internacionales y economía. Todo ello ha contribuido a su rápida expansión y a afianzar su importancia en el campo de las organizaciones (Lane, Koka & Pathak 2006, Volberda, Foss & Lyles 2010, Zahra & George 2002, Todorova & Durisin 2007) .

A pesar de las constantes contribuciones realizadas a la teoría, las cuales han permitido mejorar nuestro entendimiento sobre el concepto, varios de los estudios recientes muestran que el concepto todavía se encuentra rodeado de cierta incertidumbre que impiden explotar su potencial. Lane, Koka y Pathak, (2006) en su artículo revisaron 289 artículos escritos sobre el concepto y señalaron que este había sido utilizado de una manera reducida, debido a que la mayor parte de los artículos habían tratado la temática sin discutir ni profundizar sobre los aspectos centrales del concepto. En otro trabajo reciente Volberda, Foss & Lyles, (2010) muestran que el concepto presenta cierto grado de ambigüedad respecto a su (1) definición y naturaleza, (2) los dominios en que existe, (3) sus implicaciones y principales antecedentes. Son varios los factores señalados en la literatura como antecedentes de la AC, sin embargo no se ha llegado a un acuerdo acerca de la importancia relativa de estos. Muestra de ello es la alta variabilidad que existe en su uso y medición.

Aunque los estudios antes mencionados facilitan el entendimiento de varios de los aspectos centrales de la AC, estos no dejan claro el nivel de validez alcanzado en la medición de los principales antecedentes e implicaciones del concepto. Dicho aspecto nos llevó a formular la siguiente pregunta de investigación: ¿existe algún consenso en la identificación y medidas del constructo, y en las supuestas relaciones entre constructos? Nosotros suponemos que un consenso sobre estos aspectos es lo que permite a una teoría avanzar en una manera sistemática y acumulativa (David & Han 2004). Aunque la falta de conceso paradigmático y la resistencia de llegar a tal consenso dentro de los estudios de AC es evidente (Volberda, Foss & Lyles 2010, Lane, Koka & Pathak 2006) , un análisis en profundidad de las hipótesis centrales del constructo analizadas en la literatura nos podría conducir a identificar cuáles de ellas presentan deficiencias o cuáles un mayor desarrollo teórico. Para la selección y la evaluación del cuerpo de estudios empíricos, aplicamos una versión adaptada del modelo desarrollada por David y Han (2004) y por Newbert (2007). Este nos permitió evaluar el nivel de apoyo alcanzado por varias de las proposiciones centrales del concepto e identificar áreas en las que la teoría ha sido más o menos exitosa.

Nuestro estudio se encuentra estructurado en cuatro secciones: en un primer apartado presentaremos una visión general del concepto, seguido de esto expondremos la metodología aplicada para el estudio, a continuación presentaremos los principales resultados obtenidos tras aplicar la metodología antes expuesta, luego indicaremos las conclusiones, y por último las limitaciones y futuras líneas de investigación que quedan abiertas.

2. EL CONCEPTO DE CAPACIDAD DE ABSORCIÓN

El concepto de capacidad de absorción (AC) fue introducido en 1989 por Cohen y Levinthal en su artículo “Innovation and learning: the two faces of R&D”. En este lo definen como “la habilidad de las organizaciones para reconocer, asimilar y aplicar conocimiento externo”. Para ellos, el nivel de inversión que las empresas realizan en actividades de I+D es lo que les permite a las empresas identificar ventajas tecnológicas del entorno y apropiarse de ellas. Por ello establecen la I+D como el factor clave que facilita el aprendizaje y, por ende, el desarrollo de AC en las organizaciones.

En su artículo de 1990 “*Absoptive capacity: an new perspective on learning and innovation”* estos autores readaptan la definición inicial y la conectan con la habilidad de aplicar el conocimiento con fines comerciales. De manera similar a su trabajo previo, consideran la AC como un concepto formado por tres dimensiones esenciales: la capacidad de identificar, asimilar y aplicar el nuevo conocimiento con fines comerciales. Sin embargo, en este consideran que la AC de las empresas no solo constituye el resultado de las actividades de I+D, sino que también el conocimiento previo y los mecanismo organizacionales que facilitan la comunicación y la compartición de conocimiento, juegan un papel importante en su desarrollo.

Para ellos, la base de conocimiento previo permite a las organizaciones identificar en el ambiente externo aquel conocimiento que es importante para sus procesos y por ende influye significativamente sobre su capacidad de identificar conocimiento. Así mismo, mientras mayor sea el grado de relación que guarde el conocimiento externo con el existente en la organización, más fácil será para estas identificar y asimilar el nuevo conocimiento. Dada estas condiciones, la capacidad de las organizaciones para identificar y asimilar conocimiento nuevo del entorno estará limitada a la cantidad de AC acumulada en un período previo y a la posesión de una experiencia relacionada (Cohen & Levinthal 1990). No obstante, tanto para la identificación como para la aplicación efectiva del conocimiento serán necesarias estructuras de comunicación que faciliten el intercambio de información, tanto con el ambiente externo como con las diferentes unidades de la organización.

Posterior a los trabajos antes citados de Cohen y Levinthal (1989, 1990) (ver tabla 1), varios académicos abordan la temática en sus análisis a diferentes niveles de la organización, sin modificar la definición original de Cohen y Levinthal o modificando ligeramente las dimensiones propuestas por estos autores. Lo que hacen estos autores es limitar las dimensiones originales del concepto a dos. La primera, ligada a la habilidad de identificar información valiosa en el ambiente externo y de posteriormente combinarla con la base de conocimiento existente, (capacidad de reconocer, identificar, monitorear o asimilar el conocimiento externo). La segunda, relacionada con la transferencia del conocimiento adquirido a nivel interno para así facilitar su posterior implementación (capacidad de comunicar y aplicar). Por ejemplo, Arbussá y Coenders (2007) tomando como base los trabajos previos de Arora y Gambardella (1994), y de Cassiman y Veugelers (2005) consideran dos dimensiones del concepto: capacidad de escanear y capacidad de integrar el conocimiento nuevo. Estos autores emplean como aproximación del término las actividades de I + D y los procesos de innovación de las organizaciones. Asimismo, relacionan la primera dimensión del concepto con la capacidad de identificar conocimiento tecnológico no complejo y la segunda con la capacidad de integrar en sus actividades conocimiento tecnológico más distante o de carácter tácito.

George et al., (2001) consideran solo dos de las dimensiones propuestas por Cohen y Levinthal (1990) y las miden tomando en cuenta los gastos en I + D (capacidad de valorar) y las patentes (capacidad de aplicar). En otro estudio, Murovec y Prodan (2009) la definen basados en el tipo de innovación que la AC organizacional es capaz de generar (AC impulsada por la demanda y AC desarrollada por la ciencia), pero a diferencia de los anteriores, a parte del conocimiento tecnológico consideran la relevancia que tiene también el conocimiento de mercado en las innovaciones organizacionales. La primera dimensión se basa en la capacidad de absorber conocimiento de naturaleza científica o tecnológica, el cual puede provenir de universidades o centros de investigación. La segunda, permite adquirir conocimiento de clientes, suplidores o del entorno competitivo para así desarrollar innovaciones requeridas por el mercado.

La primera modificación relevante hecha tanto a la definición como a las dimensiones del concepto fue la realizada por Zahra y George (2002). Estos autores redefinen el concepto como *"el conjunto de rutinas y procesos organizacionales por medio de las cuales las organizaciones adquieren, asimilan, transforman y explotan el conocimiento para producir una capacidad dinámica organizacional"* (Zahra & George 2002). De acuerdo con estos autores, la AC representa un tipo de capacidad dinámica que permite a las organizaciones readaptar continuamente la base de conocimiento y la visión estratégica de la empresa para así hacer frente a los continuos cambios que ocurren en su entorno. Estos además, consideran la AC como una estructura de cuatro dimensiones y no de tres como habían formulado Cohen y Levinthal (1990). Cada una de dichas dimensiones se apoya mutuamente para conferir a las organizaciones de las capacidades necesarias para promover el cambio y la evolución organizacional. Este proceso se realiza mediante dos fases: una primera denominada capacidad de absorción potencial (PACAP), la cual comprende las dimensiones de identificar y asimilar el conocimiento; y una segunda denominada capacidad de absorción realizada (RACAP), formada por las dimensiones de transformar y aplicar el conocimiento.

Según Zahra y George (2002) ambos subgrupos presentan funciones separadas pero, que a la vez, son complementarias. Por ejemplo, una organización puede presentar altos niveles de PACAP, sin embargo este simple hecho no faculta a la organización de la capacidad de aplicar el conocimiento. Asimismo, las organizaciones necesitan tener presente cierta capacidad para adquirir e integrar el conocimiento nuevo antes de poder explotar nuevas ideas que repercutan en su desempeño innovador. Basados en este argumento, Zarha y George (2002) introducen el concepto de factor de eficiencia con el que resaltan la importancia de llevar un balance adecuado de ambos subgrupos para el desarrollo de ventajas competitivas.

Posterior al trabajo de Zahra y George (2002), la revisión realizada por Lane et al. (2006) representa otra de las principales contribuciones hechas al concepto (Easterby-Smith et al. 2008, Lichtenthaler 2009, Camisón & Forés 2010). En su análisis identifican dos problemáticas vigentes en la literatura del concepto: primero, que la mayor parte de los artículos han utilizado el concepto sin discutir ni profundizar sobre los aspectos centrales; y segundo, que el término ha sido utilizado de una manera reducida.

Para reconducir la teoría y con ello eliminar la manera reducida en la que había sido desarrollado hasta el momento, Lane et al., (2006) proponen una nueva definición del concepto. Para ello toman como base cinco de los artículos centrales escritos sobre el término (Szulanski 1996, Mowery, Oxley & Silverman 1996, Lane & Lubatkin 1998b, Dyer & Singh 1998, Koza & Lewin 1999, Zahra & George 2002) . Ellos presentan el término como una capacidad que concede a las organizaciones la habilidad de utilizar el conocimiento externo a través de tres procesos secuenciales: *(1) reconocer y entender el valor potencial del nuevo conocimiento fuera de la organización a través del aprendizaje explorador, (2) asimilar el conocimiento nuevo valioso a través del aprendizaje transformador, y (3) usar el conocimiento asimilado para crear nuevo conocimiento y salidas comerciales a través del aprendizaje explotador* (Lane, Koka & Pathak 2006) . Con esta nueva definición, contribuyen a reconectar el término con las dimensiones originales introducidas por Cohen y Levinthal (1990) y además, con los procesos de aprendizaje que permiten el desarrollo de dichas dimensiones, resaltando con ello la naturaleza multidimensional del término. El modelo propuesto por estos autores divide los antecedentes de la AC en dos grupos (interno y externos) y las salidas del término en dos tipos (salidas comerciales y de conocimiento).

En otra importante aportación, Todorova y Durisin (2007) traen a relieve algunas críticas a la re-conceptuación realizada por Zarha y George (2002) sobre término de capacidad de absorción. Estos autores consideran que la definición de Zarha y George (2002) deja de lado algunos aspectos importantes del concepto originalmente propuesto por Cohen y Levinthal (1990), y aquellos relacionados con el aprendizaje organizativo e innovación. Estos autores proponen un ajuste sobre dos aspectos del modelo de Zarha y George (2002): los componentes de las AC y los factores contingentes.

De los componentes propuestos en el modelo de Zarha & George (2002), ellos critican la redefinición de la primera dimensión del concepto original "*reconocer el valor*" (recognizing the value) por el término "*adquisición*" (adquisition) de conocimiento externo. Según Todorova y Durisin (2007), esta nueva noción y su explicación dirigen principalmente la atención a la intensidad, rapidez y esfuerzo en obtener conocimiento y pasa por alto las trampas de no ser capaz de ver o entender el conocimiento externo del todo.

Asimismo, consideran que la dimensión de "*transformación*" debe ser considerada, no como una continuación de la dimensión de "*asimilación*", sino como un proceso alterno como ha sido demostrado por investigadores de psicología cognitiva y de aprendizaje. Cuando el conocimiento externo encaja con los modelos cognitivos previos de las empresas, este solo necesita ser ligeramente modificado para ser integrado con los sistemas actuales, lo cual es posible a través de la asimilación. En cambio, cuando el conocimiento externo se distancia mucho de los modelos cognitivos ya existentes, las estructuras mentales deben ser adaptadas y transformadas para que el componente novedoso del conocimiento pueda ser incorporado (Todorova & Durisin 2007).

Por último, estos autores consideran que se debe revisar la definición y el alcance de los dos subgrupos de AC propuestos por Zahra y George (2002): PACAP y RACAP (AC potencial y AC realizada), ya que su papel en el desempeño de las organizaciones no está del todo claro, por lo que es necesario aclarar los conceptos en términos del contenido y de su contribución a la creación de valor en la empresa. A diferencia de Todorova y Durisin, (2007), Camisón y Forés (2010) consideran que la principal limitación del modelo de Zarha y George (2002) tiene su origen en el uso de la condición de complementariedad para describir la relación entre las cuatro dimensiones (adquisición, asimilación, transformación y aplicación) del constructo y entre sus dos componentes (PACAP y RACAP). Estos autores basándose en el análisis de los diversos factores que conforman las dimensiones del concepto, lo definen como "*Una capacidad dinámica sistemática que existe como dos subgrupos de capacidades: capacidad de absorción potencial y realizada"*(Camisón & Forés 2010).

Algunos trabajos recientes también han contribuido a esclarecer el vínculo de la AC con áreas muy cercanas como son el aprendizaje organizativo (Sun & Anderson 2010) y la gestión del conocimiento (Sun 2010). Desde su inserción, el concepto de AC ha sido conectado con nociones de aprendizaje organizativo (Cohen & Levinthal 1990, Szulanski 1996, Veugelers & Kesteloot 1996, Kim 1998, Lane & Lubatkin 1998a, Lane, Salk & Lyles 2001) , sin embargo la naturaleza precisa de su relación no ha sido establecida (Sun & Anderson 2010). La relación de los dos conceptos es bastante aparente en el estudio de Cohen y Levinthal, (1990), no obstante estos autores no discuten explícitamente la relación entre los dos conceptos o no los distinguen. Otros estudios han insinuado que las dimensiones de la AC son creadas a través de procesos de aprendizaje (Lane, Koka & Pathak 2006, Lichtenthaler 2009) , sin embargo no han tratado de explicar la naturaleza de esta relación o de integrar la teoría reciente sobre AC con los abundantes modelos de aprendizaje organizativo. En su artículo Sun y Anderson (2010), proponen una integración del modelo de aprendizaje organizativo 4I presentado por Crossan et al., (1999) y de la re-conceptuación de AC propuesta por Zahra y George (2002).

La esencia de su argumento se basa en que la AC debe ser considerada como un tipo específico de aprendizaje organizativo concerniente a la relación de las empresas con el conocimiento externo. Ellos ven cada dimensión de la AC como una capacidad de aprendizaje generada por procesos específicos de aprendizaje socio-psicológicos, los cuales se ven afectados por factores organizacionales (Sun & Anderson, 2010). Cada una de estas capacidades de aprendizaje son generadas a diferentes niveles de la organización y la combinación de las mismas dotan a las empresas de la capacidad dinámica necesaria para responder a los cambios estratégicos.

Tabla 1. Principales definiciones y contribuciones hechas a la medición

Autores	Definición	Dimensiones	Modelo de medida	Contextos	Autores que han aportado a los modelos	Medidas empleadas
Cohen y Levinthal (1990)	Capacidad de valorar, asimilar y aplicar el nuevo conocimiento con fines comerciales	Valorar, asimilar y aplicar	Unidimensional	Organizacional	Cohen Y Levinthal (1989, 1990), Mowery et al. (1996)	Intensidad en I + D,
			Dos dimensiones	Organizacional, inter-organizacional, individual y equipo	Arora y Gambardella (1994), Cassiman y Veugelers (2005), George et al., (2001), Liao et al., (2003), Murovec y Prodan (2009)	Base de conocimiento existente, tipo de conocimiento externo, Conocimiento relacionado, comunicación interna
			Tres dimensiones	Organizacional, inter-organizacional	Lane y Lubatkin (1998), Lane et al. (2001), Jantunen (2005) García-Morales et al., 2008,	Base de conocimiento, similitud de los modelos y estructuras, nivel de motivación, habilidades del personal,
Zahra y George (2002),	Conjunto de rutinas organizacionales y procesos estrategicos por medio de los cuales las organizaciones adquieren, asimilan, transforman y explotan el conocimiento con el fin de crear valor.	Adquirir, asimilar, transformar y explotar	Cuatro dimensiones	Organizacional, inter-organizacional	Jansen et al., (2005), Liao et al. (2003), Fosfuri y Tribó (2008), Lev et al. (2009), Sun y Anderson (2010)	Base de conocimiento previo, Mecanismos de integración social, confianza, características de las estructuras organizacionales,
Lane et al., (2006)	Capacidad de reconocer , asimilar y aplicar el conocimiento nuevo a través de tres procesos de aprendizaje: aprendizaje explorador, aprendizaje transformador y aprendizaje explotador.	Reconocer-entender, asimilar y aplicar	Tres dimensiones	Organizacional	Lichthenthaler (2009)	Procesos de aprendizaje organizativo (explorador, transformador, explotador)
Todorova y Durisin, (2008)	Capacidad de reconocer el valor, asimilar o transformar y aplicar el nuevo conocimiento	Reconocer el valor, asimilar o transformar, aplicar	Multidimensional	Organizacional	Todorova y Durisin (2007)	No se ha medido

3. METODOLOGÍA

Con el fin de evaluar el apoyo empírico que ha tenido la literatura sobre AC, hemos decidido usar una versión adaptada del modelo desarrollado por David y Han (2004) en su artículo *"A systematic assessment of the empirical support for transaction cost economics"* y el posteriormente adaptado por Newbert (2007) en su artículo *"Empirical research on the resource-based view of the firm: an assessment and suggestions for future research",* ambos publicados en la *Strategic Management Journal*. Comparada con la tradicional revisión teórica, la metodología aplicada por estos autores, provee de una serie de técnicas que ayudan a la selección de la muestra de estudio de una manera sistemática y explícita. Así mismo, permiten mitigar la parcialidad que suele ocurrir cuando los datos son recolectados a través de criterios puramente subjetivos. La búsqueda y la definición de la muestra se realizó en 6 pasos: (1) búsqueda de artículos en ABI/Inform, (2) asegurar la relevancia sustancial de los artículos, (3) asegurar la relevancia empírica (4) selección de artículos publicados en revistas con múltiples publicaciones, (5) lectura de resúmenes (6) lectura completa de artículos.

En primer lugar, empleamos las bases de datos ABI/INFORM y EconLit para la búsqueda de artículos que trataran la temática de AC. Establecimos como requisito que los artículos incluyeran "absoptive capacity" en la cita o resumen. El rango de fechas establecido para la búsqueda fue desde Enero de 1992, hasta Enero del presente año. Además, para mejorar los criterios de control decidimos limitar la búsqueda a revistas científicas. Este tipo de revista, en comparación con las no publicadas o con capítulos de libros, deben pasar por rigurosos filtros y procesos de revisión antes de obtener la publicación, por lo cual limitando nuestra búsqueda a esta población de artículos nos aseguramos de obtener trabajos de una calidad mejorada (Newbert 2007, David & Han 2004).

En segundo lugar, para asegurar que los artículos seleccionados tratasen temas centrales de la teoría de AC, establecimos 18 palabras claves las cuales debían estar incluidas en los resúmenes o los títulos de los artículos examinados. Estas palabras claves corresponden a los principales antecedentes, componentes, dimensiones y salidas del concepto, los cuales identificamos en la artículo de Lane et al. (2006) "*The Reification of Absorptive Capacity: a Critical Review and Rejuvenation of the Construct*": *learning, knowledge, explor**[46]*, exploit*, innovat*, perfomance, potencial, realized, acquire, assimilat*, transformat*, appl*, enviroment*, cognition, strateg*, structur*, capabilit*, relation**. En dicho trabajo, estos autores hicieron una revisión de las bases centrales del concepto desarrolladas en los trabajos de Cohen y Levinthal (1989, 1990, 1994). Además, realizaron un análisis considerable de las principales aportaciones realizadas en trabajos posteriores a las publicaciones de Cohen y Levinthal. Es por ello que consideramos que este artículo representa una buena fuente de referencia para la identificación de los principales elementos que conforman el concepto.

En tercer lugar, para garantizar el contenido empírico de los artículos que superaron el filtro anterior, requerimos la inclusión de al menos una de las siguientes palabras en el título o resumen: data, empirical, test*, statical, finding*, result* o evidence. De acuerdo David y Han, *"al exigir la existencia de al menos una de las palabras anteriores nos aseguramos de eliminar aquellos artículos que no sean de tipo empírico"* (David & Han 2004).

A continuación, eliminamos los artículos irrelevantes tras seleccionar solo aquellos artículos que aparecen en revistas en las cuales se han publicado múltiples artículos sobre esta temática. Según David y Han *"Es poco probable que un único artículo de un tema en concreto, publicado*

[46] Los * fueron colocados para así poder recoger las diferentes variaciones que puede asumir la parte final de la palabra, por ejemplo explor* puede ser *exploration* o *explore.*

en una única revista, sea a la vez sustantivo y metodológicamente relevante si los comparamos con aquellos que fueron publicados en revistas con múltiples artículos de la misma temática"(David & Han 2004). Así mismo, dado que algunas de las revistas encontradas se repetían en ambas bases de datos, procedimos a eliminar las revistas duplicadas en EconLit.

Seguido de lo anterior, aseguramos la relevancia sustantiva y empírica mediante la lectura de los resúmenes de los artículos restantes. Para ello el artículo debía presentar el constructo de AC en el contexto en que había sido discutido en la literatura y no como una mera citación del término. Asimismo, para asegurar la relevancia empírica del artículo, este debía mencionar aspectos relativos a la metodología empírica como pueden ser el tamaño de la muestra, sector de empresas, período de estudio, etc. Además, se decidió dejar fuera de la muestra aquellos artículos teóricos o basados en estudios de casos, ya que no existe forma de comparar los resultados de este tipo de metodología con los obtenidos a través de técnicas estadísticas (David & Han, 2004).

Por último, para garantizar la relevancia empírica y de contenido de los artículos restantes, llevamos a cabo la lectura completa de estos trabajos. En esta fase sólo fueron escogidos aquellos artículos que presentaron los resultados de análisis estadísticos multivariantes[47] y que además, examinaban los aspectos centrales del concepto. El resto de artículos que no cumplían con estas condiciones fueron eliminados de la muestra.

4. RESULTADOS

La tabla 2 resume el número de artículos obtenido en cada una de las fases de la metodología aplicada, alcanzándose así una muestra final de 78 artículos. De estos artículos, el 76% (56) evaluaron la AC como una variable independiente y analizaron su efecto sobre las diferentes salidas, procesos y entradas de las organizaciones. El 22%(17) siguiente consideraron la AC como una variable dependiente y estudiaron los principales antecedentes organizacionales y del entorno que afectan las dimensiones, procesos y salidas que la conforma. Por último, el 4% restante analizaron aquellos elementos que moderan la relación entre los antecedentes y la AC existente en las organizaciones.

En los siguientes apartados procederemos a desglosar los resultados obtenidos en el grupo de artículos que examinaron la AC como variable independiente, para así evaluar las relaciones exploradas y el tipo de enfoque de análisis empleado.

Tabla 2. Resumen de los criterios de selección.

[47] Los artículos que solo presentaban los resultados de pruebas estadísticas bivariantes (tales cómo regresión simple, *paired t-test* o correlación) fueron eliminadas, ya que dichos tipos de estudios carecen de rigor metodológico (Newbert, 2007).

Tipo de Filtro	Descripción	Resultados en ABI/INFORM	Resultados en EconLit
Sustancial	Artículos con "Absorptive Capacity" en la Cita o en el resumen	769	239
Sustancial	Selección de revistas evaluadas por expertos	459	239
Sustancial	Al menos una de las dieciocho palabras claves indicando relevancia sustancial debe aparecer en el título o en el resumen.	356	185
Metodológico	Al menos una de las siete palabras claves indicando datos empíricos o análisis deben aparecen en el título o en el resumen.	324	126
Sustancial	Artículos publicados en revistas que tienen más de una publicación en el tema	250	69
Sustancial	Eliminar revistas duplicadas en EconLit	250	11
Sustancial y metodológico	Lectura de los resumenes tomando en cuenta la relevancia sustancial y análisis estadístico	150	8
Sustancial y metodológico	Lectura completa de los artíclos restantes para asegurar relevancia sustancial y análisis estadístico	78	2

4.1 Principales componentes y salidas del concepto.

La tabla 3 resume los principales componentes (variables independientes) y salidas (variables dependientes) empleadas en los 59 artículo que analizaron la AC como variable independiente. Asimismo, se indica el número de pruebas *"test"* ejecutados con cada variable, las pruebas en las que se encontró apoyo empírico y el número de pruebas en las que los resultados fueron contrarios a lo establecido en la literatura.

Los artículos clasificados en esta categoría contienen 464 pruebas empíricas de las cuales 239 (52%) fueron apoyadas estadísticamente y sólo 9 (2%) arrojaron resultados contrarios a la teoría. Al igual que David y Han (David & Han 2004) hemos decidido emplear un valor de corte *"cut-off"* de $p<0.05$ para considerar una prueba como estadísticamente significativa. Esta acción nos permitió homogeneizar la muestra, ya que muchos artículos consideraban significatividad a valores de $p<0.10$, mientras que otros no contemplaron significatividad a valores mayores de $p<0.05$. Basándonos en lo anterior, aquellas pruebas cuyo p valor superaba los 0.05 fueron consideradas como no significativas.

En nuestros análisis pudimos distinguir diferentes métodos empleados para medir el concepto, los cuales dependían de la forma en la era definido y del tipo de antecedente considerado como determinante del término. Estas aproximaciones las clasificamos en seis grupos: (1) capacidad "*capability"*, (2) base de conocimiento "*knowledge base"*, (3) características del capital humano "*human capital characteristic"*, (4) actividades de gestión del conocimiento "*knowledge management activities"*, (5) el tipo de relación inter-organizacional "*inter organizational relationship"* y (6) características de la organización "*organizational characteristic"*.

El primer grupo considera la AC como un concepto multidimensional y evalúan como los diversos mecanismos que integran las dimensiones del término afectan de manera aislada o conjunta las salidas, los procesos o el entorno de las organizaciones (Lane & Lubatkin 1998, Lane, Salk & Lyles 2001, Arbussà & Coenders 2007, Whangthomkum, Igel & Speece 2006, Jantunen 2005, Lev, Fiegenbaum & Shoham 2009, Haro-Domínguez et al. 2007) . Estos la definen como una capacidad dinámica o proceso de aprendizaje que permite a las organizaciones adaptarse a los continuos cambios del entorno y definir las vías necesarias para su desarrollo y evolución. La principal diferencia entre estos estudios radica en el número de dimensiones consideradas del concepto. Por ejemplo, Arbussá y Coenders (2007) asumieron dos tipos de AC: capacidad de escanear el ambiente externo en búsqueda de nuevas tecnologías y la capacidad de poder integrar el nuevo conocimiento externo en los procesos internos de innovación. Lane et al. (2001) dividieron el concepto en las tres dimensiones originales introducidas por Cohen y Levinthal (1990), pero en esta ocasión relacionándolas con los procesos de aprendizaje a través de la cooperación empresarial internacional. Haro-Domínguez et al. (2007) segmentó el termino en las cuatro dimensiones propuestas en un inicio por Zarha y George, (2002) (adquisición, asimilación, transformación y explotación) y evaluó el efecto conjunto de estas sobre el proceso de adquisición tecnológica de las organizaciones.

Tabla 3. Variables independientes y dependientes

Independent variables	No. Articles[1]	% Total articles	No. Test	% Total Test	No. Support	% Supported	No. Counter	% Counter
Capability	23	39%	173	37%	100	58%	4	2%
Knowledge base	21	36%	126	27%	69	55%	6	5%
Human capital characteristic	13	22%	45	10%	27	60%	0	0%
Knowledge management activities	5	8%	68	15%	20	29%	0	0%
inter organizational relations	5	8%	47	10%	17	36%	0	0%
Organizational charateristic	3	5%	6	1%	4	67%	0	0%
Total	59	100%	465	100%	237	-	10	-
Dependent Variables								
Innovation	14	24%	78	17%	55	71%	0	0%
Organizational Perfomance	13	22%	64	14%	24	38%	4	6%
Exploration	12	20%	97	21%	53	55%	2	2%
Exploitation	7	12%	91	20%	40	44%	0	0%
Strategy	7	12%	70	15%	27	39%	2	3%
organizational learning	6	10%	28	6%	16	57%	2	7%
Knowledge transfer	5	8%	29	6%	14	48%	0	0%
Realized AC	2	3%	8	2%	8	100%	0	0%
Total	59	100%	465	100%	237	51%	10	2%

[1] Because sevaral articles use a variety of independent and dependent variables, the totals reported in this column do not equal their sums

El siguiente grupo considera las características del conocimiento previo o del relacionado como el principal antecedente de la AC. Varios de estos estudios emplearon aproximaciones tales como los gastos en I + D, la formación previa de los empleados o las patentes (Cantner & Joel 2011, Gomez & Vargas 2009, Tsai 2001, Dushnitsky & Lenox 2005, Zhang, Baden-Fuller & Mangematin 2007) . Por ejemplo, Fabrizio (2009) encontró que las organizaciones que desarrollan más investigaciones internas exhiben un desempeño superior en la búsqueda de nuevas innovaciones, todo ello como producto de la base de conocimiento y la experiencia que desarrollan gracias a las actividades de I + D interna. No obstante, la AC no solo representa el producto de la base de conocimiento previo que poseen las organizaciones, sino que existen otros aspectos vinculados a la organización o la gestión los cuales juegan un papel vital para su desarrollo (Lane & Lubatkin 1998, Volberda, Foss & Lyles 2010, Lane, Koka & Pathak 2006, Lichtenthaler 2009) .

Por otro lado, los que evalúan la AC como producto de las características del capital humano enfatizan la importancia de las habilidades individuales y la motivación para poder alcanzar una correcta absorción del conocimiento externo (Muscio 2007, Chen & Ching 2004, Kwok & Gao 2005, Chou 2005, Zhao & Anand 2009). Ellos asumen que la AC organizacional depende de los modelos mentales, del nivel de experiencia y de motivación de los individuos que la conforman, por lo que estos aspectos determinarán el tipo de conocimiento que la organización sea capaz de absorber (Sun & Anderson 2010). Por ejemplo, Chou (2005) analizó la AC a nivel individual y encontró que la capacidad de trasferir y captar información de los individuos contribuye positivamente a la creación de conocimiento, siempre y cuando, la organización establezca mecanismos que promuevan el desarrollo de dichas capacidades entre los miembros que la conforma.

Siguiendo a los anteriores se encuentran los que emplean actividades de gestión del conocimiento como aproximación del término. Estos se centran en aquellos procesos y actividades que promueven la gestión efectiva del saber hacer *"know how",* su integración con el conocimiento externo y su aplicación final (Schmidt 2010, Cantner & Joel 2011, Minbaeva 2005). Actividades como son la rotación del personal, las actividades de formación, el establecimiento de incentivos y de ciertas prácticas de recursos humanos permiten a las organizaciones crear las condiciones necesarias para promover el flujo de conocimiento y el posterior desarrollo de AC a diferentes niveles (Sofka 2008, Lane & Lubatkin 1998, Cantner & Joel 2011).

Por otra parte, los que utilizan las relaciones inter-organizacionales examinan como ciertas características del conocimiento externo y de las redes de trabajo establecidas influyen sobre la capacidad de las organizaciones para valorar y aplicar el conocimiento nuevo adquirido (Liao et al. 2010, Fabrizio 2009). Como el conocimiento ubicado fuera del entorno de las empresas no se adquiere con facilidad, las empresas tienden a establecer vínculos con diferentes tipos de agentes externos para así facilitar su acceso y adquisición. Por ejemplo, Fabrizio (2009) encontró que las empresas que establecen colaboraciones con científicos universitarios obtienen beneficios en cuanto al desarrollo de nuevas innovaciones. Sin embargo, aquellas organizaciones que combinaron este tipo de colaboración con el desarrollo de actividades de I + D interna, obtuvieron un mayor rendimiento en los procesos de innovación, ya que el efecto conjunto de ambas actividades les permitió desarrollar innovaciones en un menor tiempo y con un mayor impacto que aquellas organizaciones que solo se centraban en una de las actividades antes mencionadas.

Por último, los académicos que miden el concepto por medio de las características organizacionales emplean aspectos relacionados con las estructuras empresariales, como pueden ser las similitudes entre los modelos de gestión o la posición estratégica de la empresa (Liao, Tu & Marsillac 2010, Jabar, Soosay & Santa 2011) . De acuerdo con estudios previos, el tipo de estructura y forma organizacional establecida en la empresa influye en gran medida sobre el éxito de los procesos de transferencia de conocimiento y, por ende, sobre el desarrollo de AC a nivel organizacional (Lane, Koka & Pathak 2006) . Antes de que las organizaciones sean capaces de utilizar el conocimiento adquirido a través de los vínculos externos, estas deben desarrollar la capacidad de entender dicho conocimiento. Este proceso se ve facilitado cuando existe cierto grado de similitud entre la estructura y los modelos cognitivos de las empresas que colaboran, ya que el esfuerzo que deberá invertir la empresa receptora del conocimiento para adaptar el nuevo conocimiento al lenguaje y a los procesos existentes será menor (Lane, Salk & Lyles 2001, Liao, Tu & Marsillac 2010) .

De los componentes antes citados, el más utilizado ha sido la capacidad. Este fue aplicado en 23 (39%) artículos y en un total de 173 (37%) pruebas estadísticas, de las cuales 100 (58%) fueron apoyadas empíricamente, mientras que 4 (2%) resultaron significativas en la dirección opuesta. Por ejemplo, Laursen et al., (2010) analizaron si la amplitud de los procesos exploratorios previos influían en la decisión de las empresas de llevar a cabo estos procesos a mayores distancias geográficas. Estos encontraron que las empresas con experiencia en exploraciones previas tienden a dedicar más esfuerzo a sus actividades tecnológicas centrales, en vez de encaminarse en exploraciones más profundas del entorno tecnológico.

La base de conocimiento representa el segundo componente más empleado. Este fue utilizado en 21 artículos (36%) y en 126 (27%) pruebas empíricas, de las cuales 69 (55%) recibieron apoyo empírico y 6 arrojaron resultados contrarios. Gran parte de estos estudios consideraron la AC como producto del conocimiento previo, la inversión en actividades de I + D o las patentes, dejando de lado el carácter multidimensional del concepto (Lee, Liang & Liu 2010, Gómez & Vargas 2009, Marcin 2008) .

El tercer componente más utilizado es el capital humano, empleado en 13 (22%) artículos y 45 (10%) pruebas estadísticas. De las pruebas realizadas 27 (60%) fueron validadas. Varios de estos estudios evaluaron la AC como producto de la experiencia o los modelos cognitivos de los individuos (Minbaeva 2005, Deng, Doll & Cao 2008) . Por ejemplo, Minbaeva (2005) encontró que la habilidad de los empleados y su motivación representan los aspectos claves de la AC de empresas subsidiarias, ya que les permite obtener beneficios de los flujos internos de conocimiento. Deng et al., (2008) adaptó el concepto de AC al contexto de los individuos que desarrollan trabajos de IT y lo dividió en dos partes: una que toma en cuenta la base de conocimiento previo de los individuos y una segunda que incluye los mecanismos de razonamiento que estos emplean para la toma de decisiones.

Finalmente los componentes menos utilizados fueron: las actividades de gestión del conocimiento, con 5 (8%) artículos y 68 (15%) pruebas estadísticas; las relaciones inter-organizacionales, con 5 (8%) artículos, y 47 (10%) pruebas estadísticas; y las características organizacionales con 3 (5%) artículos y 6 (1%) pruebas empíricas. De los componentes antes mencionados, las características organizaciones obtuvieron el mayor número de pruebas confirmandas, ya que el 67% de las pruebas realizadas fueron validadas estadísticamente. El nivel más bajo de apoyo lo obtuvo las actividades de gestión del conocimiento en donde sólo el 29% de las pruebas fueron empíricamente sustentadas.

La segunda parte de la tabla 2 muestra los resultados de acuerdo al tipo de variable dependiente evaluada. Tomando en cuenta el tipo de salida considerado pudimos distinguir ocho grupos de variables dependientes: (1) innovación (2) desempeño (3) procesos de exploración, (4) procesos de explotación, (5) estrategia organizacional (6) aprendizaje organizativo "*organizational learning*", (7) transferencia del conocimiento "*knowledge transfer*" y (8) la AC realizada *(RACAP)"*.

La innovación constituye la salida más frecuentemente examinada con un total de 14 (24%) artículos y 78 (17%) pruebas estadísticas, de las cuales 55 (71%) obtuvieron apoyo empírico. Los artículos dentro de esta categoría tratan de capturar el efecto de la AC o de las dimensiones que la conforman sobre la velocidad, la frecuencia y la magnitud de las innovaciones de las empresas. Hay que señalar que la mayor parte de estos estudios emplearon medidas tangibles como son los esfuerzos de innovación, el desarrollo de nuevos productos, las patentes o la importancia de las innovaciones desarrolladas (Nieto & Quevedo 2005, Jabar, Soosay & Santa 2011, Chou 2005) Por ejemplo, García-Morales et al., (2007) hallaron que la capacidad de absorber conocimiento tecnológico tiene un efecto positivo sobre la tasa de introducción de nuevos productos o servicios en empresas españolas. Por otra parte (Koch & Strotmann 2008)

Koch y Strotmann (2008) demostraron que el acceso al conocimiento y a la información representan dos determinantes importantes de las actividades de innovación en el sector de empresas de intensidad en conocimiento (KIBS). Asimismo, el tipo de aliado probó ser un elemento importante a la hora de analizar el tipo de innovación obtenida en este sector de empresas.

La segunda salida más analizada fue el desempeño con un total de 13 (22%) artículos y 64 (14%) pruebas estadísticas de las cuales sólo el 39% encontraron validez y un 5% arrojaron resultados opuestos a lo establecido en las hipótesis de investigación. Estos estudios se centraron en medir el impacto de la AC sobre el logro de los objetivos o de los procesos empresariales. Para ello emplearon medidas tales como: la productividad, el desempeño financiero, los resultados de ventas, el desempeño exportador, entre otras. Al igual que con la innovación, varias de las medidas utilizadas para capturar el desempeño representaban medidas tangibles, sin embargo algunos autores también llegaron a aplicar medidas intangibles de esta salida. Por ejemplo, Tsai (2001) encontró que la AC de una organización, medida por medio de la intensidad de I + D, afecta positivamente las ganancias que obtienen las empresas como producto del desarrollo de nuevos productos. Esto sugiere que las empresas con altos niveles de AC presentan mayores posibilidades de obtener beneficios de la aplicación del conocimiento externo comparada con aquellas que poseen bajos niveles. Rhee (2008) analizó el efecto de la AC de los empleados sobre el nivel de desempeño alcanzado a través de la internacionalización de nuevas alianzas y encontró que ésta influye positivamente sobre los niveles de desempeño financiero, como pueden ser los niveles de ventas, las ganancias y el crecimiento de ventas; y aquellos no financieros, como son la división del mercado, el marketing, la reputación y el acceso al mercado. En otro estudio Lev et al. (2009) integraron aspectos de la literatura sobre dirección estratégica con la definición de AC desarrollada por Zarha y George (2002) y redefinieron la AC en base al stock competitivo de las empresas. Estos autores al evaluar el efecto de las tres dimensiones (interna, externa y tiempo) competitivas del stock de la AC realizada (RACAP) sobre el desempeño, hallaron que la dimensión interna afectaba significativamente las medidas de reputación y el uso eficiente de los recursos en los hospitales, en cambió la dimensión externa presentó un efecto negativo significativo sobre las medidas de desempeño antes mencionadas.

Los procesos de exploración representa la siguiente salida más evaluada en las investigaciones sobre AC. Estos estudios analizan como la AC influye sobre los procesos y las actividades de búsqueda de conocimiento externo en las organizaciones. Dicha salida fue considerada en 12 (20%) artículos y en un total de 97 (21%) pruebas estadísticas, de las cuales 53 (55%)

encontraron apoyo empírico. Algunos ejemplos de este tipo de salidas son: el desarrollo de *joint venture* tecnológicas, la adquisición de nuevas tecnologías, el establecimiento de alianzas exploradoras, los cambios en el cruce de citación de patentes, etc. (Estrada, de la Fuente & Martín-Cruz 2010, Xia & Roper 2008, Zhang, Baden-Fuller & Mangematin 2007, Mowery, Oxley & Silverman 1996) . El resto de detalles referentes al número de artículos, pruebas realizadas y confirmadas de las demás variables dependientes se indican en la tabla 2.

De los ocho grupos de variables dependientes consideradas, las que demostraron un mayor grado de dependencia de la AC fueron RACAP y la innovación. Del total de pruebas en las fueron evaluadas estas variables se obtuvo un nivel de apoyo del 100% para RACAP y del 71% para la innovación. Por ejemplo, Nemanich et al., (2010) demostraron que la capacidad que tienen los miembros de los equipos de I +D para asimilar el nuevo conocimiento está directamente relacionada con la habilidad de estos últimos de aplicar el conocimiento adquirido con fines comerciales. Así mismo Lev et al. (2009) encontraron sustento a la hipótesis en la que señalaban que los altos niveles de stock del potencial de capacidad de absorción (PACAP) contribuían positivamente al desarrollo del stock de RACAP.

Por otra parte, las variables que mostraron un menor grado de dependencia fueron las relacionadas con el desempeño y la estrategia organizacional, ya que en ambos grupos se obtuvo un nivel de apoyo del 39% para la totalidad de pruebas realizadas. Por ejemplo, Spanos y Voudouris (2009) sólo encontraron apoyo parcial al efecto de la AC organizacional sobre la adopción de tecnologías avanzadas de manufactura (AMT), ya que de los tres tipos de AMT consideradas (integradas, intermedias e independientes *"stand-alone"*) solo encontraron una relación significativa en la adopción de AMT intermedias. Así mismo George et al., (2001) tampoco pudieron demostrar que la habilidad de aplicar conocimiento influye positivamente sobre la introducción y desarrollo de nuevos productos, o en las ventas netas de las empresas.

4.2 Pares de Variables independientes y dependientes

Para identificar las principales relaciones exploradas en los diferentes modelos de medida de la AC antes citadas, hemos decidido incluir un resumen de las relaciones de variables independientes y dependientes analizadas. Estas se detallan en la tabla 5.

Como se puede apreciar, las principales salidas empleadas por aquellos estudios que midieron la AC como una capacidad fueron la innovación, el desempeño, los procesos de exploración y los de aprendizaje organizativo, con un total de 5 (8%) artículos en cada caso. De las relaciones antes mencionadas la que obtuvo el mayor nivel de apoyo fue la relativa al efecto de AC sobre innovación, donde las 17 pruebas realizadas fueron sustentadas estadísticamente. En cambio, en las restantes el nivel de apoyo no superó el 56% del total de pruebas efectuadas para cada caso. Por ejemplo, Nieto y Quevedo (2005) encontraron que las compañías que habían exitosamente acumulado determinada AC en el pasado eran capaces de usar de una manera innovadora el conocimiento generado internamente o a nivel externo, lo cual les permitía a estas desarrollar ganancias a partir de dichas salidas. Kim et al. (2010) demostraron que la AC contribuía positivamente en los procesos de integración de sistemas y de desarrollo de prácticas modulares, ya que esta permitía crear las condiciones organizacionales necesarias para la implantación de dicha clase de actividades.

En algunas ocasiones las relaciones analizadas en este enfoque arrojaron resultados contrarios a las hipótesis establecidas. De las 27 pruebas que evaluaron el efecto de la AC sobre los procesos de aprendizaje, 2 (7%) proporcionaron resultados contrarios a los esperados. Así mismo, en las 38 pruebas en las que se evaluó como la AC afectaba los procesos de exploración, 1(3%) de ellas arrojó valores negativos a la relación. Por ejemplo, Lane y Lubatkin (1998) en su estudio definió 4 medidas para captar la similitud entre las estructuras de las organizaciones. Al analizar cómo esta variable se comportaba en el proceso de aprendizaje entre empresas farmacéuticas y de biotecnología que establecían alianza de I + D, encontró que 2 de estas medidas (la similitud en la formalización de la alta dirección y la similitud en la centralización de la gestión) afectaban negativamente la relación.

Siguiendo con los estudios que emplearon la base de conocimiento como medida, las principales salidas consideradas fueron: los procesos de exploración, (6 artículos y en 39 pruebas), la estrategia (5 artículos y en 33 pruebas) y la innovación (5 artículos y 19 pruebas). De las tres, la que obtuvo el mayor nivel de apoyo fue la innovación en donde el 68 % de las pruebas realizadas fueron confirmadas. Por ejemplo, Kim y Song (2007) demostraron la existencia de una relación inversa en forma de U entre el desarrollo de innovaciones conjuntas y la dependencia de los socios de alianzas en las empresas de la industria farmacéutica. Sofka (2008), demostraron que la inversión en el desarrollo de AC contribuye positivamente a que las organizaciones impulsen la innovación de sus productos domésticos gracias a la globalización de las fuentes de conocimiento.

Al igual que el modelo de medida anterior, algunos artículos al analizar el efecto de la base de conocimiento sobre la estrategia, los procesos de exploración o la estrategia obtuvieron resultados contrarios. Un ejemplo sería el estudio de, Nooteboom et al., (2007) en donde estos autores encontraron que la interacción entre el capital tecnológico y la distancia cognitiva impacta negativamente el desempeño de las compañías que establecieron alianzas de base tecnológica.

Tabla 4. Pares de variables independientes y dependientes

Independent variable	Dependent variable	No. Articles	% Total articles	No. Test	% Total Test	No. Supported	% Supported	No. Counter	% Counter
Capability									
Capability	Exploitation	4	7%	60	13%	33	55%	0	0%
Capability	Exploration	5	8%	39	8%	17	44%	1	3%
Capability	Innovation	5	8%	17	4%	17	100%	0	0%
Capability	Organizational learning	5	8%	27	6%	15	56%	2	7%
Capability	Performance	5	8%	22	5%	10	45%	1	5%
capability	Realized AC	2	3%	8	2%	8	100%	0	0%
Subtotal		23	39%	173	37%	100	58%	4	2%
Knowledge base									
knowledge base	Exploitation	1	2%	9	2%	2	22%	0	0%
knowledge base	Exploration	6	10%	35	8%	24	69%	1	3%
knowledge base	Innovation	5	8%	23	5%	17	74%	0	0%
knowledge base	Performance	4	7%	13	3%	8	62%	3	23%
Prior knowledge base	Strategy	6	10%	45	10%	17	38%	2	4%
knowledge base	Organizational learning	1	2%	1	<1%	1	100%	0	0%
Subtotal		21	36%	126	27%	69	55%	6	5%
Human capital characteristic									
Human capital characteristic	Exploitation	1	2%	2	<1%	2	100%	0	0%
Human capital characteristic	Exploration	2	3%	6	1%	3	50%	0	0%
Human capital characteristic	Innovation	2	3%	4	1%	2	50%	0	0%
Human capital characteristic	Knowledge transfer	2	3%	4	1%	2	50%	0	0%
Human capital characteristic	Performance	6	10%	28	6%	17	61%	0	0%
Human capital characteristic	Strategy	1	2%	1	<1%	1	100%	0	0%
Subtotal		13	22%	45	10%	27	60%	0	0%
Knowledge management activities									
Knowledge management activities	Strategy	1	2%	24	5%	9	38%	0	0%
KM activities	Exploration	1	2%	4	1%	1	25%	0	0%
HRM activities	Knowledge transfer	2	3%	20	4%	7	35%	0	0%
KM activities	Performance	1	2%	20	4%	3	15%	0	0%
Subtotal		5	8%	68	15%	20	29%	0	0%
inter organizational relations									
inter organizational relations	Exploitation	1	2%	18	4%	1	6%	0	0%
inter organizational relations	Innovation	4	7%	29	6%	16	55%	0	0%
Subtotal		5	8%	47	10%	17	36%	0	0%
Organizational charateristic									
Organizational charateristic	Exploration	1	2%	1	<1%	1	100%	0	0%
Organizational charateristic	Innovation	2	3%	5	1%	3	60%	0	0%
Subtotal		3	5%	6	1%	4	67%	0	0%
Total		59	-	465	-	237	51%	10	2%

[1] Because sevaral articles use a variety of independent and dependent variables, the totals reported in this column do not equal their sums

Por otra parte, los artículos que aplicaron el modelo basado en las características del capital humano, se centraron principalmente en ver como dichas características afectaban el desempeño organizacional. De las 27 (6%) pruebas que evaluaron dicha relación, 18 (67%) de ellas fueron confirmadas. No obstante, de todas las relaciones examinadas en esta categoría la que obtuvo el mayor número de pruebas confirmadas fue la relativa a los procesos de explotación donde las 2 (<1%) pruebas efectuadas fueron sustentadas.

Siguiendo con las actividades de gestión del conocimiento, la principal salida analizada fue los procesos de transferencia de conocimiento, explorada en 2 (3%) artículos y en 20 (4%) pruebas. Sin embargo, solo pudo ser confirmado el efecto sobre esta variable en 3 (19%) de las pruebas.

Por último los estudios que emplearon las relaciones inter-organizacionales y las características organizacionales consideraron como principal salida del concepto la innovación, con un total de 30 (6%) y 5 (1%) pruebas respectivamente. De dichas pruebas sólo 17 (57%) fueron validadas para el caso de las relaciones inter-organizacionales y 3 (60%) para el caso de las características organizacionales.

4.3 Medición de los componentes de AC

Para poder entender mejor las relaciones indicadas en la tabla 4, hemos decidido también incluir la manera en la que la variable independiente ha sido medida. Dicho análisis nos permitirá ver que tan consistente ha sido la literatura en la medición del concepto.

En la tabla 5 se detallan las diferentes variables consideradas en la medición de AC como una capacidad. Como se puede apreciar, hemos agrupados estas variables en cuatro grandes categorías las cuales corresponden a las dimensiones iniciales desarrolladas por Cohen y Levinthal (1990) y las posteriores modificaciones introducidas a la definición y a las dimensiones originales del concepto (Zahra & George 2002, George et al. 2001, Arbussà & Coenders 2007, Murovec & Prodan 2009).

Los artículos que usan un enfoque de dos dimensiones limitan el concepto a dos: la primera relacionada con reconocer, identificar, monitorear o asimilar el conocimiento externo y la segunda con la comunicación o la aplicación de dicho conocimiento (Camisón & Forés 2010). En esta categoría, a parte de los gastos en I + D *"R&D spending"* ninguna de las medidas consideradas es utilizada en más de 2 (9%) artículos o en más de 12 (3%) pruebas. Además, poco más de la mitad (12 de 20) del total de las medidas consideradas obtuvo un nivel de apoyo que superara el 50% del total de pruebas efectuadas.

También, hay que destacar que el nivel de apoyo para cada una de las dimensiones analizadas en esta categoría varía considerablemente dependiendo del constructo empleado en la medición. Para la dimensión de *scan/monitoring,* el mayor grado de validez la obtuvo la estrategia de búsqueda de conocimiento *"Knowledge search strategic",* donde el 100% de las pruebas fueron confirmadas. En cambio, el menor grado de valides lo alcanzó la amplitud de la habilidad de monitoreo *"Monitoring ability breadth"* donde ninguna de las 3 pruebas efectuadas fue apoyada. Para la dimensión de asimilación en 3 de las 4 medidas utilizadas se obtuvo un nivel del apoyo del 100% para el total de pruebas efectuadas. Sin embargo, para la medida "backward citations reported" ninguna de las 2 pruebas fue sustentada. Por ejemplo, Laursen et al., (2010) no encontraron ninguna relación directa que demostrara que la amplitud de las actividades previas de búsqueda tecnológica (monitoring ability breadth) influyera en la decisión de las empresas de explorar conocimiento tecnológico más distante. Asimismo, Arbussá y Coenders (2007) al evaluar como la capacidad de escanear el ambiente externo influye en la búsqueda de conocimiento tecnológico, estos no encontraron valores significativos sobre el promedio de empresas de manufactura y de servicios analizadas. Sin embargo, esta capacidad demostró tener un efecto considerable en la búsqueda de conocimiento de mercado para industrias con alto contenido tecnológico y de conocimiento.

Además, con excepción de Liao et al.,(2010), una minoría de los estudios (2 pruebas) en esta categoría intentaron capturar el efecto conjunto de las diferentes dimensiones que conforman el concepto. Estos autores evaluaron cómo los diferentes componentes del concepto como son las redes y clima de comunicación, la capacidad de escáner el conocimiento y el conocimiento de los trabajadores y los directores influyen sobre los niveles de integración de los sistemas de manufactura, y sobre las prácticas de manufactura de base modular. Las 2 pruebas ejecutadas para valorar esta relación fueron validadas en el 100% de los casos.

Los estudios que utilizan el enfoque de tres dimensiones emplean las tres dimensiones originalmente definidas por Cohen y Levinthal (1990) y algunas de las modificaciones introducidas en trabajos posteriores a los contextos de análisis o a los límites y procesos que conforman las dimensiones del concepto. Aquí ninguna de las medidas empleadas fue aplicada en más del 4% del total de artículos. Las dimensiones más analizadas fueron la de asimilación y aplicación del conocimiento externo con 4 (17%) artículos cada una y la menos utilizada es la de reconocer/valorar con 1 (4%) artículo.

Al igual que en el enfoque anterior el grado de validez para cada una de las dimensiones estudiadas varía considerablemente de acuerdo a la medida empleada. De las 8 medidas utilizadas para capturar la dimensión de asimilación sólo 3 alcanzaron un nivel de apoyo que superaba el 50% del total de pruebas aplicadas y una de ellas arrojó resultados contrarios a la teoría. Sin embargo, de las 6 medidas empleadas para la dimensión de aplicación, en las 6 se obtuvo un grado de validez del 100% para el total de las pruebas examinadas. También, hay que destacar que los estudios que intentaron capturar el efecto integrado de las diferentes dimensiones del concepto alcanzaron niveles de apoyo considerables. De las 3 pruebas realizadas el 100% de ellas fueron validadas.

Tabla 5. Enfoque basado en las capacidades.

Measure	No. Articles [1]	% Total articles [2]	No. Tests	% Total Tests [3]	No. Supported	% Supported	No. Counter	% Counter
Two dimensional approach								
scan/monitoring								
Importance to innovation of external sources of information	1	2%	12	3%	4	33%	0	0%
Knowldeg search strategy	1	2%	8	2%	8	100%	0	0%
Monitoring ability breadth	1	2%	3	1%	0	0%	0	0%
Monitoring ability scale	1	2%	3	1%	2	67%	1	<1%
Subtotal	3	5%	26	6%	14	54%	1	<1%
integrate								
internal factors that hamper a firm's innovation activity	1	2%	7	2%	1	14%	0	0%
Value/identify/recognize								
team ability to evalue	1	2%	1	<1%	1	100%	0	0%
R&D spending	2	3%	3	1%	3	100%	0	0%
Manager experience	1	2%	8	2%	1	13%	0	0%
Workers experience	1	2%	8	2%	1	13%	0	0%
R&D employee/ Graduated	1	2%	1	<1%	1	100%	0	0%
Subtotal	4	7%	21	5%	7	33%	0	0%
communicate								
Communication climate	1	2%	8	2%	5	63%	0	0%
Communication network	1	2%	8	2%	5	63%	0	0%
Subtotal	1	2%	16	3%	10	63%	0	0%
Acquire								
External knowledge acquisition	1	2%	4	1%	1	25%	0	0%
Assimilate								
ability to assimilate technological development	1	2%	4	1%	4	100%	0	0%
firms' patent portfolio dispersion	1	2%	1	<1%	1	100%	0	0%
number of backward citations reported	1	2%	2	<1%	0	0%	0	0%
intrafirm knowledge dissemination	1	2%	2	<1%	2	100%	0	0%
Subtotal	3	5%	9	2%	7	78%	0	0%
Apply								
Patent	1	2%	2	<1%	0	0%	0	0%
Products innovations	1	2%	1	<1%	1	100%	0	0%
Subtotal	2	3%	3	1%	1	33%	0	0%
Overall AC								
Communication climate and network, knowledge scanning, worker knowledge, management knowledge	1	2%	2	<1%	2	100%	0	0%
Group subtotal	16	27%	88	19%	43	49%	1	<1%

Tabla 5. (Continuación)

Measure	No. Articles [1]	% Total articles [2]	No. Tests	% Total Tests [3]	No. Supported	% Supported	No. Counter	% Counter
Three dimensional approach								
Value/identify/Reconigze								
Ability to recognize the benefices of external information	1	2%	3	1%	2	67%	0	0%
Understand								
Basic Knowledge	1	2%	1	<1%	1	100%	0	0%
Compensation practices	1	2%	1	<1%	1	100%	0	0%
Knowledge breath	1	2%	1	<1%	0	0%	0	0%
Relative AC	1	2%	9	2%	4	44%	0	0%
Trust	1	2%	3	1%	1	33%	0	0%
Subtotal	2	3%	15	3%	7	47%	0	0%
Acquire								
Background Knowledge	1	2%	3	1%	1	33%	0	0%
Knowledge adoption activities	1	2%	1	<1%	0	0%	0	0%
Subtotal	2	3%	4	1%	1	25%	0	0%
assimilate								
capacity to generate output	1	2%	3	1%	2	67%	0	0%
Formalization-centralization	1	2%	4	1%	1	25%	2	<1%
Goals for International join venturing	1	2%	2	<1%	0	0%	0	0%
IJV Flexibility & Adaptability	1	2%	3	1%	1	33%	0	0%
knowledge codification and efforts to asimilate it	1	2%	1	<1%	0	0%	0	0%
Management Support by Foreign Parent	1	2%	2	<1%	1	50%	0	0%
Specialization by IJV's Parent	1	2%	1	<1%	0	0%	0	0%
Training by Foreign Parent	1	2%	3	1%	2	67%	0	0%
Subtotal	4	7%	19	4%	7	37%	2	<1%
Apply								
Ability to develop outputs	1	2%	3	1%	3	100%	0	0%
Commercializing new knowledge	1	2%	1	<1%	1	100%	0	0%
IJV's strategy	1	2%	1	<1%	1	100%	0	0%
knowledge learned from the foreign parent	1	2%	1	<1%	1	100%	0	0%
Knowledge utilization	1	2%	1	<1%	1	100%	0	0%
Training competence of IJV	1	2%	1	<1%	1	100%	0	0%
Subtotal	4	7%	8	2%	8	100%	0	0%
Overall AC								
identification/assimilation/application (8 items)	1	2%	2	<1%	2	100%	0	0%
Prior related Knowledge (5 items)	1	2%	1	<1%	1	100%	0	0%
Subtotal	2	3%	3	1%	3	100%	0	0%
Group subtotal	15	25%	52	11%	28	54%	2	<1%
Four dimensional approach								
Potencial AC								
Continuity of R&D	1	2%	2	<1%	1	50%	0	0%
Links with the environment, level of experience, Knowledge diversity and overlapping, strategic posture	1	2%	1	<1%	1	100%	0	0%
importance of external knowledge flows	1	2%	1	<1%	1	100%	0	0%
personnel with a university degree	1	2%	2	<1%	1	50%	0	0%
R&D intensity	1	2%	2	<1%	2	100%	0	0%
Internal/External/Time dimension PACAP Stock	1	2%	3	1%	3	100%	0	0%
Subtotal	4	7%	11	2%	9	82%	0	0%

Tabla 5. (Continuación)

Measure	No. Articles [1]	% Total articles [2]	No. Tests	% Total Tests [3]	No. Supported	% Supported	No. Counter	% Counter
Realized AC								
Internal/External/Time dimension RACAP Stock	1	2%	3	1%	1	33%	1	<1%
Overall AC								
ability to acquire, assimilate, to transform, and to exploit, (3 items)	1	2%	1	<1%	1	100%	0	0%
ability to acquire, assimilate, transform, and exploit, (4 items)	1	2%	2	<1%	2	100%	0	0%
Subtotal	2	3%	3	1%	3	100%	0	0%
Group subtotal	3	5%	6	1%	4	67%	1	<1%
Type of knowledge								
Capacity to absorb market	1	2%	4	1%	4	100%	0	0%
Capacity to absorb scientific knowledge	1	2%	4	1%	4	100%	0	0%
Capability to absorb technological knowledge (4 items)	1	2%	2	<1%	2	100%	0	0%
Capacity to use various	1	2%	6	1%	6	100%	0	0%
Group Subtotal	3	5%	16	3%	16	100%	0	0%
Totales	23	39%	173	37%	100	58%	4	1%

[1] Because sevaral articles use a variety of independent and dependent variables, the totals reported in this column do not equal their sums.
[2]The total number of articles is 59. [3]The total number of tests is 465.

En el enfoque de cuatro dimensiones, el componente más estudiado fue el potencial de AC (PACAP) con un total de 4 (17%) artículos y 11 pruebas estadísticas de las cuales 9 (82%) fueron confirmadas. De las 6 medidas empleadas para capturar el PACAP solo 2 no superaron el 50% de pruebas confirmadas. Por ejemplo, Xia y Roper (2008) demostraron que la formación de los empleados tiene un efecto significativo en el comportamiento de las alianzas de las empresas Europeas, sin embargo no presenta un efecto significativo para las empresas de Estados Unidos. Por otro lado, las dos medidas que examinaron el efecto conjunto de las cuatro dimensiones del concepto alcanzaron un nivel de apoyo bastante alto. Las 3(1%) pruebas realizadas en esta categoría fueron validadas en el 100% de los casos.

Por último, los académicos que consideraron el tipo de conocimiento dividen la AC atendiendo a la habilidad presente en la organización para adquirir y aplicar conocimiento externo de diferentes ámbitos. Aquí las 6 medidas aplicadas fueron validadas para el total de pruebas realizadas. El resto de resultados de este enfoque se muestran en la tabla 5.

La tabla 6 muestra como los académicos han medido el modelo basado en el conocimiento. En esta identificamos 21 formas diferentes de medir el término las cuales clasificamos en 4 grandes categorías: I + D, características del conocimiento, patentes y experiencia. De las 21 medidas sólo la intensidad en I + D y la experiencia previa fueron utilizadas en más del 3% del total de artículos examinados. La intensidad de I + D fue aplicada en un total de 8 (14%) artículos y 32 (7%) pruebas estadísticas. Sin embargo, el nivel de apoyo empírico alcanzado para esta medida no fue lo suficientemente alto, ya que solo el 47% del total de pruebas fueron validas. Asimismo, el 6% de las pruebas proporcionaron resultados contrarios a la teoría.

La mayor parte de las medidas aplicadas en este enfoque son relativas a las patentes (11 de 20). El nivel de apoyo alcanzado en varias de estas medidas fue considerablemente alto (superior al 74%), sin embargo, en 3 de estas no se encontró ningún apoyo empírico y 1 arrojó resultados contrarios a lo establecido en la teoría. Por ejemplo, Harrison y Koski, (2010) en su análisis de la estrategias en empresas de software Finlandesas, no encontraron ninguna relación entre el volumen del capital intelectual que este tipo de empresas poseía y la adopción de una estrategia de software de código abierto (Open Source Software, OSS). Asimismo, Kim y Song (2007) no encontraron ningún indicio que validara la hipótesis de que el solapamiento tecnológico influyera significativamente en el desarrollo de innovaciones conjuntas.

Tabla 6. Modelo basado en el conocimiento

Measure	No. Articles	% Total articles	No. Test	% Total Test	No. Support	% Supporte	No. Counter	% Counter
R&D								
Engagement R&D	1	2%	4	1%	3	75%	0	0%
Firm basic research	1	2%	6	1%	4	67%	0	0%
R&D expenditure/ University-Technical formation	1	2%	1	<1%	1	100%	0	0%
R&D intensity/expenditure	8	14%	32	7%	15	47%	2	6%
Knowledge charateristics								
Diversity-overlapping Knowledge (items)	1	2%	3	1%	2	67%	0	0%
Human capital of a region	1	2%	24	5%	13	54%	0	0%
Prior related Knowledge (5 items)	1	2%	1	<1%	1	100%	0	0%
Patent								
breadth of knowledge base	1	2%	1	<1%	1	100%	0	0%
breadth of knowledge base / centrality of R&D	1	2%	5	1%	4	80%	0	0%
Technological capital	1	2%	2	<1%	2	100%	0	0%
Technological capital x Cognitive distance	1	2%	2	<1%	0	0%	2	100%
Patent stock	1	2%	1	<1%	1	100%	0	0%
Technological breadth	1	2%	3	1%	0	0%	0	0%
Technological skill	1	2%	4	1%	3	75%	0	0%
Tecnology Overlap	1	2%	1	<1%	0	0%	0	0%
Citation to patents owned by firm	1	2%	1	<1%	1	100%	0	0%
Patent self-citation ratio	1	2%	1	<1%	1	100%	0	0%
intellectual property	1	2%	1	<1%	0	0%	0	0%
Experience								
Level of Knowledge-experience (items)	1	2%	3	1%	3	100%	0	0%
Previous Experience with sell-off	2	3%	5	1%	4	80%	0	0%
Size								
Sales (size)	1	2%	1	<1%	0	0%	1	100%
Totales	20	34%	102	22%	59	58%	5	5%

En la tabla 7 resume las diferentes medidas utilizadas para medir la AC según las características del capital humano. Como se puede ver, la más utilizada de las medidas ha sido el grado de formación del personal, empleada en 4 artículos y en 12 (3%) pruebas estadísticas. En esta medida solo el 50% de las pruebas efectuadas fueron validadas.

Las siguientes dos medidas más utilizadas fueron la capacidad de absorción individual, y la medida de la motivación y habilidad de los empleados aplicadas en 3 artículos cada una. De las 5 pruebas que midieron el nivel de motivación y de habilidad de los empleados sólo 3 (60%) fueron confirmadas. No obstante, las 7 que trataron de capturar la AC individual fueron validadas en todas las pruebas.

Tabla 7. Modelo basado en las características del capital humano

Measure	No. Articles	% Total articles	No. Test	% Total	No. Suppor	% Suppor	No. Counter	% Counter
Personnel with a university degree	4	7%	12	3%	6	50%	0	0%
Individual AC	3	5%	7	2%	7	100%	0	0%
Employee abilities and motivation (items)	3	5%	5	1%	3	60%	0	0%
Employee abilities (items)	2	3%	6	1%	6	100%	0	0%
Personnel involved in R&D activities	2	3%	5	1%	3	60%	0	0%
Professional and technological personnel	1	2%	5	1%	1	20%	0	0%
Awareness	1	2%	4	1%	2	50%	0	0%
Management skill (items)	1	2%	4	1%	3	75%	0	0%
Marketing skill (items)	1	2%	4	1%	3	75%	0	0%
Proportion of scientific and technical personnel	1	2%	3	1%	1	33%	0	0%
Totales	15	25%	55	12%	35	64%	0	0%

Continuando con la medición de las actividades de gestión del conocimiento, al igual que en el componente anterior, ninguna de las medidas aplicadas fue utilizada en más del 2% del total de artículos. Además, sólo 4 del total de medidas empleadas fueron confirmadas como mínimo en el 50% de las pruebas efectuadas. Las prácticas de gestión de los recursos humanos (HRM) y el flujo de conocimiento fueron las medidas que presentaron el mayor número de pruebas estadísticas confirmadas, sin embargo el grado de validez alcanzado en estas no superó el 20% del total de pruebas. El total de resultados se resumen en la tabla 8.

Por último, las tablas 9 y 10 resumen las medidas empleadas para capturar las “relaciones inter-organizacionales” y “características de las organizaciones”. En ambos enfoques las medidas no fueron aplicadas en más de 1 artículo. En el primero de los modelos de medida, las medidas que obtuvieron el mayor número de pruebas confirmadas fueron las conexiones con empresas del entorno (3 pruebas) y el conocimiento tecnológico de origen nacional (6 pruebas) donde todas las pruebas fueron afirmadas. En el segundo, las medidas de la centralidad de la estructura de I + D organizacional (1pruebas) y la AC colectiva (4 pruebas) fueron las que obtuvieron los mayores grados de validez.

Tabla 8. Modelo basado en las actividades de gestión del conocimiento

Measure	No. Articles	% Total articles	No. Test	% Total Test	No. Supporte	% Supporte	No. Counter	% Counter
Communicative KM	1	2%	6	1%	3	50%	0	0%
Educational KM	1	2%	6	1%	3	50%	0	0%
external KM	1	2%	6	1%	3	50%	0	0%
internal KM	1	2%	6	1%	0	0%	0	0%
training	1	2%	4	1%	1	25%	0	0%
HRM practices	1	2%	16	3%	3	19%	0	0%
Management stimulation for innovation	1	2%	3	1%	3	100%	0	0%
Administrative capability	1	2%	3	1%	0	0%	0	0%
Knowledge Flow (Backward citations to a external source)	1	2%	20	4%	3	15%	0	0%
Totales	7	12%	70	15%	19	27%	0	0%

Tabla 9.Modelo basado en las relaciones inter-organizacionales

Measure	No. Articles	% Total articles	No. Test	% Total Test	No. Supporte	% Supporte	No. Counte	% Counter
Number of alliances of each type	1	2%	15	3%	1	7%	0	0%
Type of technology alliances	1	2%	3	1%	0	0%	0	0%
Links firm-surrounding environment	1	2%	3	1%	3	100%	0	0%
Firm collaboration w/university scientists	1	2%	5	1%	2	40%	0	0%
Type of Cooperation	1	2%	4	1%	1	25%	0	0%
Type of partner	1	2%	6	1%	3	50%	0	0%
Technologically distant knowledge of national origin	1	2%	6	1%	6	100%	0	0%
Technologically distant knowledge of international origin	1	2%	2	<1%	0	0%	0	0%
Technologically proximate knowledge of international origin	1	2%	4	1%	2	50%	0	0%
Cooperations	1	2%	6	1%	0	0%	0	0%
Total	5	8%	54	12%	18	33%	0	0%

Tabla 10. Modelo basado en las características de la organización.

Measure	No. Articles	% Total articles	No. Test	% Total Test	No. Supported	% Supported	No. Counter	% Counter
Centrality of R&D organization structure	1	2%	1	<1%	1	100%	0	0%
Strategic positioning	1	2%	3	1%	2	67%	0	0%
Similarities between partnering firms and willingness to transfer	1	2%	2	<1%	1	50%	0	0%
Collective AC	1	2%	4	1%	4	100%	0	0%
Totales	3	2%	10	2%	8	50%	0	-

5. CONCLUSIONES

El presente estudio ha sido realizado con el fin de identificar la manera en la que el concepto de capacidad de absorción ha sido examinado empíricamente en la literatura y evaluar el nivel de apoyo empírico alcanzado en su estudio. Para ello fue seleccionada una muestra representativa de los estudios empíricos que han medido el concepto desde enero de 1990 hasta enero del

2010. Se identificaron un total de 78 artículos y 465 test de los cuales el 76% (56) de los artículos evaluaron la AC como variable independiente, el 22%(17) la examinaron como variable dependiente y el 4% restante analizaron aquellos elementos que moderan la relación entre los antecedentes y la AC existente en las organizaciones.

El concepto de AC ha sido reconocido como uno de los constructos más importantes que ha emergido en la literatura sobre dirección (Volberda, Foss & Lyles 2010) . Muestra de ello es la diversidad de áreas a las que pertenecen las revistas en las que se han publicado artículos sobre la temática. Sin embargo, a pesar de la amplia difusión del concepto, hemos encontrado que el nivel de apoyo empírico que ha recibido ha sido marginal. De los 59 artículos que evaluaron el efecto de la AC sobre las salidas, los procesos o el entorno de las organizaciones sólo se encontró apoyo empírico para el 51% de las pruebas realizadas. De los 17 artículos que examinaron el efecto de los diferentes antecedentes organizacionales y del entorno sobre el término, sólo obtuvo validez empírica el 44% de las pruebas. Aunque este índice de apoyo pueda parecer bajo, comparado con el nivel de difusión que ha obtenido la literatura, este se asemeja al nivel alcanzado en revisiones hechas a otras corrientes teóricas en dirección estratégica. Por ejemplo David y Han (2004), aplicando una metodología similar a la utilizada en el presente estudio, encontraron niveles de apoyo empírico del 47% para las pruebas referentes a la teoría de costes de transacción (TCE). Asimismo Newbert (2007), utilizando una versión adapta de la metodología de David y Han (2004), halló un nivel de apoyo del 53% para las pruebas que examinaron la Teoría de Recursos y Capacidades (RBV). Aunque los niveles de apoyo alcanzados en una teoría y otra no son comparables, estos resultados muestran que los valores obtenidos en el presente estudio no son atípicos.

Otro aspecto importante a destacar es el grado en el que la validez alcanzada por el concepto varía dependiendo del modelo de medida utilizado o de la relación analizada. Por ejemplo, aquellos estudios que evaluaron el efecto de la AC (medida como una capacidad) sobre los procesos de exploración y el desempeño obtuvieron un nivel de apoyo del 44% y del 45% respectivamente. En cambio, los que analizaron estas salidas midiendo la AC en base al conocimiento existente en las organizaciones alcanzaron un nivel de apoyo empírico del 69% y del 64% para la totalidad de pruebas contempladas. Basándonos en los resultados anteriores, se podría pensar que el modelo basado en el conocimiento representa el más idóneo para evaluar la manera en la que incide la AC sobre los procesos de exploración y el desempeño de las organizaciones. No obstante, la AC no solo constituye el subproducto del conocimiento previo, sino que existen otros elementos del entorno, de los procesos y de las estructuras organizacionales que influyen en su desarrollo(Lane, Koka & Pathak 2006, Zahra & George

2002) . Por ejemplo, Cohen y Levinthal (1990) resaltaron la importancia que tiene las políticas y los procesos organizacionales para facilitar la comunicación y la aplicación del conocimiento nuevo. Asimismo, señalaron la importancia de estos elementos cuando el conocimiento a absorber se encuentra a una mayor distancia cognitiva (Cohen & Levinthal 1990). Estos elementos constituyen aspectos importantes de la teoría de AC, sin embargo han sido desatendidos en los estudios previos del concepto.

Trabajos recientes han contribuido a corroborar y a enriquecer los argumentos antes señalados por Cohen y Levinthal (1990) al demostrar empíricamente como diferentes elementos del entorno interno y externo a las empresas contribuyen significativamente al desarrollo y mantenimiento de la AC organizacional (Lichtenthaler 2009, Jansen, Van Den Bosch, Frans A J. & Volberda 2005, Van den Bosch, Volberda & de Boer 1999, Lane, Salk & Lyles 2001, Lane & Lubatkin 1998b, Minbaeva et al. 2003) . Según estos estudios la AC constituye un concepto multidimensional, por lo cual al analizar de manera aislada el conocimiento previo como única aproximación del concepto, esto puede proporcionar una visión sesgada de la realidad del término. Por ejemplo, Lichtentharler (2009) al evaluar las diferencias entre las ganancias desarrolladas por las empresas a partir del conocimiento externo, encontró que la intensidad en I + D no era relevante para explicar dicha disparidad ya que esta solo contempla el conocimiento tecnológico y deja de lado la importancia que tiene el conocimiento de mercado. Ambos componentes del conocimiento son complementarios, por lo que su integración en los procesos de aprendizaje de las organizaciones dotará a estas últimas de la capacidad necesaria para adaptase a los continuos cambios del entorno.

Para capturar la naturaleza multidimensional del concepto los académicos tienden a combinar diferentes modelos de medidas. Por ello, el nivel de apoyo empírico alcanzado con estos componentes varía dependiendo del nivel de análisis (individual, organizacional, intra o inter organizacional) y de las variables consideradas para su estudio. Por ejemplo, el enfoque basado en las capacidades ha experimentado en los últimos 4 años un considerable aumento en el número de publicaciones y en el nivel apoyo empírico, el cual alcanzó valores mínimos del 75% para el total de pruebas examinadas. Asimismo, existe una mayor tendencia a medir la AC tomando en cuenta a parte de la base de conocimiento, otros elementos como son la motivación, las habilidades personales o los mecanismos de gestión. Estos nuevos lineamientos han servido para confirmar el carácter multidimensional del término y para demostrar que medidas como son la I + D, las patentes o los vínculos externos no tienen suficiente poder de explicación por si solas. Por ejemplo, de las 32 pruebas en las que se consideró la intensidad en I+D como medida del conocimiento previo solo se encontró validez en 47% de los casos.

Un tercer aspecto a destacar es la alta variabilidad existente en los constructos utilizados para medir la AC. Como se puede ver de la tabla 5 a la 10, se aplicaron diferentes tipos de medidas y enfoques para capturar los componentes centrales y las dimensiones que conforman el término. Por ejemplo, en las 291 pruebas en la se evaluaron los principales componentes de la AC se utilizaron 21 medidas distintas para la base de conocimiento, 10 para las características del capital humano, 9 para los mecanismo de gestión del conocimiento, 10 para las relaciones inter-organizacionales y 4 para las características de las organizaciones. En lo que respecta a las capacidades, identificamos 4 tipos de enfoques utilizados y una amplia variedad de medidas para capturar cada dimensión (Ver tabla 5). Asimismo, una mínima cantidad de estas medidas recibieron atención en múltiples artículos. Por ejemplo, en el enfoque basado en las características del capital humano, ninguna de las medidas fue utilizada en más del 7% del total de artículos. Todo esto demuestra el alto grado de flexibilidad que concede la teoría para su aplicación y además la falta de consenso que aun impera en la medición del constructo. La definición de AC desarrollada por Cohen y Levinthal, (1990) deja poco claro los límites del término, lo cual ha dado libre albedrío para que muchos académicos utilicen el constructo de acuerdo a sus necesidades (Volberda, Foss & Lyles 2010, Lichtenthaler 2009, Zahra & George 2002) .

Son varias ya las revisiones y los trabajos en los que se ha propuesto una nueva re-conceptuación del término. Sin embargo, hasta la fecha no se ha llegado a un conceso respecto a qué dimensiones conforman el concepto y cuáles elementos del entorno son los que inciden con mayor éxito sobre cada una de las fases del proceso de absorción del conocimiento. Futuros trabajos podrían intentar integrar aquellas mediciones que han demostrado tener un mayor nivel de validez pero que a la vez capturen el carácter multidimensional del concepto de AC.

6. LIMITACIONES Y FUTURAS LÍNEAS DE INVESTIGACIÓN

Aunque para el desarrollo del presente estudio hemos tratado de utilizar criterios lo suficientemente claros y transparentes tanto para la selección como para el análisis de la muestra, esto no significa que se encuentren exentos de limitaciones, las cuales podrían sugerir nuevas líneas de investigación. Primero, la presente muestra de artículos no representa todos los trabajos empíricos realizados sobre el concepto de capacidad de absorción, ya que la base de datos de ABI/Inform no recoge todos los artículos publicados en el campo de la capacidad de absorción. Asimismo, los criterios por los cuales los artículos fueron seleccionados pueden haber limitado la muestra de estudio, tal manera que no se hayan incluido los artículos que emplearon palabras claves diferentes a las definidas en los distintos filtros del estudio o que utilizaran una metodología cualitativa para el análisis del concepto.

Futuros estudios podrían utilizar otras bases de datos como la EconLit, con el fin de ampliar la muestra y recoger otros artículos que aporten enfoques o escalas de medidas diferente a la utilizada en la presente muestra de artículos. Además, los académicos que traten de replicar el presente estudio podrían considerar otros criterios de selección en orden de expandir o contrastar los resultados aquí detallados. Por ejemplo, visto que la AC representa un concepto multidimensional y multinivel, futuros estudios podrían evaluar cómo ha sido medida en diferentes niveles (individual, grupo, organizacional o inter-organizacional) y contextos (High-Tech vs Low Tech) para así determinar cuáles de los componentes considerados de la AC son los que proporcionan un mayor valor diferenciador en cada caso.

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OPEN INNOVATION AND TECHNOLOGY DISRUPTION IN FIRM'S AGGLOMERATIONS: INKJET TECHNOLOGICAL PARADIGM ENTRANCE IN THE GLOBAL CERAMIC VALUE CHAIN

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Abstract: the economic geography literature assumes that large leading firms (technology gatekeepers) (TGs) with high absorptive capacity and high-intensity R&D expenditures, shape the district learning process. However, there is an absence in the literature of a dynamic analysis of the role of the TG. Instead, most of the evidence provided is set at a single point in time and considers only one stage of the cluster life cycle (CLC). This paper challenges the aforementioned assumption, and introduces into the discussion two important influences on outcomes: the *type of knowledge* created (whether it be continuous or radical) in the cluster by technology gatekeepers, and the *stage of the cluster life cycle* (CLC) at which that knowledge is created. This work addresses the roles of the TG and the CLC together, responding to the gap that not much is known about the role and the persistence of the TG dynamically across different stages of the cluster life cycle. Using qualitative longitudinal case-study research, a world-class cluster is analysed over the last twenty years. The results show that there are *temporary technological gatekeepers* across cluster life cycles which assume the (temporary) role of leaders when it is a question of bringing in disruptive knowledge. The study's findings have important implications for scholars and policymakers.

Key words: technological gatekeepers, cluster life cycle, clusters, radical knowledge, spin-offs.

1. INTRODUCTION

This paper tells a story about a technology disruption which challenges assumptions in the industrial district[48] (ID, hereafter) literature. The paper attempts to answer the question of how clusters evolve, change and reinvent themselves, focusing especially on the role of technology gatekeepers (TGs, hereafter). Most works on TGs have been set at a single point in time (e.g. Morrison, 2008), and little research has been undertaken on gatekeepers over an extended period, with two exceptions (Giuliani, 2011 and Graf and Krüger, 2011). This is the case despite the existence of a rich stream of research analyzing the cluster life cycle (CLC, hereafter) (e.g., Menzel and Fornahl, 2010). In fact, the majority of studies about technology gatekeepers are contextualized at central stages of a cluster's life cycle (e.g., Giuliani, 2011; Morrison, 2008), and there is little in the literature that analyses their roles across a cluster life cycle, helping "push" a cluster from a mature stage to a renewal stage. This study aims to fill this gap.

The study aims first and foremost to answer the following question: which types of firms create knowledge at the different stages of a cluster's life cycle? Most of the literature on IDs assumes that the main providers of knowledge are TGs, i.e. focal firms which orchestrate networks and access external flows of knowledge (Allen, 1977). TGs carry out two key functions for a cluster's innovation system: sourcing knowledge from outside the cluster, and then diffusing that knowledge within the local system (Allen, 1977; Giuliani, 2005). Therefore, most of the research conducted on TGs assumes that large leading firms, with high absorptive capacities and high R&D expenditures, shape a district's learning process (e.g. Lorenzoni and Lipparini, 1999; Morrison, 2008) by making significant investments in searching, learning and diffusing knowledge within their own networks for the purpose of maximizing profits. However, this argument does not hold up when the linearity of such a TG-led learning process is challenged by considering the effects of two important influences, namely: first, the influence of *type of knowledge* that TGs create, and, second, the influence of the particular *stage of the cluster's life cycle* at which the aforementioned knowledge creation and diffusion process occurs. The argument is as follows.

[48] This paper recognizes "social" differences between industrial districts and clusters, although we refer to both terms throughout the text indistinctively.

The aforementioned literature implicitly assumes circumstances of *continuous (i.e. non-radical) innovation* generation in a context where TGs seek to maintain a central position in inter-firm networks. Radical, disruptive or breakthrough innovations can be based on *novel* technologies (new to the firm), or on *emergent* technologies (new to the entire industry)[49]. Bower and Christensen (1995) defined disruptive technologies as those which "*bring to a market new value propositions".* While TGs are supposed to maintain stable and high-quality linkages (Lorenzoni and Lipparini 1999; Giuliani, 2011:1339-40) a potential technological disruption in the cluster could alter the *status quo.* When a TG is dominant in a cluster it focuses research and knowledge creation to its own benefit (Agrawal and Cockbrun, 2003), and whole networks could be locked-in to a particular knowledge paradigm. Consequently, as Gargiulo and Benassi (2000) point out, cluster firms embedded in stable local networks can be trapped due to the fact that technological breakthroughs or radical changes could threaten the existing power of TGs (Allarakhia and Walsh, 2010). This argument is confirmed in the entrepreneurship and strategic management literature, contradicting the economic geography assumption that has characterised TGs as firms which lead and shape learning in IDs (e.g., Lazerson and Lorenzoni, 1999, Lissoni, 2001). TGs as incumbent firms are more engaged in providing incremental improvements to existing products while small new entrepreneurial firms are the ones which create radical innovations (Baumol, 2004), which incumbents are unable to challenge (Christensen 1997).

The literature about the different stages of the CLC (e.g. Menzel and Fornahl, 2010) has established that knowledge is more heterogeneous in the early stages and, then, after a shake-up process has quietened down, cluster maturity occurs, leading firms become dominant, the knowledge heterogeneity is reduced, and the leading firms head the cluster knowledge and learning process. Most of the works on TGs (e.g., Morrison, 2008; Albino et al., 1998) are focused on clusters that are at a central stage of their life cycle when there are few or none new entrants and when knowledge is more homogeneous, and the context is one where continuous (rather than radical) innovation is the norm. Other studies on TGs focus on single points in time (e.g. Morrison, 2008) and no analysis of the CLC is carried out. This produces the problem that consequently little is known about whether existing TGs will continue as TGs in the following stages of a CLC: whether they will be bearers of renewal or decline. In fact, there are few articles addressing these later stages of the CLC (e.g. Grabher, 1993). Indeed, to the best of our knowledge, there are neither articles discussing the role of the TG at the renewal stage of a

[49] See Ahuja and Lampert (2001) for a discussion, extension and deep analysis of the terms.

CLC, nor are there ones that address explicitly the theoretical cross-fertilization between TGs and the CLC. Put differently, when it comes to the issue of renewing a cluster, not much is known about which TGs are involved, how active they are, and what their roles are. Indeed, are the TGs the same firms at different CLC stages?

Thus, this paper addresses an important paradox. While TGs play an important role as knowledge leaders , they have no incentive to alter the status quo by promoting new technologies which threaten their own roles in clusters. In fact, the literature says that new knowledge is created by new entrepreneurial firms. Without new knowledge the cluster cannot be renewed, and eventually it may face lock-in and decline. Consequently, the question is who can act as technology gatekeepers that contribute to renewing clusters before they decline? By drawing on a range of literatures, including that focussed on economic geography, as well as others concerned with entrepreneurship, management and technology strategies, this article develops an integrated perspective. Through such a perspective we look at the roles of technological gatekeepers in cluster life cycles, in order to better understand the mechanisms which dynamically shape the learning process and how clusters evolve. In addition, we specifically focus on the renewal stage in the CLC, extending our knowledge of the learning process at that point. We also provide novel insights about different types of TGs and the new technological trajectories which open up a cluster's knowledge architecture.

This paper considers the interplay between technological discontinuities, cluster dynamics and external (to the cluster) sources of new knowledge. The study supports the findings of previous research that incumbent firms are often unable to adapt to the impact of new knowledge and that small entrepreneurial firms are the major sources of radical innovations. The major contribution lies in the finding that the renewal stage of the CLC fosters the establishment of new and *complementary* TGs, challenging the established assumptions about the role of TGs in clusters. In addition, the paper extends the concept of external linkages by providing a different approach, one in which the actors which exchange knowledge and information are from non-related industries. By accessing radical knowledge a cluster avoids potential knowledge lock-in and opens itself up to new paradigms which could potentially serve to promote a general rejuvenation and reinvention.

This paper is based on a qualitative longitudinal case-study of how the Castellon ceramics cluster in Spain has evolved over the last twenty years. The objective has been to first describe the cluster's initial stages, and then the subsequent consolidation of a technological discontinuity together with the evolution of the TGs. After this introduction, section 2 addresses the theoretical treatment of technology gatekeepers and spin-off processes. Then, in a third section, the paper considers the issue of different cluster life cycles. In a fourth section, the qualitative case study is presented. Finally, the last two sections discuss and conclude, pointing out the implications of the paper for theory, scholars and policy makers.

2 TECHNOLOGY GATEKEEPERS AND SPIN-OFFS.

TGs are said to be essential to cluster learning processes by accessing external (to the cluster) knowledge, and conducting a conversion process which deciphers external knowledge and turns it into something locally understandable and useful (Becattini and Rullani, 1996). The gatekeepers (Allen, 1977; Morrison, 2008) or *anchor tenants* (Agrawal and Cockburn, 2003; Baglieri et al., 2011) are focal companies or agents which mobilize knowledge, orchestrate the cluster by attracting investments, provide a vision for nurturing innovation, and supply technological knowledge to local start-ups (Baglieri et al., 2011). Anchor tenants are said to generate new knowledge by combining specific local knowledge with external knowledge components (Agrawal and Cockburn, 2003). This is facilitated by having abundant external (to the cluster) ties that enable the exploration of new forms of knowledge (Baglieri et al., 2011; Giuliani, 2007), through both formal and informal channels (e.g. Gittelman and Kogut, 2003). In particular, most of the research conducted on TGs assumes that large leading firms with high absorptive capacity and high-intensity R&D activities shape the district learning process (Morrison, 2008; Lazerson and Lorenzoni, 1999; Albino et al., 1998; Lorenzoni and Lipparini, 1999; Lissoni, 2001; Munari et al., 2011; Baglieri et al., 2011; Giuliani, 2007) by engaging in major investments to search for, acquire and diffuse knowledge within their own company networks in order to maximize profits.

Nevertheless, the literature about technological gatekeepers and their effects on clusters presents certain paradoxes. The technology strategies literature highlights the notion of competence destroying technological discontinuities (or radical innovations) (Tushman and Anderson, 1986), with the suggestion that such discontinuities can trigger changes in the competitive landscape in ways that frequently disadvantage incumbent firms. Such new technological changes allow new entrants to establish innovative and dominant designs (Abernathy and Utterback, 1978) and incumbents often prove unable to respond (Bower and Christensen, 1995; Christensen 1997). In addition, the literature on entrepreneurship has pointed out that new small entrepreneurial firms are the ones responsible for major revolutionary breakthroughs (Baumol, 2004; Zucker et al., 1998; Jorgenson, 2001), while the incumbents are more engaged in providing incremental improvements to existing products (Baumol, 2004). Therefore, the assumption that the technological gatekeepers are the incumbents which orchestrate a cluster, and provide its dynamism, and are the firms which provide the cluster with knowledge, is only valid as long as there are no radical changes. When radical knowledge appears the TG incumbents oppose it in order to maintain the status quo and their central positions in the cluster's networks (e.g., Allarakhia and Walsh, 2010).

According to Tushman and Anderson (1986), technology evolves through periods of incremental change, punctuated by technological breakthroughs that either destroy or enhance a firm's competences in an industry and especially in IDs. In general, competence destroying discontinuities are initiated by new firms while actions to enhance competence are initiated by existing firms. Leading companies stay closely tuned to their customers' needs and new technologies may either be perceived as (a) presenting different performance attributes, not valued or known, by existing customers or (b), as creating value attributes which may improve at such a rapid rate that the new technologies can threaten established markets (Bower and Christensen, 1995). Incumbent firms tend to stay close to their customers, and the processes of identifying customer needs, and forecasting technology trends, as well as the allocating of resources, are centred on current customers and markets, and therefore such firms may not be attracted by new technologies and will probably avoid disruptive technologies (Bower and Christensen, 1995). In addition, Tellis (2006) highlights an incumbent's lack of vision of its market and a desire not to destroy existing assets when serving the market. He points out that not only do small new entrants introduce disruptive technologies, but also large and incumbent firms can be later developers of such new technologies. For Tellis (2006), incumbents do not consider investments in disruptive technologies a rational financial decision.

According to our theory, and as has been pointed out by other authors (Baumol, 2004), incumbent TG firms will be reluctant to destroy the status quo, and will be less effective than new entrants in introducing radical or disruptive innovations that threaten their own product portfolio. But what are the characteristics that new entrepreneurial firms need to possess? Such firms have been termed as visionary leaders (Tellis, 2006) and according to Assink (2006) they should have disruptive innovation capabilites[50] defined as the *"internal driving energy to generate and explore radical new ideas and concepts, to experiment with solutions for potential opportunity patterns detected in the market's white space and to develop them into marketable and effective innovations, leveraging internal and external resources and competencies.*

Therefore, taking into account that new small entrepreneurial firms are disruptive agents, the next question is: are those small entrepreneurial firms new start-ups or spin-offs? Put differently, are the new entrants, as opposed to incumbents, from inside or outside the cluster? The literature on clusters, mainly from the strategic management perspective, is clear about the answer: knowledge spillovers are related to heredity, that is, knowledge flows from successful incumbents to those organizations with previous experience in the industry. This means that organizations (incumbents in our reasoning) spawn new enterprises through spin-off processes (Klepper and Sleeper, 2005; Klepper, 2007). According to Klepper's and Thompson's (2006ab) framework, spin-offs follow from disagreements which arise because incumbent management has a limited ability to recognize superior ideas from employees. In addition, as Klepper (2007) suggests, spin-offs are the key reasons to explain agglomeration economies.

3 CLUSTER LIFE CYCLE, LOCK-IN AND RENEWAL

The burgeoning cluster life cycle literature emphasises the problem of knowledge lock-in, (Menzel and Fornahl, 2010; Giuliani, 2011; Bergman, 2008). The characterisation of different stages of the cluster life cycle vary, depending on the author (Lorenzen, 2005; Van Klink and De Langen, 2001; Menzel and Fornahl, 2010), but all of them agree that there are distinct "emergence", "growth", "maturity" and "decline" phases. In the first stages of a CLC,

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[50] We prefer the concept of Disruptive Technology [50] which is more precise and is more useful for explaining industry change, the processes involved and the implications. Bower and Christensen (1995) defined disruptive technologies as those which "*bring to a market new value propositions*".

knowledge has a more heterogeneous character (Menzel and Fornahl, 2010) and clustered firms have higher growth rates than in later stages, and there is a pervasive spin-off process (Klepper 2007) which drives cluster growth. In the growth stage, self-reinforcing processes based on trust and reciprocal interactions are crucial. Audretsch and Feldman (1996) found that clustered firms have a high innovation rate during the growth phase. By the time of the maturity phase, the competitive shake-up period is largely over, and the cluster has been shaped with leading firms playing a dominant role as TGs. Knowledge has become more stable and homogeneous. Finally, in the latter stages there is a decrease in innovation (Pouder and St. John, 1996) which potentially leads to knowledge lock-in.

There is a diversity of explanations for the emergence of clusters and the development of the decline stage (e.g. Shin and Hassink, 2011). However, what is missing is analysis of a CLC's renewal stage. How a cluster moves through its life cycle depends on whether there is an increase or decrease of heterogeneity amongst the cluster's organizations (Menzel and Fornahl, 2010), and whether there is a renewal of its technology life cycle (Anderson and Tushman, 1990). The question is how can heterogeneity be increased in order to renew a cluster and initiate a new growth stage? Most cluster studies focus on successful cases at a time when they are in their central life stages. Some studies analyse emergence (Bresnahan et al., 2001), and a few cluster decline (Grabher, 1993), but literature on cluster renewal is scarce. Klepper (2007) showed how radio producers in the USA shifted to making televisions, and Tappi (2005) documented the shift from mechanical manufacturing methods to the use of electronics in the accordion cluster in Marche, Italy. But neither of them analysed the role of TGs, nor the processes by which new knowledge is created. The reason to expect that incumbents cannot cope with technological disruption is related to the phenomenon of the learning trap (Levinthal and March, 1993) whereby leading organizations foster specialization and inhibit experimentation, and find it difficult to adapt and diversify (March, 1991). Ahuja and Lampert (2001:527) summarized why it can be so difficult to increase knowledge heterogeneity:

Mature technologies are likely to have highly developed value networks and organizational and extra-organizational assets that are co-specialized with these technologies (Christensen and Rosenbloom, 1995). These co-specialized assets and networks make subsequent innovations on these existing technologies easier, but may impede experimentation with nascent technologies that require different sets of assets, inputs, and complements.

Our argument can be summarized as follows. First, the TG orchestrates the networks that control and shape most of the learning process in a cluster, focussing mainly on the creation of non-radical incremental knowledge. In this process, a TG's superior resources provide it with centrality and control over the networks. Second, while the TG is able to dominate during the mature or central stages of a CLC when knowledge is more homogeneous and stable, there is no evidence suggesting the TGs will then lead the creation of radical knowledge which can move the cluster on a renewal trajectory and thereby avoid decline. On the contrary, it is new entrepreneurial local spin-offs that may threaten the existing technological status quo and thus rejuvenate the cluster. See table 1 which explicitly addresses the proposed framework[51]. (See Table 1)

4 The case study.

The case study utilizes secondary data analysis alongside in-depth interviews aimed at understanding the evolution of the Castellon ceramic cluster over the last 20 years. Interviewed respondents (twenty nine) included: the inventors of a new technology; the lead users of, and improvers of, the technology; the managers of leading firms; officials of public research laboratories; academics; consultants; and policy officials. Interviews were conducted informally from 2000 to 2011 by one author of this paper, who was a consultant to the inventors of the technology and was commissioned to find government funding for the intensive R&D process which led to the new breakthrough. Formal semi-structured interviews with the inventors and other complementary firms have also been carried out, especially during 2011. In total, 12 key informants were formally interviewed over periods of 2-3 hours per person. In respect of the inventors of the technology, the formal and informal interviews carried out amounted to around 200 hours. In addition, we achieved triangulation of data through specific questions with interviewees, discussion with experts in the industry and policymakers and also by comparing results with secondary data (e.g. Baxter and Eyles, 1997). As well as carrying out the

[51] It should be pointed out that our argument does not imply that TGs cannot maintain and provide some form of renewal to the cluster by continuous non-radical innovation.

aforementioned interviews, we have also analysed archival data, internal documents and reports, and academic publications to document how the cluster, its anchor firms and the new entrants have evolved over time. This approach is consistent with Yin (2008).

4.1 The Castellon cluster in Spain The Castellon ceramics cluster is a meta-cluster (Hervas-Oliver and Albors-Garrigos (2007) that includes all the activities of the ceramics value chain, as well as various public R&D organisations such as the Institute of Ceramic Technology (ITC-ALICER, hereafter), educational centres such as the Jaume I Universitat and private institutions such as trade associations (including Ascer, Anffecc, and Asebec). The cluster provides 20,000 direct jobs (in 2010) and there are 300 firms in related industries (Ascer 2010).

Within the cluster, glazing is the most important of the auxiliary industries (Meyer-Stamer et al., 2004; Hervas-Oliver and Albors-Garrigos, 2008). The Castellon glazing industry is the world leader with 26 firms exporting around 66% of total production valued at 900 million euros; and employing around 3,200 workers in 2010 (Anffecc, 2010)[52]. It has extensive operations in other clusters including in Italy and Brazil. The strength of the concentration of companies from different, but interrelated, industries in the Italian and Brazilian ceramics clusters is reflected in high location quotients for these districts. For example, in the Italian (Sassuolo) ceramics cluster the quotients range from from 3.5 to 5.70, which means that the level of concentration for the industry ranges from about 350% to 570% higher than the national mean (depending on the specific municipalities within the cluster) (Boix 2009). As in Castellon, the ceramics industry in Italy has a location coefficient of about 4.5 in the cluster, which means that the concentration of the industry in the cluster is 450% above the national average (ISTAT 2006).

Institutional support in the Castellon cluster is strong. For example, the local university in Castellon (Universitat Jaume I, UJI) offers a chemical ceramic engineering degree, as well as a masters and a PhD - which are unique in the world. These academic qualifications are offered by UJI jointly with the ITC-Alicer R&D centre. The R&D centre (ITC-Alicer) is the body

[52] Similarly, the ceramic machinery equipment industry from the Emilia-Romagna area is also the world leader, with a total turnover of 1,393 million euros in 2010 and exporting around 76% of its total production (Acimac, 2010).

responsible for transferring knowledge to the cluster through conducting research projects with local firms. It has around 120 researchers. Collaboration between ITC-Alicer and UJI constitutes an excellent example of university-industry knowledge exchange. Lectures in the UJI are provided by ITC-Alicer researchers who have daily contact with the industry.

According to Meyer-Stamer et al. (2004) and Hervas et al. (2008) the cluster has sufficient public R&D centres, and educational institutions, and private organisations such as fairs and trade associations, to provide proper support to the value chain. For example, the cluster organises international congresses on frits and glaze (through Qualicer), and private international fairs (through Cevisama). However, it is inter-organisational interaction exemplified by that of the ITC with the Jaume I Universitat that is a crucial part of the cluster's "innovation engine" (Meyer-Stamer et al. 2004; Hervas, 2004), and the true strength of the Castellon cluster lies in its *systemic behaviour*. The mechanism of innovation diffusion is very difficult to replicate elsewhere – as confirmed in interviews carried out while preparing this paper. Ceramic tile company technicians are in continuous contact with technicians from glazing companies. At the same time, ceramic tile companies hire chemical engineers specialized in ceramic tiles and trained at the ITC and the Jaume I Universitat. Accordingly, there is a dynamic information and knowledge flow within the cluster network system. This is why the glazing industry is the main signatory of contracts with the ITC and is the cluster sector with the most developed R+D. Knowledge is transferred through its interrelations and links with tile companies. At the same time, these links are strengthened by the ITC's support for the tile companies and the hiring of technicians experienced in the various industries. This creates a fluid circulation of tacit and explicit knowledge. This process is aided by the use of a common language, culture, understanding, and personal relationships between local workers – who are implicitly motivated by the same objectives (Meyer-Stamer et al., 2004).

4.2 Technology Disruption from Rotocolor to INKJET technology

4.2..1. The technology status quo

Until 1994, the decorating process in the tile ceramics sector was mainly based on screen printing technology utilising flat or cylinder screens, an inefficient process which required large batch series. In 1994, the Italian company *System,* produced the Rotocolor machine. This important innovation replaced the screens with laser engraved polyethylene rollers which transferred the design colour patterns to the tiles. Although this technique was a significant improvement, it did not solve all the design reproduction problems and implied the need for specialized technicians that would manage the production process. Furthermore, it still required electronic engraving of the rollers and needed large production batches. Furthermore, the design transfer process was arduous, lengthy and costly. As a proof of Rotocolor becoming a dominant technology, a number of competitors copied this design which opened a number of legal litigations (Russo, 2004). By the end of the 1990s this technology had been adopted in 20-25% of ceramic tile producing plants.

4.2.2. Developing a disruption

In 1998, a local Spanish computer entrepreneur engineer with extensive experience in the tile ceramic industry, along with a chemist working in a leading glaze and pigment multinational firm, began exploring new possibilities for decorating tile ceramics based on digital technologies, and in 1999 they developed a first prototype based on inkjet printing. The initial prototype proved its feasibility and led to the founding of a spinoff entrepreneurial firm, Kerajet, spawned by a leading frits and glazing incumbent MNE firm, Ferro. Based on a design consisting of multiple inkjet head systems, control hardware, software design transmission, and inkjet handling subsystems, Kerajet presented their first industrial prototype in the CEVISAMA exhibition in 2000 and also acquired two PCT patent applications.

At this early stage financial support from the glazing firm Ferro was crucial. It was agreed that Kerajet would develop electronics and software applications and the decorating machine, while the glazing MNE would focus on the development of inks for the new technology. The new technology consisted of four basic subsystems: inkjet print heads; inks or colours to decorate the tile; mechanical parts; and software that ensured the transfer of the design artwork to the printing system, and controlled the process. The third and fourth subsystems continually evolved while the first and second ones had more punctuated evolutions. Inkjet technology constituted a complete breakthrough in the decoration process. In effect, a *cooking* craft process (Russo, 2004) was replaced by a digitized process.

4.2.3. The adoption of the technology.

Ceramic tile producers were confronted with the innovator's dilemma (Christensen, 1997). The decision that confronted them was whether to adopt a new technology that required a complete break from a tried and tested existing craft production culture to a digital computing one, in circumstances where the advantages of a new approach were still uncertain. Moreover, for Italian producers there was the added factor that the new technology had been invented by a Spanish firm. In Italy, the design leaders, and also leaders in mechanical equipment manufacture, were Italian, and for non-Italians trying to break into the market there was a significant "*not invented here*" barrier.

Even though the new technology promised users the possibility for introducing cutting edge designs and applications, during the early years of development (2000-2004) only four tile producers with capacities in advanced production technologies really understood the innovatory implications, and so committed themselves to inkjet technology. Their profile was varied. One of them was a medium-sized firm (employing around 300 employees) which exported to Germany and England, and which specialized in cutting edge designs. This firm, acquired four inkjet printers. The firm also contributed suggestions to Kerajet for printer improvements. It was the first firm in the Spanish cluster to envision the capabilities of the new technology and so was the first to incorporate digital control intothe decoration process. In a personal interview their plant engineer showed us reports demonstrating the enormous savings made by using the inkjet technology. The other early inkjet adopters were remarkably small companies (only employing around 60 to 70 employees each). In an interview, one plant foreman explained to us how the new technology increased his firm's ability to cope with short batch runs, to cut down inventory and to satisfy niche customers.

A problem for the issue of knowledge dissemination was that the early lead users believed they were developing competences that differentiated them from competitors and so this perceived competitive advantage persuaded them to avoid disseminating their new knowledge throughout the cluster. At the same time, there were other lead producers who tried the technology but who rejected it because it did not meet the needs of their mainstream customers and this time their knowledge about the rejection was disseminated[53]. The lead-users which contributed to refining the Kerajet prototypes were neither TGs nor leading firms and were not embedded in large networks orchestrated by leading TG incumbent firms.

4.2.4 Technology development and success.

The Kerajet team needed to solve two particular technical problems, both of which required sourcing knowledge from outside the cluster. First, there was the problem of developing a print head adapted to ceramic tile decorations. The necessary knowledge for this was available in neither the Castellon nor Sassuolo clusters. In fact, this knowledge was new to the entire industry. The entrepreneurs decided to search for appropriate printing technology competences within the high tech Cambridge cluster, UK. After various trials and mishaps, the Cambridge firms SEIKO and XAAR were selected, and finally an agreement was reached with SEIKO to develop print heads specifically designed for ceramic tile applications. Cooperation between Kerajet and SEIKO lasted from 2002 to 2009. Additionally, Kerajet also made agreements to develop software with research laboratories external to the Castellon cluster. These are two interesting examples of the creation of knowledge linkages that were not only external to the cluster but also to the industry.

In respect of the inks required for the application, it soon became clear to the entrepreneurial team that the existing state of the art pigment technology (based on inorganic soluble salts) was not compatible with the print heads required by the new inkjet technology. There were two problems. First, Ferro, the sponsor of Kerajet, was reluctant to invest heavily in the new technology. Second, there were technological barriers to producing the required new organic pigments because the pigment size required could not be met by existing ceramic tile milling technology. Consequently, Kerajet built on their own premises a small laboratory to develop the new inks, utilising nano-technology micro mills and testing new organic solvents. By 2004, significant advances had been made with the new print head and inks technologies and the most acute problems associated with inkjet ceramic tile decoration had been solved. Micro milling technology capable of ensuring that the new ink powder for the inkjet technology would

[53] One of the largest ceramic tile producers pointed out "*when our Italian competitors buy it we'll buy it as well"*

be fine-grained was sourced from Germany, in the heart of the area where equipment suppliers for the chemical industry were located.

It must be emphasized that incumbent TG firms in the Italian mechanical equipment industry, which had traditionally dominated the sector, were reluctant at that time to follow the new developments. These firms were slow to react. It was not until 2007 that System, the industry's leading firm, located in Emilia Romagna, signed an agreement with Kerajet. System's expectation was to adapt its own Rotocolor technology[54]. Sacmi, another TG equipment manufacturer based in Italy, registered its own patent with powder injection in 2008.

It can be concluded that by 2005 Kerajet was the leader and the pioneer in inkjet technology. Indeed, its printers were recognized internationally in the Technargilla Fair of September 2004 in Rimini Italy. It has also since developed and commercialized not only conveyor inkjet printers but also a large flat bed printer with moving print heads.

4.2.5 The new technology becomes a dominant design

The mid 2000s marked the development of inkjet technology as a dominant design. The glaze and pigments leaders followed the path of Kerajet and started to develop and market for the inkjet technology new inks, after realising that they provided much higher added value.

Kerajet was challenged by new entrants, basically from within the pigment and glaze industrty. The first follower was a pigment producer, Torrecid, which partnered with Durst to offer on the market in 2005 the second inkjet printer using organic pigments. It was followed later by Cretaprint, a small rotocolor manufacturer in Spain.

[54] Kerajet had a temporary agreement with System, the inventor of Rotocolor, to integrate its technology into their system,.

Print head producers, pioneered by XAAR, began to develop inkjet print-heads adapted for tile decoration. After five years, ceramic tile inkjet print heads became a standardised product, with four international firms accounting for 99% of the market. Organic pigmented inks (necessary for the new technology) also became a standard, and today 10 Spanish glaze and pigment producers have them in their catalogues, while 4 of them account for 85% of the international market. Three inkjet printer manufacturers (also based in the Spanish cluster) dominate the international market, with a combined 75-80 % share[55]. The remainder is accounted for by three or four manufacturers, including two Italian equipment producers – of which, one, Durst has a plant in Spain.[56] The Spanish Castellon cluster dominates the technology.

It must be pointed out that the initial lack of infrastructures inhibiting the development and dissemination of inkjet innovation, such as a lack of software competencies, a lack of microelectronic suppliers, a lack of print head technology suitable for the ceramic tile application, and a lack of computer trained operators, have been surmounted by the visionary efforts of the entrepreneurs who initiated change and established external linkages for sourcing knowledge from distant non-ceramic clusters.

The new technology offers extraordinarily sharp image resolutions, fast line speeds and heightened productivity, as well as the potential for producing cutting edge designs unthought of a few years ago. It has been recognized as a leading competitive technology and the major inkjet equipment manufacturers are inundated with orders. New printer models have been developed with an increased number of attributes and improved specifications. It is estimated that there are currently more than 500 ceramic tile manufacturing lines equipped with inkjet machines.

During the early years (2000-06) the pioneer firm (Kerajet) dominated completely the market with printer sales going to leading customers. Even now, according to interviews with leading firms, Kerajet still has a strong penetration, accounting for an estimated 50-60% of global purchases of the technology. The evolution of printer sales has followed an exponential curve,

[55] Técnica Cerámica, 349, pp. 1307-1322.

[56] Técnica Cerámica, 394, pp. 497-498

and the technology still seems to be in a growth phase. According to the estimates of experts (Ceramic World Review, 2011)[57], in 2011, 18-20 % of total worldwide ceramic tile producing lines were digital while the projection is that by 2013 the percentage will reach 63-65%. In 2011, the leading countries in inkjet adoption were Spain, with a 30% share of the use of the technology, and Italy with 23 %. Italy's lower adoption figure may be interpreted, as was mentioned earlier, as being a consequence of barriers associated with the *not invented here* syndrome[58]. In emerging countries, the penetration of inkjet technology is lower. China only accounts for 1.0, % of global technology takeup, while Brazil and India account for 10 % each. The "disruptive innovation" theory can explain the slower takeup since in these countries the technology still does not meet the needs of mainstream markets. However, experts' projections for 2013 for these countries is that by then China, Brazil and India will account for 10%, 20% and 20%, respectively of global takeup, implying that the value proposition changes – as predicted by the disruptive innovation theory (Ceramic World Review, 2011[59], Tecnica Ceramica, 2010[4]). Nevertheless, with 2012 figures, two-thirds of the inkjet production is in Sassuolo and Castellon.

5. DISCUSSION OF RESULTS

According to our study, a number of elements were determinant in the final success of the inkjet expansion, most of which were crucial for neutralizing the inhibitors of disruptive innovation capabilities in clusters, as pointed out by Assink (2006).

The main actors responsible for the project's success were the initial entrepreneurs, the enterprise of whom had been spun-off from a leading TG. Their knowledge of the various actors in the Spanish cluster (such as equipment suppliers, tile producers, customers, and pigment and glaze producers), along with their skills (in the fields of information and communication technologies, mechanical engineering, electronics and chemistry), and also their

[57] Ceramic World Review (2011), Ceramic Inkjet Printing, making sense of the technology, 92, pp. 165-159.

[58] This is the reason why in 2007 Kerajet opened an office in the centre of the Italian Sassuolo ceramics cluster.

[59] Ceramic World Review (2011), Ceramic Inkjet Printing, making sense of the technology, 92, pp. 165-159.

vision for the industry, were the main drivers of the new project. Their vision was a necessary requirement for overcoming a conservatism in respect of innovation and the appliance of new technologies to tile decoration processes, an area where craft was the dominant paradigm[60]. Incumbent TGs were reluctant to embrace the new technological trajectory, and in fact saw the new technology as threatening their main business areas (Tellis, 2006; Danneels, 2004).

A fundamental role was played by lead users in the tile producer sector. Four producers in Spain made a commitment to the new technology, and demonstrated this, not only by the early acquisition of machines but also by offering numerous suggestions for the development of new models (von Hippel, 1986; Urban and von Hippel, 1998). In some instances, 80% of the changes in a new model came out of lead users' comments. Early in the development of the technology the 4 Spanish producers were aware of the cost advantages offered by the inkjet technology and they profited from improvements to its design. When inkjet technology started to be popular some lead users substituted almost all their screen printing lines with digitized equipment[61]. They were firms not strongly embedded in the established networks orchestrated by the incumbent leading frits and glazing firms. They carried out a bridging role between research and development and market adoption (Adner, 2002).

Our results confirm various parts of the literature. First, the technology gatekeepers cannot be the ones which introduce radical technologies. That role belongs to new entrepreneurial firms (Audretsch and Feldman, 1996) which have spun off from incumbents (Klepper, 2007). Through them the cluster can be renewed and re-set on a new growth trajectory. In fact, the spin-offs which introduce radical knowledge into the cluster act as temporary technology gatekeepers.

[60] For a view on the production technology approach of ceramic tile producers see Albors et al (2006)

[61] One of the main marketing errors made by Kerajet was to go for global marketing rather than concentrate on selling to innovative lead user producers. The standard ceramic tile producer required a standard technology suited to their mainstream customers' markets, and was not prepared to endure the learning curves that the new technology required. A reliance on word of mouth worked against the spread of the new technology since it was for lead users a source of technical advantage which they did not want to pass on to others.

Second, the networks controlled by the TG follow the rules and constraints imposed by the TG, because the latter has incentives to orchestrate the network in its own favour. This implies that an incumbent TG tends to deter the adoption of any new technology which might threaten the *status quo* (e.g. Allarakhia, M., Walsh, 2010). Thus, those lead users which are early adopters of radical knowledge cannot belong to the TG's stable networks. Nevertheless, once the new technology has become more established the traditional or incumbent TGs also become adopters in order to keep pace with the new technological trajectory, and thus maintain their previous TG role.

Pigment and glaze producers facilitated the growth of the technology either by being early followers and competitors, or simply through being late adopters and facilitating the standardisation of pigments for the new application. Despite an initial reluctance from incumbent pigment and glazing producers to accept a new technology that challenged the status quo, a multinational firm, Ferro, contributed equity and capital to the enormous investment required initially by the project. Later, cooperation between pigment producers and equipment suppliers to the pigment industry was fundamental to the development of process innovation for the new pigment production.

Though Italian equipment manufacturers viewed the new technology as a threat to their main business areas (Tellis, 2006; Danneels, 2004), System, the Italian inventor of *Rotocolor*, was a temporary partner in the project and contributed indirectly to technology dissemination in the latter phases of the consolidation of the new technological paradigm. System's collaboration with the new temporary TG, Kerajet, confirms Giuliani's (2011) observation that TGs mainly exchange knowledge with other TGs (Kerajet with Ferro, Torrecid and System). Tis knowledge exchange also permitted new spin-off TGs to enter the incumbents' established networks.. In fact, nowadays the incumbent TGs previous to the disruption still retain their roles, but now sharing with the new inkjet leaders.

Strikingly, Kerajet acted as a focal firm and a *temporary gatekeeper* by overcoming the district's lack of critical competences by making a bridge to knowledge external to the cluster and the industry when required, thereby confirming the view of the role of a TG to be an access agent to global pipelines. Specifically, research cooperation was carried out with two inkjet print-head manufacturers from the Cambridge cluster (XAAR and SEIKO). This led to the development of customized print-heads for use in the ceramic tile field, and eventually to standardisation of the application. The development of electronics and software for control and management of the equipment was carried out in cooperation with various external research centres and firms. Artwork software selection and training was essential for the transference of designs to the production line. A pigment micro-milling application (Netzsch) solved the initial phases of organic pigment development, and was brought in from other external industries such as chemicals and electronics. These facts support the view of the importance of external linkages (e.g. Bathelt et al., 2004) in improving the availability of resources to clusters and avoiding myopia (Maskell and Malmberg, 2006). Nevertheless, in our argument the novel result obtained in this study is the fact that the new knowledge was sourced from different industries and knowledge domains, specifically from the printing industry (from within the Cambridge cluster) and from the micro-milling industry (from within the chemical industry). This confirms Jeppesen's and Lakhani's (2010) assertion that the provision of winning solutions to problems is positively related to increasing distance between the solver's field of technical expertise (in this case printing, and micro-milling) and the focal field of the problem (in this case ceramics). The importance of "marginality" or technical and social distance from the focal problem field (Jeppesen and Lakhani, 2010) is supported by studies in the sociology of science which stress that:

"Inventions are usually made by outsiders, that is, by men who are not engaged in the occupation which is affected by them and are, therefore, not bound by professional customs and traditions" (Ben-David, 1960:557).

Thus, the marginality effect is explained by individuals from outside bringing into play knowledge perspectives different to those held by the focal companies in the problem field (e.g. Gieryn and Hirsh, 1983). The cluster literature has also pointed out this fact, although with the reservation of not specifically referring to new-to-the-industry knowledge. Thus Menzel and Fornahl (2010:231) stated:

"Clusters can increase heterogeneity and renew themselves by enlarging their boundaries, either by integrating firms in the same industry, but in other places, or by integrating organisations in spatial proximity, but outside the thematic focus of the cluster"

The clusters' main institutions contributed to the dissemination of the new technology. International industry exhibitions and fairs, such as CERSAI in Italy and CEVISAMA in Spain, witnessed a progression of the technology from the 2000s onwards. New equipment was exhibited and ceramic tile producers presented cutting edge designs that imitated marble, natural stones, and photographs, as well as showing off old classic decorations applied with the new technology. Nevertheless, the transition of the disruptive technology to significant market use was slow, and took almost six years. The comments published in professional magazines after each exhibition show how the inkjet moved from a disruptive technology to an accepted standard.

The other actors in both the Castellon and the Sassuolo clusters played important roles as well. Lead users played critical parts as early adopters, and as reviewers of successive developments. ITC contributed to disseminating the technology, training operators and technicians. Industry associations (i.e., ASEBEC, ACIMAC, ASCER, Assiopiastrelle) and technical-professional magazines (i.e., Técnica Cerámica, Ceramic World Review, Tile & Stone Journal) sponsored many workshops in Italy and Spain where the inkjet applications were discussed and thus helped to disseminate the new technology worldwide. Incumbent firms in the equipment sector also played active roles. For example, System was a distribution-partner, Cretaprint was a follower, and Ferro was an equity-partner. Once the technology was clearly defined, these firms resumed the TG role, sharing it with the newcomers (Cretaprint, Kerajet, and Durst). Pigment and glaze producers facilitated the progression of the technology, either by being early followers and competitors (such as Torrecid), or simply by being late adopters (as was the whole of the Castellon glazing industry), and by helping to ensure the standardisation of pigments for the new application. (See table 2)

Figure 1 illustrates the critical internal and external networking and partnering connections in the innovation process that led to the development and dissemination of the new inkjet technology. (See figure 1)

As shown in table 3, the dynamics of TG development across the differing stages of the CLC are particularly interesting. Overall, the previously existing TGs have prevailed (except one Italian company: Tecnoitalia) but now there are also other technology gatekeepers. The most important new TGs are Kerajet, the focal spinoff, Cretaprint which successfully completed a transition to the new technology and has been bought by EFI a printing company in Silicon Valley[62] and Durst. All these three companies retain more than 75% of the market share. The incumbents also made the transition and now are key actors developing the special inks for the new technology. In addition, and confirming CLC theory, new entrants arrived in the cluster (that is to say, Durst, Jettable, Intesa, Projecta, Tecnoferrari, among others) during the growth stages (2007 to 2012), not when the technology was experimental and emergent (2000-2006). Overall, the incumbent TGs did not renew the cluster. Rather, it was a spin-off company which temporarily adopted the main roles, developing external ties and engaging in technology creation and diffusion – which are traditionally supposed to be performed by the TG. Nevertheless, incumbent TGs established strategic alliances with the new entrants to ensure access to the latter's products (new inkjet equipment producers are the distribution channel for the new inks developed by traditional frits-glazing firms, i.e., the existent incumbents), and the new entrants also took advantage of the alliances to enter to the incumbent TGs networks. (See table 3)

[62] AFI is a world leader in customer-focused digital printing innovation *in* Silicon Valley in the USA. In 2012 it was announced it had acquired Cretaprint,, a leading developer of inkjet printers for ceramic tile printing, based in Castellon. Retrieved in January, 2012. http://www.bookbusinessmag.com/article/efi-acquires-cretaprint-expands-inkjet-focus-ceramic-tile-printing/1

Thus, this research differs from others which implicitly focus on non-radical knowledge changes which do not alter the cluster status quo. For instance, Klepper and Sleeper (2005) analyzed spin-offs from incumbent laser firms which then produced similar lasers to their parents' products. Similarly, in the spin-off process in the US automobile industry, documented by Klepper (2007), the new firms did not face, or provoke, a disruption: the new entrepreneurial firms exploited the available technical knowledge in the field, i.e. that which existed in the car industry. In contrast, in our study the spin-off focal firm is spawned from a frits (chemical) and glazing tile firm and, despite inheriting knowledge, it started to produce equipment (based on IT and electronics) to decorate or rather "print" tiles through new to the ceramics industry disruptive inkjet technology. Put differently, the technical change triggered from the spin-off process in Castellon was a radical one, and thus the CLC moved to a new stage: renewal from a discontinuous innovation.

6 CONCLUSIONS

The paper attempts to answer the question of how clusters evolve, change and reinvent themselves in order to prevail. Specifically, the objective has been to dissect the dynamics of technology gatekeepers across different stages of the cluster life cycle. In order to fulfil this goal, the paper used a qualitative longitudinal case-study research methodology, covering the last twenty years of the cluster. For this, analysis of archival data and interviews with key informants was carried out. The paper has challenged the assumption that technology gatekeepers are large leading firms with high absorptive capacity and high-intensive R&D expenditures which shape the district learning process. Framework in the aforementioned objectives, the main questions answered are: (1) Are small new entrepreneurial firms or incumbent TGs the ones which create knowledge to reinvent clusters? (2) Are TGs resilient at different CLC stages?

The paper looked at two key aspects : the *type of knowledge* created by technology gatekeepers and the *stage of the cluster life cycle* at which knowledge is created. Using a perspective based at the economic geography, the entrepreneurship and the management and technology strategy literature, this work has constructed a fertile cross-field framework to study the themes of technological gatekeepers and cluster life cycles in conjunction.

A main finding in the study is that TGs are resilient, confirming Giuliani (2011), but they do not create knowledge in all stages of the cluster life cycle. This contradicts assumptions in the mainstream TG literature (e.g., Morrison, 2008; Lazerson and Lorenzoni, 1999; Albino et al., 1998; Lorenzoni and Lipparini, 1999). Instead, we see the appearance at the point of transition from one CLC stage to another of temporary technological gatekeepers which take the role of leaders and introduce disruptive knowledge into the cluster. Further, these "temporary" TGs then become permanent when through alliances they are able to enter into the incumbents' networks, a development which also helps incumbents to maintain their centrality. Consequently, disruption can be expected to be led by new entrepreneurial firms and not from incumbent TGs, confirming previous research in entrepreneurship (e.g., Audretsch and Feldman, 1996) and technology strategy (Baumol, 2004; Zucker et al., 1998; Jorgenson, 2001). Similarly, the economic geography view is also confirmed by the incumbent TGs' rejection of the disruptive technology in order to maintain the status quo and their centrality in their networks (e.g., Allarakhia and Walsh, 2010). Therefore, it is new spin-offs from incumbent TGs, and not the TGs themselves, which create knowledge for renewing clusters, confirming the management literature perspective which asserts that knowledge is inherited and that the main engine of the cluster (re-)formation is the spinoff process (Klepper, 2007). Once the new technology has become established the incumbent TGs still retain control of their networks by accessing the new technology and sharing centrality with the new TGs that created the new technology.

Temporary TGs established global pipelines to access external knowledge, corroborating what is being said in the external linkages debate (e.g. Bathelt et al., 2004). Nevertheless, our findings have gone one step further: the type of knowledge necessary to challenge incumbent TGs must be new to the industry and to the cluster, that is to say disruptive ideas must come from other industries. If this was not so, the incumbent TGs would have an advantage and a new entrepreneurial firm can be blocked.

This study contributes to the open innovation literature (Chesbrough, 2002), but also highlights the multiplier effect (Becattini, 1990) that the cluster atmosphere exerts on the knowledge creation and diffusion process. The paper has important implications for policymakers and scholars. First, policymakers should understand the positive and contributory role of TGs, but also their limited role in amplifying technological trajectories in clusters. Therefore, new spin-offs should be promoted, or supported, and assistance given to the development of channels to new technologies and knowledge from outside the cluster, while encouraging also the exploration of new-to-the-industry knowledge. Second, scholars should also research the potential role of temporary technology gatekeepers and how it relates to the dynamics of cluster life cycles. These insights open up new research avenues, including the need for more empirical evidence to support theory building regarding technology gatekeepers and their relation to cluster life cycles.

The paper's findings are limited in the first place by an analytical focus on a single industry (glazing for ceramics) during a certain period of time. Secondly, account has to be taken of the fact that the type of TG addressed is one which channels technical knowledge, and not one which conveys knowledge concerning new markets and fashion trends.

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Tables

Table 1 Framework obtained from integrating different strands of the literature

	Continuous knowledge innovation	**Radical knowledge appearance**
Cluster life cycle stage:	Central stages	Renewal or growth stages
Knowledge heterogeneity:	Moderate heterogeneity, and a low technology paradigm has been established and is mature	High heterogeneity, with different technological trajectories
Technology gatekeepers:	Leading firms control networks and the learning process. The incumbents are established,after the shake-up stage and the consolidation of the dominant technology	The incumbent TGs have limited radical knowledge roles. Likelihood of new entrepreneurial firms from within the cluster, i.e. spin-offs
Networks:	TGs are central to existing networks	Stable but changing, subject to a new configuration brought about by TG changes
New entrants:	Not expected, except possibly multinationals from other related clusters.	Expected, mainly from within the cluster, including new spin-offs and even start-ups.

Source: own

Table 2 Summary of the case study for discussion.

	Results
Cluster life cycle and Knowledge heterogeneity	Large and mature, dominant organisations were established in Castellon and Sassuolo up until the 2000s. In particular, in Castellon big leading glazing firms acted as TGs. High knowledge heterogeneity appeared after 2000, when the inkjet concept arose and new technological trajectories came into being. At that time, Rotocolor and traditional (rollers) technology were more productive but were limited in their design application. The innovator's dilemma occurred in the first stages of the inkjet application, the performance of which was poor but promising. The testing of the new technology occurred with isolated firms (those not belonging to established TG networks). In the Italian Sassuolo cluster inkjet technology entered significantly later on, around 2004.
Technology gatekeepers	A small entrepreneurial spinoff (Kerajet) acted as a temporary gatekeeper during the emergence and growth of the new technology (2000-2012). Incumbent TGs were reluctant to accept the new technology. Only some TGs contributed to the development of the new technology. Preliminary ideas were rejected by incumbent TGs. Once the dominant design was more broadly accepted (around 2005-06) the traditional TGs establish alliances with inkjet firms and resumed their roles as TGs, together with the new leading inkjet firms (Kerajet, Cretarprint, Durst, etc.) and then new entrants appear (Intesa, Jettable, Tecnoferrari, etc.). Nowadays, Kerajet, Cretaprint and Durst are new incumbent TGs, together with the "traditional" incumbents (big frits and glazing firms).
Networks	Networks became more stable after the disruption shock when incumbent TGs resumed their central roles in the decorating process by establishing alliances with the new leading inkjet firms. The latter also became new TGs in most networks.
Lead users	Lead users were central at the renewal stage. Non-leading firms were not constrained by stable networks led by TGs. Later on, incumbent TGs became also new lead users and began to incorporate the new technology in their capability portfolios.
External knowledge	External knowledge was crucial, from different non-related clusters and industries: -High-tech Cambridge cluster, (Xaar, Seiko) -Germany (micro milling technologists, Nezstch) -Silicon Valley (EFI) since 2012 (after acquisition of Cretaprint). In addition, key external knowledge from the Italian cluster.
New entrants	-Kerajet (disrupter): spinoff from an incumbent TG (Ferro, established in the Castellon cluster) -Cretaprint (follower, former equipment ceramic producer in the Castellon cluster) -Durst (follower, from printing industry, new entrant) -New start ups and spinoffs (after 2006), Jettable, Intesa, Tecnoferrari, Projecta, Tecwin, etc.

Source: own

Figure 1. Facilitating elements in technology development and diffusion.

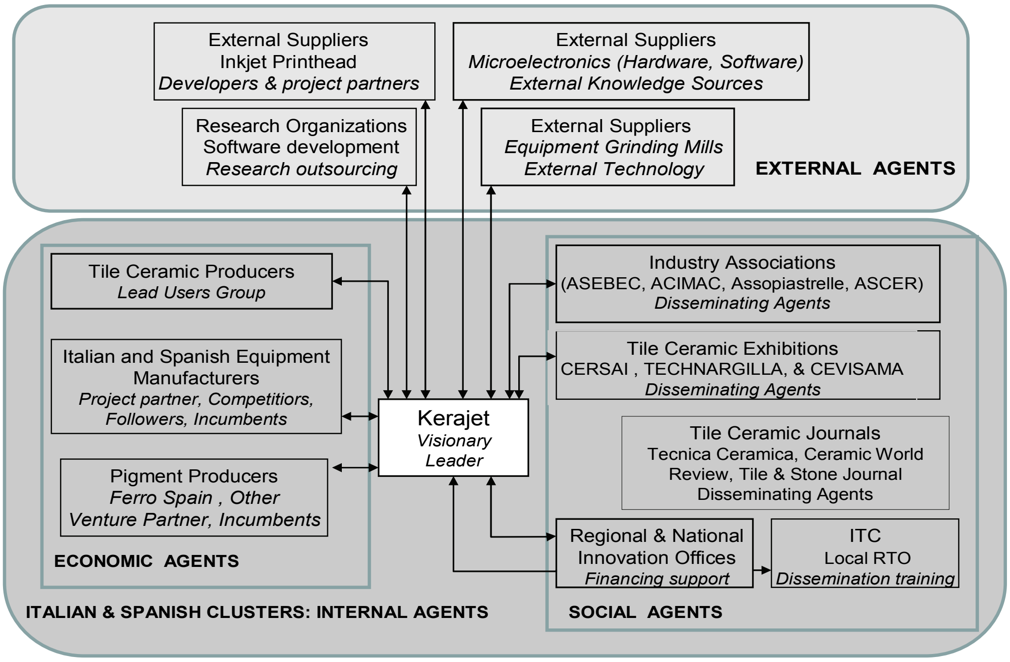

Table 3. Evolution of Main Technological Gatekeepers in Ceramic Tile Decoration Technology.

CLC: central stages	**CLC: Emergent renewal stage**	**CLC: Growing stage**
Rotocolor technology dominant paradigm; Knowledge heterogeneity reduced and focused around Rotocolor and traditional screen tech. Established TGs (big frits and glazing firms: Esmalglass, Ferro, Torrecid, Endeka, Colorobbia	Knowledge heterogeneity increases in the transition from Rotocolor towards Inkjet Spinoff process leading disruption Temporary technology gatekeepers Main existing TGs reluctant to adopt new technology Knowledge uncertainty Resistance to change to the new technology.	Acceptance of the inkjet technology and a process of paradigm change from Rotocolor towards Inkjet New entrants expected Sassuolo and Castellon leading clusters adopting new technology. New TGs in the cluster, plus the previous incumbents Inkjet market leaders (around 75% of the inkjet market) allied with incumbent TGs producers of inks for inkjet (80% of the new inks market share): exchange of networks and collaboration to establish standards -Torrecid with Durst -Ferro with Kerajet -Esmalglass with Cretaprint Big Sassuolo TGs from the equipment Industry also spinoff laggards in the inkjet technology (less than 15% of the market share for inkjet): Intesa, Project, Espectra, Tecnoferrari, etc.

Table 3 continued

Gatekeepers in Cluster (1990-1999)			**Breakthrough and temporary Gatekeepers in Inkjet technology (2000-2006)**			**Current Gatekeepers in all technologies (2007- 2012)**		
Mechanical Equipment: Based at Rotocolor and traditional screen	Pigment Producers	Inkjet tech manufacturers	Mechanical Equipment	Pigment Producers	Inkjet tech manufacturers	Mechanical Equipment	Pigment Producers	Inkjet tech manufacturers
4 Italian companies co-located in Castellon with headquarters in Sassuolo (System, Tecnoitalia, Sacmi and Barbieri)	1 Italian producer in Castellon, headquarters in Sassuolo (Coloribbia) Technology: Frits and glazes for Rotocolor and traditional screen	None	0 Sassuolo	0 Sassuolo		4 in Sassuolo cluster (System- Tarozzi, Sacmi, Barbieri)	1 Italian producer in Castellon, headquarters in Sassuolo (Colorobbia)	Mainly spinoffs from big equipment manufacturers in Sassuolo, Intesa (Sacmi) Projecta (Barbieri) Espectra (System): laggards
1 Firm in Castellon (Cretaprint) Technology: Rotocolor	4 world-class frits-glazing firms with headquarters in Castellon (Torrecid, Esmalglass, Ferro and Endeka)* Technology: Frits and glazes for Rotocolor	None	1 Castellon Cretaprint, following Kerajet	1 Castellon (FerroSpain, the firm which spawned Kerajet) was first developed of inks for the inkjet technology, and specifically for Kerajet machine	1 Castellon (Spin-off firm: Kerajet) Kerajet is the only one in the world market with a Patent and has issued the rest for patenting infringement.	1 Firm in Castellon (Cretaprint) Technology: Rotocolor	4 Castellon firms (Ferro Spain, Endeka, Torrecid, Esmalglass)	2 Castellon (Kerajet, Cretaprint) 2 Firms from outside the Sassuolo and Castellon cluster (Durst, Jettable): new entrants from printing technology field, no spin-offs; early new entrants

Source: Own, based on Serri, A., Ceramic decoration paradigms, Cuaderni di cer 2008, 5-1-2008 Dossier Inkjet, Tecnica Ceramica, 369, pp. 1308-1315.2010

RELATING PROCESS AND MANAGEMENT INNOVATION: PATTERNS, ANTECEDENTS AND RESULTS

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Abstract

The excessive concentration of the innovation literature on product development, its drivers and effects, has almost neglected an important strategy which develops and sustains a firm's competitive advantage: the process development or innovation. Specifically, the paper unfolds the black-box of the process innovation and goes beyond process innovation as a mere dependent variable for just predicting innovators, extending insights on the poor attention that the process innovation variable has received as a mediator to explain a firm's performance. In addition, the paper relates the process with the management innovation phenomenon. Using 8,977 firms from Spain through CIS data, the main contributions are: (1) most of the process innovation performance is explained without R&D variables; (2) it is observed a strong dependence on external sources of knowledge to explain the process innovation performance, mainly through the acquisition of embodied knowledge; (3) it is observed an important "implementation" effect or "learning by trying" effect in which the acquisition of embodied knowledge require that the organization is reprocessed to couple the new technology; (4) the simultaneous co-adoption of management innovation positively moderates and improves the process performance (5) the product innovation is not related to the process innovation performance. The latter result is different from considering co-adoption of product and process innovation. Two-step Heckman procedures control for selection process. The paper presents important implications for policymakers and scholars.

Key words: process innovation, process innovation performance, management innovation, embodied knowledge acquisition, product innovation.

1. INTRODUCTION.

Despite the recognition than firms have specific types of innovation objectives within the "technical goals" (Cohen and Malerba, 2001:590), there is a tendency or excessive concentration of the innovation literature on product innovation and its effects on sales (Escribano et al., 2009; Vega-Jurado et al., 2008), to the extent that the existing literature has almost neglected an important strategy or objective which also develops and sustains a firm's competitive advantage: the process innovation activities or process development (e.g. Lager, 2011, European Commission, 2008; Niehaves, 2010; Reichstein and Salter, 2006). Process innovation is defined as new elements introduced into a firm's production or service operation to produce a product or render a service (e.g. Rosenberg, 1982; Utterback and Abernathy, 1975) with the aim to improve productivity, capacity, flexibility, quality, reducing costs, rationalizing production processes (Edquist, 2001; 2001; Simonetti et al., 1995) and lowering labour costs (Vivarelli and Toivanen, 1995; Vivarelli and Pianta, 2000).

Following Reichstein and Salter (2006) process innovation is related to new capital equipment (Salter, 1960) and the existence of learning-by-doing and learning-by-using (Cabral and Leiblein, 2001; Hollander, 1965). Similarly, the OECD (2005:49) defines process development as:

"Process development (process innovation) is the implementation of new or significantly improved production or delivery methods. This includes significant changes in techniques, equipment and/or software"

In this vein, this paper explores and sheds light on firm's innovators whose literature is less developed (exceptions are Womack et al., 1990; Clark & Wheelwright, 1993, among others). Specifically, this paper goes beyond process innovation as a mere dependent variable indicating whether the firm successfully introduced or not new processes, extending the insights towards the effects or objectives accomplished from the introduction of new processes. Therefore, the paper focuses on the process development and its subsequent process innovation performance (through production flexibility improvement, production capacity enhancement, labour costs reduction or efficiency using materials and energy in the production process).

To the best of our knowledge, most of the literature on process innovation, with few exceptions (e.g. Reichstein and Salter, 2006), has been conducted on predicting the introduction of new processes (Pires et al., 2008) or predicting incremental versus radical process innovation accomplishment (Reichstein and Salter, 2006), usually in tandem with product innovation (e.g. Santamaría et al., 2009). Put differently, the majority of works are based at finding the predictors which explain whether the firm engage in product, process or both technological modes of innovation simulatenously, and not on the specific effects that those innovations exerts on a firm's performance. In parallel, most of the innovation management literature has been devoted to the understanding of product innovation (e.g. Taylor, 2010; Turner et al., 2010). In fact, innovation effects obtained from introducing new processes in a firm have rarely been used in the innovation literature, compared with the typical percentage of annual sales that comprises new or substantially improved products over a period of time which has been extensively researched on the literature, biasing the firm's performance towards product innovators rather than complementary embracing process innovators.

Complementary, process innovation is related to management innovation, in the sense that the management systems usually complement the technical ones (e.g., Womack et al., 1991). Following Polder et al. (2009, p. 23) it is evidenced that "*product and process innovation only lead to higher productivity when performed together with an organizational innovation*". This result confirms previous literature (Luria, 1987; Ettlie, 1988; Nabseth and Ray, 1974; Thompson, 1967), suggesting that management practices and its related organizational capabilities do complement the process innovation. In particular, it is confirmed that the process innovation activities involve both organizational and technological changes (Gopalakrishnan and Damanpour, 1997; Reichstein and Salter, 2006) blurred and difficult to separate (Edquist et al., 2001; Ettlie and Reza, 1992; Womack et al., 19909. In this vein, the process innovation is going to be explored in tandem with the management innovation. All in all, this paper covers the following gaps: (1) the paper presents an attempt to offer new insights on understanding the introduction of new processes in firms, its antecedents and performance effects on processes objectives; (2) the paper also investigates the complementary role of the process and the management innovation.

The paper contributes to the literature in the following ways. First, the paper provides insight about the antecedents of the almost neglected process innovation and its results on process (production) objectives. Second, the paper also contributes to the management innovation literature by exploring its complementary role with the technological mode by analyzing the complementarities between process and management innovation adoption. In order to accomplish the latter, the paper links the disconnected strands of literature based solely on the adoption of the technical strategy (technology strategy literature) with that of the management adoption (management and organizational learning strand). Therefore, with this paper's contributions it is expected that the *conversation* about the technical innovation is going to be improved and expanded by addressing the process innovation activities and their complementarities with the organizational innovation.

In general, our findings point out that the innovation pattern of the process innovators does not use R&D (internal or external) activities in order to explain returns from process innovation (based on production flexibility, production capacity, lower labor costs or materials and energy reduction). On the contrary, the process effects are highly influenced by search strategies to source external knowledge, mainly from the acquisition of embodied knowledge and knowledge from the industry. In addition, the process effects are amplified by engaging simultaneously in the adoption of new management practices, finding a significant and positive relationship between the process and the management activities. Finally, the combination of the acquisition of embodied knowledge with the introduction of new management practices yields significant returns from process development, that is, an interaction effect is captured. In addition, as showed in the Appendix A and B, the product effects, even for process innovators, showed a different pattern of innovation.

The study is based on 8,977 process innovators using data from the CIS in Spain, from the 2006 EUROSTAT data. The structure of the paper is as follows. In the second section the literature is revised and the hypotheses are formulated. Then, in the third section the empirical design is presented, while in the fourth section findings are showed and discussed. Finally, the conclusion is presented in the last section.

2. THEORY DEVELOPMENT AND HYPOTHESIS

2.1 Process and organizational innovation

In general, innovation is claimed not to be an exclusive technological effort, but a strategic, market-driven perspective (e.g. Bessant & Tidd, 2007; Terziovski, 2010) in which technological and management (administrative) activities complementary support each other (Damanpour & Evan, 1984; Damanpour, 1987). Ettlie (1988) dubs the simultaneous use of management innovation and technological innovation “synchronous innovation“ and argues that the use of appropriate forms of management innovation made technological innovation more effective in manufacturing firms in the United States in the 1980s. That positive gain from combining technical and non-technical innovation in tandem is supported in the literature (e.g., Battisti & Stoneman, 2010; Damanpour et al., 2009; Damanpour and Evan, 1984). In particular, the process innovation activities involve both organizational and technological changes (Gopalakrishnan and Damanpour, 1997; Reichstein and Salter, 2006) blurred and difficult to separate (Edquist et al., 2001; Ettlie and Reza, 1992; Womack et al., 1990). Edquist et al., (2001) includes within process innovation activities two distinct but related activities: technological process and organizational process innovation. *Technological process innovations* are new goods that are used in the process of production and include investment goods and intermediate goods such as processing machines, industrial robots and IT equipment. Complementary, *organizational process innovations* are new ways to organize business activities such as production and have no technological elements but with the co-ordination of human resources and work practices, such as just-in-time production, total quality management or lean production. All in all, the literature on management has evidenced that the application of process technology in industries depends on changes in structure and administrative practices (Ettlie, 1988; Nabseth and Ray, 1974; Thompson, 1967). Besides of the management literature, the systematic overlap of the organizational and process innovation is also systematically stressed in the operations management literature. For instance, group technology, uniform workload, multifunction employees, *Kanban*, and just-in-time purchasing practices all of them within the *lean* manufacturing systems are made up of technological and organizational processes simultaneously (e.g. White and Ruch, 1990). Similarly, flexible manufacturing technique use advanced manufacturing technologies, have an organizational structure with less levels and uses innovative human resources policies (Duguay et al., 1997). In this vein, Luria (1987) evidenced that the changes in organizational structure or process technology alone did not yield any significant cost reductions in automobile component plants. Nevertheless, the majority of this literature is based on case studies or specific industries (e.g., Womack et al., 1990; Ettlie, 1988; Luria, 1987; Thompson, 1967). Few studies has showed those complementarities between process innovation and organization innovation using CIS data (e.g., Polder et al., 2010). Therefore, more general evidence is needed. All in all, it is stated that the process and management innovation are usually observed in tandem. And the effects or objectives achieved from the process activities will be amplified when the introduction of new management practices accompany the introduction of new processes. Thus, the first hypothesis is stated as follows:

Hypothesis 1. A firm's complementary adoption of process and organization innovation simultaneously will positively affect the process innovation performance.

Specifically, the technological process innovation is related to the incorporation of new capital equipment (Salter, 1960), processing machines, industrial robots or IT equipment (Edquist, 2001: OECD, 2005) or just capital embodied technology (Rouvinen, 2002) usually obtained from the purchase of advanced machinery, computer hardware and software (Huang et al., 2010; OECD, 2005). This idea addresses the fact that the returns on process innovation from embodied technology acquisition are positive and constitute one of the main drivers of incorporating technology in a firm to renew its processes and its process innovation performance. In general, it is recognized that process innovation in small firms is much more related to the ‘‘embodied technological change’’ incorporated in the physical capital formation rather than in intangible investment in R&D (Conte and Vivarelli, 2005; Santarelli and Sterlacchini, 1990; Vaona and Pianta, 2008).

Flowers (2007) refers to the acquisition, implementation and exploitation from the demand-side or the buyer perspective, which is less explored in the literature, rather than the extensively researched supplier-centricity. That is, when selling/purchasing equipment or infrastructure, both physical (machinery) or intangible (a software like an ERP, Enterprise Resource Planning, MRP, Manufacturing Resource Planning, or other IT systems for production or organizational purposes) most of the work on technological change is focus, by large, on the supply-side dynamics (Adner and Levinthal, 2001; Dosi, 1992; Flowers, 2007) rather than on the demand (buyer) side. In this vein, the buyer/producer firm (which buys technology capital goods or services from others suppliers in order to integrate them into their own products) is distinct from the buyer/user firm which buys technology capital goods and services in order to use them within their own operational infrastructure (Flowers, 2007). In this paper we refer to the buyer/user typology. Thus, the acquisition of machinery is carried out with the purpose to adopt embodied knowledge into a firm's innovation process, as aforementioned. However, the explanation of the implementation of the acquired embodied technology, to the best of our knowledge, solely the *technology strategy* literature presents some evidence about the implementation of technology to work as commercially successful operating systems, starting mainly in the 80's (Bessant, 1985; Leonard-Barton and Deschamps, 1988; Rhodes and Wield, 1985). Implementation of new equipment or embodied knowledge is an organizational learning process (Voss, 1988) which constitutes a key component of the innovation process (Leonard-Barton and Deschamps, 1988) which has been systematically under-researched (Fleck, 1994; Flowers, 2007; Voss, 1988). Fleck (1994) has described the implementation as a process of "learning by trying" or "learning by struggling to get it to work", that is, improvements and modifications done to the constituent components before the configuration can work as an integrated entity. Specifically, Fleck (1994) point out that the *learning by trying* is different from the *learning by doing* (progressing up the learning curve, Arrow, 1962) and the *learning by using* (improvements made after functioning, Rosenberg, 1982).

The point is to understand that the acquisition of new technology requires a mutual adaptation of technology and organization (Ettlie, 1988; Ettlie and Reza, 1992; Fleck, 1994; Leonard-Barton and Deschamps, 1988; Voss, 1988), that is, the adaptation of the technology transfer through the implementation process requires that managers recognize and assume responsibility for both technical and organizational change (Leonard-Barton and Deschamps, 1988). For instance, Ettlie (1988) found that better performing organizations synchronize the adaptation of administrative policies with the introduction of technology. Fleck (1994) also recognized the necessity to adapt the management procedures to the new technology implemented and Voss (1988) explicitly addressed the complementary effects of integrating new technology with the organizational perspective in order to successfully adopt new technology for process innovation. All in all, technology is an occasion for structuring and the actual outcomes depend on how the new processes brought from the new technology are coupled with the organization (Barley, 1986; Cohen and Zysman, 1987; Damanpour, 1991; Ettlie and Reza, 1992; Markus and Robey, 1988; McCann and Galbraith, 1981). Thus, capturing value from process innovation activities needs to make process innovation an unique occasion for restructuring and creating coupling arrangements (Cohen and Zysman, 1987) with internal and external change processes. Similarly, Bresnahan et al. (2002) highlighted the complementary nature of information technology and workplace reorganization to innovate. The latter work showed that IT investments only result in improvements in firm performance when they are combined with new work practices and investments in human capital. In addition, from the operations management literature, it is also evidenced that the technology adoption process by acquiring embodied technology is amplified when the workplace and structure changes follows simultaneously (Boer and During, 2001). Therefore, we expect that the returns on process innovation from embodied technology acquisition, which is a prominent driver of the process innovation, will be amplified when organizational changes follow, complement and couple the introduction of technology in a firm. Thus, the second hypothesis is stated as follows:

Hypothesis 2. The technology acquisition effect on the process innovation performance is positively moderated by the simultaneous co-adoption of organization innovations

3. EMPIRICAL DESIGN

The data is sourced from the Spanish Innovation Survey (Technology Innovation Survey is the official name) administered by the Spanish National Statistics Institute (INE) and conducted in 2006. This survey is based on the core of Eurostat Community of Innovation Survey (CIS). The method and the types of questions in CIS are described in the Organisation for Economic Co-operation and Development (OECD, 2010). CIS were widely piloted and tested before implementation, and since their first use in the early 1990s, the questions have been continuously revised. CIS are often described as “subject-oriented” because they ask firms directly whether they were able to produce an innovation. Following Reichstein and Salter (Oslo manual: OECD, 2005) the CIS questionnaire itself draws on previous generations of research on innovation, including the Yale survey and the SPRU innovation database (2006, p. 661). Stockdale (2002) contains an overview of the methodology and basic descriptive findings of the survey. CIS data are increasingly being seen as a key data for the study of innovation at firm level in a large number of studies across countries in Europe, Canada, and Australia (Klevorick et al., 1995; Pavitt et al., 1987).

In order to pursue the purpose of this research the final sample was based on process innovators firms (8,977 firms), defined as firms having introduced at least one new or improved process in the research period and being innovation active (innovation expenditures >0), regardless of having also conducted product or organization innovation activities. Nevertheless, the total firms available in the population (28,649) are used to conduct robustness checks using two-step Heckman processes to control for potential selection biases (only using process innovators).

This study takes the process innovation output as a mediator, following Crossan and Apaydin (2010) suggestion, and not as a mere dependent variable. On the one hand, the dependent variable captures the effects on processes from the introduction of new processes is quite a novel approach. First, on the one hand, the process effects are obtained from four variables addressing the effects on processes, fact which is different from a firm’s overall performance or productivity, and permits to isolate better the effect of undertaking process innovation activities. The resulting punctuations from the factor analysis (PCA) represent the first (*Process_effects* variable) dependent variable. These process oriented effects include “improved production flexibility,” “reduced unit labour costs,” “increased capacity,” and “reduced materials and/or energy per produced unit.” The four original variables were ordered responses, represented on a scale from zero (absence, no effect) to 3 (maximum). Following this procedure, one single component from the analysis, through its punctuations, represents the dependent variable which explains 60.21 % of the variance (KMO = 0.7172, p<0.01).

Second, on the other hand, the independent or explicative variables comprise a wide range of information sources of innovation, R&D internal and external expenditures, product and organization innovations, together with industry and size as control variables. Then, the internal sources of information to innovate (*Int_sources*) represents those which arise from the firm's own departments, staff, firms from the same group, etc. The importance of that information has been measured in a four-point scale (not used = 0; poor, value = 1; medium, value = 2; high, value=3). Addressing the external sources of knowledge that a firm taps into, those are captured across a wide range of external information sources: suppliers, customers, competitors, consultants, commercial laboratories, private R&D firms, universities, technological centres, public research centres, commercial events, scientific journals and papers and professional associations. All these variables have been reduced to two factors through a factor analysis with a KMO of 0.8607 and a 56.6% of explained variance, see Table 1. The first component obtained from this PCA (*Ext_sources_fact_industrial*) corresponds to the sources related with the industrial agents from the value chain as customers, suppliers or competitors and other sources also related with the industry as commercial events, scientific journals and magazines and professional associations. The second component (*Ext_sources_fact_science*) corresponds to more scientific and specific pecuniary knowledge (commercial laboratories, private R&D firms, universities, technological centres and public research centres), see Table 1 for details. In Table 1 it is showed the list of variables representing the stated hypothesis and Table 2 shows the descriptive statistics and correlation matrix of these variables.

Table 1. Table of variables for the analysis

	Meaning	Codification
Dependent variable: Process_effects	Process innovation factors effects on Process and Product aspects of firms are the result from a PCA applied to the sample (KMO 0.7172; Variance explained: 60.21%). Resulting from the following variables measuring the effect on firms of process innovation on: - Higher production flexibility (product or service) - Higher production capacity - Lower labour cost per unit - Fewer materials and energy per produced unit Each effect has been measured in a four range scale: no effect = 0; Low effect = 1; Medium effect =2; High effect = 3	Continuous, from punctuations from factor analysis

<table>
<tr><td>Int_sources</td><td>The importance of the internal sources of information to innovate (by internal it is considered the firm's own departments, staff, firms from the same group, etc.).

The importance of information of each source has to be in a four point scale: Not used = 0 ; Poor, value = 1; Medium, value = 2; High, value=3</td><td>0-3 interval.</td></tr>
<tr><td>Ext_sources_Industrial

Ext_sources_Science</td><td>External sources factors Industry and Science are the result from a PCA applied to different variables corresponding with different sources of information to innovate (KMO: 0.86; Variance explained: 56.6%)

- External_sources_Industrial: corresponds to clients, suppliers, competitors, consultants, commercial events, scientific journals and magazines, and professional associations
- External sources_Science: corresponds to consultants, commercial laboratories, private R&D firms, universities, technological centres, and public research centres.

<table>
<tr><th>Information sources</th><th>External_sources_fact

Industry</th><th>External_sources_fact

Science</th></tr>
<tr><td>Suppliers (Info _SUPL)</td><td>0,550</td><td>-0,101</td></tr>
<tr><td>Clients (Info _CLI)</td><td>0,666</td><td>0,191</td></tr>
<tr><td>Competitors (Info _COMP)</td><td>0,711</td><td>0,178</td></tr>
<tr><td>Consultants, commercial laboratories, private R&D firms (Info _CONS)</td><td>0,333</td><td>0,575</td></tr>
<tr><td>Universities (Info _UNI)</td><td>0,160</td><td>0,812</td></tr>
<tr><td>Public research centres (Info _PUBLIC)</td><td>0,158</td><td>0,860</td></tr>
<tr><td>Technological centres (Info _TEC-CEN)</td><td>0,202</td><td>0,799</td></tr>
<tr><td>Commercial events (Info _EVENTS)</td><td>0,738</td><td>0,258</td></tr>
<tr><td>Scientific review and papers (Info _REVIEW)</td><td>0,694</td><td>0,348</td></tr>
<tr><td>Professional associations (Info _ASSO)</td><td>0,622</td><td>0,387</td></tr>
</table>

Each of information sources refer to the importance of the information in order to innovate from of each source and response to the question: "In the period 2004-2006, ¿how important has been the following information sources for the innovation activities of your enterprise?

Clients, suppliers, competitors, consultants, commercial events, scientific journals and magazines and papers, Professional associations, Consultants, commercial laboratories, private R&D firms, Universities, Technological centres, and Public research centres.

The importance of information of each source has to be in a four point scale: Not used = 0 ;</td><td>Continuous, from punctuations from the second factor analysis carried out</td></tr>
</table>

	Poor, value = 1; Medium, value = 2; High, value=3	
Int_R&D_expend	*Intramural R&D expenditures per sales measured in a 5 points scale:* (**0**: 0; **1**: <=5%; **2**: 5%< x<=10%; **3**: 10%< x<=50%; **4**: >50%)	0-4 scale
Ext_R&D_expend	*Extramural R&D expenditures per sales: it* comprises the acquisition of R&D services per sales measured in a *5 points scale*. *(0: 0; 1: 0%<x<=5%; 2: 5%< x<=10%; 3: 10%< x<=50%; 4: >50%)*	0-4 scale
Tech_expend	*Embodied technology expenditures per sales*: it comprises expenditure on the acquisition of machinery and equipment with improved technological performance, including major software, per sales, measured in a *5 points scale*. *(0: 0; 1: 0%<x<=5%; 2: 5%< x<=10%; 3: 10%< x<=50%; 4: >50%)*	0-4 scale
Inno_product	Indicates if the enterprise has introduced a new or improve product or services during the research period	Dummy 0-1
Inno_process	Indicates if the enterprise has developed a new or improve process during the research period	Dummy 0-1
Inno_organization	Indicates if the enterprise has introduced a new or improve *organisational change* during the research period	Dummy 0-1
Size	Logarithm of the annual average of full-time employees in 2006.	Continuous
Industry_NACE_code	Industry classification by NACE-93 (2-digits, 59 sectors), from 15 to 74.	Dummy 0-1
Process_industry	Indicates if the industry sector of the firm belongs to the process industries group. Process Industries CNAE: 5;6;8;10;11;17;19;20;21;22;23;24.1;24.2;24.3;5;36;37;38 (See Lager, 2011)	Dummy variable (0-1)
Inno_problems	Equal to 1 if one of the four following problems on getting output innovation on the research period: – On-going innovation activities at the end of in 2006 – On-going innovation activities at the end of in 2006, suffering important delays – Innovation activities abandoned on the early phases – Innovation activities abandoned before starting	Dummy variable (0-1)

As aforementioned, investments in intra and extramural R&D activities are also considered. The intramural R&D expenditures per sales (*Int_R&D_expend*) comprise all expenditure on R&D performed within the firm and the extramural R&D expenditures per sales (*Ext_R&D_expend*) comprise the acquisition of external R&D services. Additionally the embodied technology expenditures per sales (*Tech_expend*) reflect the acquisition of advanced machinery, equipment and computer hardware or software. The acquisition of embodied knowledge (*Tech_expend* variable, *Embodied technology expenditures per sales*: it comprises expenditure on the acquisition of machinery and equipment with improved technological performance, including major software, per sales) following Vega-Jurado et al., (2008) procedure is measured into an ordered 5 points scale to better capture its influence (0: 0; 1: 0%<x<=5%; 2: 5%< x<=10%; 3: 10%< x<=50%; 4: >50%).

The variable *Inno_product* is included to control for the firm's innovative products, i.e. firms which innovate in product or/and service. This variable is measured as a dummy variable and takes 1 if the firm have introduce a new or improve product or/and service during the period and 0 otherwise. Thus, this variable reflects the complementary effects between product and process innovation. Similarly, the organizational or management innovation output (*Inno_organization*) is also considered, capturing whether the firm has introduced a new or improve organizational change during the research period (dummy variable 0-1) and addressing the second hypothesis related with the fact that process and organization innovation are usually observed in tandem, i.e., complementary. Next, the moderation effect is represented by an interaction variable as a result of the multiplication of the new management practices variable and the technology acquisition variable. Therefore for this moderation effect we used the *Inno_organization_x_Tech_expend* variable. Eventually, the paper also introduces the sector classification in order to control for industry differences (*Industry_NACE_code*), including 58 2-digit NACE-93 industry classification as dummies, ranging from the 14 to 74 2-digit NACE-93 codes (59 industries). NACE 55 was selected as baseline for dummies specification. In addition, we also control for the typical "process industries" which are mainly dedicated to the introduction of new processes (see Lager, 2011:22), such as mining, forest or utilities (*Process_industry* variable). The variable *Size* (also a control variable) is calculated as the logarithm of the annual average of full-time employees in 2006.

Table 2 Descriptive statistics and correlation matrix

		Mean	Std.Dev	1	2	3	4	5	6	7	8	9	10	11
1	log (SIZE)	3.883	0.013	1.000										
2	group	0.269	0.005	0.431*	1.000									
3	Int_R&D_expend	0.514	0.010	-0.267*	-0.024*	1.000								
4	Ext_R&D_expend	0.122	0.005	-0.161*	0.028*	0.439*	1.000							

5	Tech_expend	0.311	0.008	-0.183*	-0.101*	-0.014	0.026*	1.000						
6	Int. sources	2.192	0.011	0.074*	0.127*	0.225*	0.091*	-0.031*	1.000					
7	Ext_sources_fact_Industry	0.000	0.011	0.057*	0.044*	0.149*	0.047*	-0.007	0.233*	1.000				
8	Ext_sources_fact_Science	0.000	0.011	0.097*	0.142*	0.273*	0.210*	-0.072*	0.150*	0.000	1.000			
9	Inno_organization	0.602	0.005	0.050*	0.047*	0.106*	0.048*	-0.046*	0.144*	0.196*	0.076*	1.000		
10	Inno_product	0.487	0.005	0.073*	0.076*	0.309*	0.124*	-0.082*	0.256*	0.248*	0.195*	0.145*	1.000	
11	Process_Industry	0.198	0.004	-0.039*	-0.055*	-0.052*	-0.030*	0.094*	-0.002	0.040*	-0.018	-0.042*	0.029*	
12	Inno_problemas	0.283	0.007	0.105*	-0.015	-0.221*	-0.109*	-0.015	-0.075*	-0.036*	-0.098*	-0.008	0.555*	0.039*

*significant at p<0.01

In general, 90% of the process innovators (8,977 firms) are SMEs. In fact, only 1,774 firms (20% of the simple) belong to “process industries”. 60% of the process innovators also innovate in organization, i.e., introducing new management practices, and 49% (4,369 firms) do the same in product innovation. Therefore, it is observed a preference for accompanying process with organization.

4. RESULTS AND DISCUSSION

4.1 Findings

Our sample is based on a threshold (i.e. whether or not firms innovate on process), our results could suffer from additional sort of selection bias. The only respondents to these questions are the technological innovators, not only the process but also the product innovators. Therefore left censoring may arises when firms in do not accomplish process innovations but product innovation and also claimed that from that product innovation introduction some process effects has been obtained. In order to tackle this problem we run a Heckman's two-stage selection model where, in the first stage, the inverse Mills ratio is obtained from a *Probit* regression (to predict whether or not a firm innovate on process) using all available observations in the population (28,649 firms). For the second stage, the inverse Mill ratio is included, as an additional variable, so as to explain the variation in innovation performance of the selected sample (8,977 firms, the process innovators). Table 3 incorporates the two-step Heckman procedure to control for selection bias of using process innovators (8, 978 out of the 28,649 which form the total population). The dependent variable measures the innovation performance as the impact of the introduction of new processes on firms through the process effects or objectives (higher production flexibility; higher production capacity; lower labor cost per unit; fewer materials and energy per produced unit). The existence of the inverse Mill's ratio in the equation, when significant, control the coefficients obtained in the regression. When non-significant, it has no effect. We carry these analyses for the *Process_effect* dependent variable. In this particular case, the inverse Mill ratio turns out to be non-significant at the 5% level suggesting that the sample selection (process innovators firms) is not an issue when the depended variable is *Process_effects*. The specification used to predict the probability to innovate in process (*Inno_process*) includes the following variables: *Int_R&D_expend, Ext_R&D_expend, Tech_expend, Inno_product, Inno_Organization, Size, Group, Industry_NACE_codes, Process_industry and Inno_problems* (the latter related with facts which hamper innovation in process) . Other variables related with technological innovations such as internal and external sources of innovations are not included because only the technological innovators answer these questions in the survey (See procedures in Heckman, Mothe and Nguyen-Thi, 2010). See table 3.

According to tables 4 (*process_effects* as dependent variable), which contains the OLS results, the three specifications offer a good fit (adjusted R^2 ranging from 0.20 to 0.21). Following Pacheco-Pires et al. (2008), and Bogers (2009), and Mothe and Nguyen-Thi (2010), the sector heterogeneity needs to be considered and for this reason an industry dummy variable is included for each of the 59 2-digit industries (58 are included, and the NACE 55 is the baseline). An important proportion of the industries affect the process innovation effects. Results about the industry effect are available upon request.

The results in table 4 about process effects, corresponding to Specification 1, indicate that the investment in internal R&D activities (*Int_R&D_expend)* to innovate do not influence the process effects. This result is repeated in all subsequent specifications. In fact, the coefficients are negative, although they are not statistically significant. Similarly, in all specifications, the variable *Ext_R&D_expend* does not work, meaning that the acquisition of R&D from external sources does not render any process returns from process innovation strategies. The result is also observed in the rest of specifications. On the contrary, there is one key variable which reflects the acquisition of embodied knowledge, *Tech_expend* which does contribute to increase the process innovation performance (coefficient 0.135, 0.151 and 0.98 in specifications 1 to 3, respectively; all of them significant at $p<0.01$). Then, the variable *Inno_product*, which is negative in all specifications (except the second) and statistically insignificant, indicating that the realization of product innovation strategies do not contribute to improve the process innovation effects, that is, product innovation activities are neutral and do not affect the process effects. On the contrary, the *Inno_organization* variable, which addresses whether the company has also conducted organizational or management innovation activities, does contribute positively to improve the process innovation performance, as the positive and significant coefficient shows in each specification (0.102, 0.086. 0.081, respectively, $p<0.01$). The latter result suggests that the accomplishment of organization innovation activities does contribute to increase the process effects from process innovation, that is, the organization and process innovation activities are complementary. Regarding the sources of information within a firm's search strategies, which benefit the process innovation performance, the results indicate in the three specifications that the internal sources of knowledge improve the process innovation performance (*Int_sources*, 0.157, 0.1574, 0.15732, respectively, $p<0.01$), indicating that there is important knowledge disperse within a firm which can be used deployed to improve the process innovation performance positively. In addition, the external sources of knowledge variables indicate that sourcing external sources of knowledge from industrial agents (i.e., the value chain; *Ext_sources_fact_Industry*) and from science sources (i.e., universities and R&D centers; *Ext_sources_fact_Science*) are both positive and significant (in all specification, $p<0.01$), meaning that there are returns and gains in the process innovation performance from the sourcing of external knowledge, and especially from the industry sources, due to the larger coefficients showed in the tables 4 (for instance, in specification 1, 0.343 in Industry, compared to 0.096 in Science, both significant at $p<0.01$). The control for the specific "process industries" does not yield any effect in the process effects but the general industry effect is important and significant. The goodness of fit, through the R2 adjusted, accounts for a range between 0.20 and 0.22.

The control variable, log Size, is positive in all specifications (with 0.038 value in most of the specifications; $p<0.01$), indicating that the larger the company, the better the process innovation performance. Lastly, the interaction shows important results. Thus, the acquisition of embodied knowledge is positively moderated, that is, there are complementarities, by the innovation management activity performed at the organization (*Inno_organization_x_Tech_expend)*, pointing out that an improvement in the process innovation performance is obtained from combining the acquisition of embodied knowledge with co-adopting simultaneously organization innovation activities at the firm (specification 3, 0.065 at $p<0.01$).

Table 3 Two-step Heckman procedure to control for selection problems.

	Probit model (INNO_PROCESS)		OLS Model Process_effect	
	Coef.	Std. Err.	Coef.	Std. Err.
constant	-1.695**	0.059	-0.801	0.122
log (SIZE)	0.157**	0.009	0.040**	0.010
group	0.061**	0.024	-0.037	0.024
Int_R&D_expend	0.019	0.015	-0.002	0.014
Ext_R&D_expend	0.058*	0.025	-0.016	0.022
Tech_expend	0.987**	0.027	0.141**	0.023
Inno_organization	0.847**	0.019	0.112**	0.032
Inno_product	0.786**	0.023	0.008	0.032
process_industry	-0.148	0.136		
inno_problems	-0.467**	0.024		
Int. sources			0.157**	0.010
Ext_sources_fact_Industry			0.343**	0.010
Ext_sources_fact_Science			0.096**	0.010
Inv Mill			**0.018**	**0.050**
Industry_NACE_code	Yes		Yes	
N	28649		8977	

chi2	10,901	
R2	0.306	0.2221
Adjusted R^2		0.2178
Error		0.00
F		52.01

Table 4 OLS Model. Dependent variable: Process_Effects

	Specification 1		Specification 2		Specification 3	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
intercept	-0.763**	0.068	-0.557**	0.043	-0.751**	0.068
log (SIZE)	0.038**	0.009	0.033**	0.009	0.038**	0.009
group	-0.039	0.024	-0.045	0.024	-0.038	0.024
Int_R&D_expend	-0.002	0.013	-0.034	0.012	-0.002	0.013
Ext_R&D_expend	-0.016	0.022	-0.018	0.022	-0.016	0.022
Tech_expend	0.135**	0.013	0.151**	0.013	0.098**	0.019
Int. sources	0.157**	0.010	0.1574**	0.010	0.157**	0.010
Ext_sources_fact_Industry	0.343**	0.010	0.350**	0.010	0.343**	0.010
Ext_sources_fact_Science	0.096**	0.010	0.104**	0.010	0.096**	0.010
Inno_organization	0.102**	0.020	0.086**	0.020	0.081**	0.021
Inno_product	-0.001	0.021	0.018	0.021	-0.002	0.021
Inno_organization_x_Tech_expend					0.065*	0.026
Industry_NACE_code	yes				yes	
Process_Industry			0.038	0.024		
R^2	0.222		0.2071		0.2227	
Adjusted R^2	0.218		0.2061		0.2187	

Error	0		0		0	
F	53.1		212.87		52.48	

Level of significance: 1% (**). Sample 8,977 firms which introduced at least new processes (these firms may also introduce new products or management practices) (*Industry_NACE_code*), including n-1 2-digit NACE-93 industry classification as dummies, ranging from the 14 to 74 codes. Code 55 is the baseline. The variable *Industry_CNAE_code* has effect on the dependent variable. Industry dummies and their coefficients are not reported to save space but are available upon request. N=8923. In addition Process_industry control for typical process industries, as aforementioned in table 1.

In order to isolate the process effects of simultaneous co-adoption of product and process activities by firms, we restrict the sample (8,977) to only "pure" process innovators, that is, firms which only introduced new processes and not new products. Put differently, we restrict the technological innovation to just process innovators. We also conducted selection process control by running a Heckman two-step procedure, see Appendix A (table A-1). As showed in table A-1, we use a Probit with the 28,649 firms and one OLS with the 4,608 pure process innovators. The motive to run the Heckman procedure consists of evaluating whether the inverse of the Mill's ratio is insignificant (p>0.05), so there is not a selection process problem. The 4,608 firms which only introduced new processes show a similar pattern of innovation to the previous sample (8,977 process innovators which may also have introduced new products). In order to isolate the pure process innovators, we construct a new dependent variable following a similar procedure as the aforementioned, getting a single component from a PCA (59.9% of the variance explained and KMO= 0.7015) for the reduce (4,608) sample. In table 5, the results showed a similar pattern of innovation for the pure process innovators (4,608) compared to the process innovators (8,977). Basically, and in line with the previous findings, it is observed that R&D activities (both internal and external) do not influence any process effect. Similarly, the acquisition of embodied knowledge (*Tech_expend* variable) does yield significant and positive returns on process effects (0.123, 0.137, 0.085 respectively in all three specifications, p<0.01). In line with previous results, the search strategies are also positive and significant. That is, the external sources of knowledge (from the industry and from the science sources) are both significant and positively related to process effects. The size effect is also positive and significant (first and third specification, 0.032 and 0.031, p<0.05) and the *Group* variable is negative and significant, indicating that the pure process innovators do not yield any effect from belonging to an industrial group. Finally, the introduction of new management practices (*Inno_organization* variable) is positively significant (0.075, 0.058, 0.0453, respectively, p<0.01). In addition, the interaction effect (*Inno_organization X Tech_expend* variables) is also positive and significant (0.082, p<0.05). The effects from the industry are significant (*Industry_NACE_code* variable) and also the effect from the process industries (specification 2, 0.0138 p<0.05). See table 5.

Table 5 OLS Model. Dependent variable: Process_Effects

	Firms which only introduce new processes (without co-adoption of product innovation objective): "pure" process innovators					
	Specification 1		Specification 2		Specification 3	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
constant	-0.570**	0.0824	-0.351**	0.0578	-0.552**	0.0826325
log (SIZE)	0.032*	0.0131	0.021	0.0130	0.031*	0.0131
group	-0.078*	0.0346	-0.079*	0.0341	-0.076*	0.0346
Int_R&D_expend	-0.002	0.0236	-0.032	0.0222	-0.002	0.0236
Ext_R&D_expend	0.039	0.0407	0.037	0.0405	0.039	0.0407
Tech_expend	0.123**	0.0170	0.137**	0.0168	0.085**	0.0228
Int. sources	0.152**	0.0122	0.153**	0.0123	0.152**	0.0122
Ext_sources_fact_Industry	0.381**	0.0138	0.386**	0.0138	0.380**	0.0138
Ext_sources_fact_Science	0.073**	0.0158	0.085**	0.0155	0.074**	0.0157
Inno_organization	0.075**	0.0269	0.058*	0.0267	0.0453	0.0294
Inno_organization_x_Tech_expend					0.082*	0.0327
Industry_NACE_code	Yes				Yes	
Process_Industry			0.138*	0.0340		
N	4608		4608		4608	
R^2	0.239		0.2212		0.24	
Adjusted R^2	0.2311		0.2195		0.232	
Error	0		0		0.000	
F	30.47		130.54		30	

Dependent variable: process_effects, (KMO = 0.7015; 59.98% variance)

Level of significance: 1% (**); 5%(*). Sample 4,608 firms which only introduced new processes (pure process innovators) and not product (*Industry_NACE_code*), including n-1 2-digit NACE-93 industry classification as dummies, ranging from the 14 to 74 codes. Code 55 is the baseline. The variable *Industry_CNAE_code* has effect on the dependent variable. Industry dummies and their coefficients are not reported to save space but are available upon request. N=4,608 In addition *Process_industry* variable controls for typical process industries, as aforementioned in table 1.

All in all, the results of the innovation pattern and the process effects on both samples, i.e., process innovators (8,977) and just pure process innovators (4,608), are pretty similar. Put differently, the R&D (internal or external) activities do not explain any return from process activities on process effects (based on production flexibility, production capacity, lower labor costs or materials and energy reduction). Then, the process effects are highly influenced by external sources of knowledge, mainly from the acquisition of embodied knowledge and the knowledge from the industry. In addition, the process effects are amplified by engaging simultaneously in the adoption of new management practices, finding a significant and positive relationship between the process and the management activities. Complementary, the combination of the acquisition of embodied knowledge with the introduction of new management practices yields significant returns from process innovation, that is, an interaction effect is captured. Finally, the introduction of new products do not yield any return on process effects.

Nevertheless, the introduction of new processes can also yield effects on products. We control for this possibility in the Appendix A and B. The results showed that the pattern of innovation regarding the product effects or objectives is pretty different from the process one, but the main findings and hypothesis are sustained. See Appendix A and B (tables A-2, A-3, B-1, B-2).

4.2 Dicussion

In general, the results point out that process innovation effects from the introduction of new processes, are mainly explained by non R&D efforts but a highly intensive process of dependence on external sources of knowledge, including formal and pecuniary acquisition of embodied technology and informal sources of knowledge from the industry and other external agents and events (fair trades, congresses, etc.). In short, the results indicate that introducing acquired embodied knowledge, together with the use of external and internal (to the firm) sources of knowledge and the introduction of new management practices, all in all, increase a firm's chances of obtaining higher performance from its process innovation strategies through reducing costs and materials per produced unit and improving flexibility and capacity in process innovation activities. Neither R&D efforts nor the product innovation activities increase or alter the chances that a firm has to improve its process innovation performance. In addition, the interaction variables show a complementary and positive effect, which reflects that the acquisition of embodied knowledge is positively moderated, and the process innovation performance is amplified, when that acquisition is complemented with the introduction of new management activities. So, how these results fit into the literature?

As Reichstein and Salter (2006) states, a central difficulty in the context of disentangling the process innovation pattern is to differentiate between product and process related R&D expenditures, due to the fact that conventional R&D statistics do not make this distinction. Despite the little effort that scholars have devoted to this particular task, however, the evidence is quite controversial. On the one hand, Reichstein and Salter (2006), Mairesse and Mohnen (2005) and Baldwin et al. (2002) found a positive relationship between process innovation and R&D intensity. On the other hand, Hervas-Oliver et al. (2011), Huang, Arundel and Hollanders (2010), Barge-Gil et al. (2011) or Rouvinen (2002) found no relationship between firm-level R&D and process innovation. The reason for this possible non-existing relationship between R&D and process innovation is found on the fact that firms innovate through activities which do not require R&D (Arundel et al., 2008), such as combining existing knowledge in new ways (e.g. Evangelista et al., 2002), through imitation and reverse engineering (Kim and Nelson, 2000) or conducting incremental changes relying on engineering knowledge (Kline and Rosenberg, 1986). Specifically, product innovation is more related to the carry out R&D compared with process innovators (Hervas-Oliver et al., 2011; Huang et al., 2010; Rouvinen, 2002). Our evidence is in line with the fact that process innovation is more related to performing non-R&D activities (European Commission, 2008; Hervas-Oliver et al., 2011; Huang et al., 2010), as observed and confirmed in the Appendix A and B. As Arundel et al., 2008 points out describing the Innobarometer in 2007: "*non-R&D innovators, compared to R&D performers, are more likely to focus on process innovation and to source ideas from within the firm from production engineers and design staff. The higher prevalence of process innovation among non-R&D performers suggests that there are more options for developing process innovations without performing R&D.*" Nevertheless, our results are novel and not really comparable to the previous literature, in the sense that we do not relate R&D or non-R&D activities to process innovation accomplishment, that is, whether firms perform or not process innovation, but the process effects or performance from the introduction of new processes. The subtleties are quite different and thus our findings suggest that the R&D activities do not yield superior process effects which improve the firm's performance.

Our paper is in line with previous studies about sourcing knowledge from external sources. In this line, as evidenced in our results, sourcing knowledge is positively related to the innovation process (e.g., Damanpour et al., 2009). External communication means environmental scanning and extra-organizational communication professional activities of members can hiring innovative ideas (Jervis, 1975; Miller and Friesen, 1982), Innovative organizations exchange information with their environments effectively (Tushman, 1977). Internal communications facilitates dispersion of ideas within a communication organization and increases their amount and diversity, which results in cross-fertilization of ideas (Aiken and Hage, 1971), which also creates an internal environment favourable to the survival of new ideas (Ross, 1974). Von Hippel (1988) suggests that process innovators work closely with external suppliers. Similarly, Freel and Harrison (2006), Rouvinen (2002) and Cabagnols and Le Bas (2002) found a correlation between the tendency of a firm to engage in process innovation and its cooperation with suppliers and universities. In the same vein, Vonortas and Xue (1997), following the approach of Bhoovaraghavan et al. (1996), studied the influence of customers in the case of process innovation. All in all, the role of consultants (e.g. Flowers, 2007) and especially the role of suppliers providing knowledge for process innovation (e.g. Cabagnols and Le Bas, 2002; Ettlie et al., 1984; Ettlie and Reza, 1992; Rouvinen, 2002; Voss, 1985) are important.

Overall, the results confirm the stated hypothesis, showing the following contributions. First, the introduction of new management practices is positively related to process effects performance, that is, the new management innovation practices also improve the process effects. This results are in line with the previous management literature (Ettlie, 1988; Nabseth and Ray, 1974; Thompson, 1967) which stated that the non-tech adoption (management innovation, *Inno_organization* variable), in line with Lam (2005) concept of *organizational innovation,* is a precondition to ensure innovation in organizations through the relevant and key organizational characteristics which enhance a firm's innovation (e.g. R. Hall, 1992; R. Hall, 1993; Henderson & Cockburn, 1994). In other words, it is empirically evidenced that the adoption of a more systemic approach to innovation through the technical (process) and non-technical mode (management) together gives a firm a superior performance, confirming previous literature (Polder et al, 2009; Lauria, 1987). However, this result does not mean a cause-and-effect of one over another, but a positive synergistic gain which is supported in the literature. Put differently, the literature does not provide a cause-effect logic and following Damanpour et al. (2009, p. 658) it is recognized that the relationship between the technical and the non-technical systems in the social-technical systems theory is a correlative relationship representing a "coupling of dissimilarities" (Damanpour & Evan, 1984; Scott, 1992). Summarizing, the concentration on either the technical or the non-technical solely would result in a low performance level, as Herbst (1974) stated.

Second, we observed an "implementation" or "learning by trying effect", that is, the acquisition of embodied knowledge is positively moderated, and subsequently the process effects are amplified, when that acquisition is complemented with the introduction of new management activities. This result confirms previous literature which suggested that technology is an occasion for structuring and the actual outcomes depend on how the new processes brought from the new technology are coupled with the organization (Barley, 1986; Cohen and Zysman, 1987; Damanpour, 1991; Ettlie and Reza, 1992; Markus and Robey, 1988; McCann and Galbraith, 1981). Therefore, the acquisition of technology is going to be successful and the process effects optimize when that acquisition is coupled with the organization and, in this case, the introduction of new management practices which support the new technology. Then, size has been found to be an important driver to explain inducements to process innovation in the literature (Cohen and Klepper, 1996; Damanpour, 2010; Klepper, 1996; Nord and Tucker, 1987; Reichstein and Salter, 2006) predicting a positive relationship among them. As Damanpour suggests (2010), researchers generally posit that size has a more positive association with process than with product innovations (e.g. Cohen and Levinthal, 1989; Fritsch and Meschede, 2001; Scherer, 1980), in line with this paper's results, contradicting other studies which do not relate innovation and size (e.g. Camisón-Zornoza et al., 2004; Rammer et al., 2009).

Finally, the introduction of new products do not yield any return on process effects. Put differently, there is no evidence about the effects that the product innovation activities exert on the process innovation activities performance, contradicting a body of literature which claim that there is not sufficient evidence on the separation (Damanpour, 2010; Fritsch and Meschede, 2001; Pisano et al., 1997; Reichstein and Salter, 2006; Walker, 2004) of product or process innovation. In fact, the previous literature has studied the co-adoption of product and process, while our study has gone as step further to assess whether the product innovation exerts or not process effects. Regardless the co-adoption, to introduce new products does yield necessarily effects on the process activities.

6. CONCLUSIONS.

This paper focuses on the impact that the introduction of new processes exert on the process innovation performance (measured through its effects on a firm's production flexibility, production capacity enhancement, labour costs reduction or a better efficiency using materials and energy in the production process) using CIS data. In this vein, this work explores and sheds light on the process innovation phenomenon, whose study has been systematically under-researched by scholars. This work especially presents insights about the poor attention paid to the process innovation variable, traditionally used as a dichotomous dependent variable, instead of being used as a mediator to explain a firm's performance. In fact, instead of merely predicting process innovators or simply understanding complementarities between product and process innovations, this paper is based on understanding the process innovation drivers which enhance productivity. Based on 8,977 firms which recorded to have introduced at least one new process, using Spanish CIS data-based innovation survey, the results suggest that the two stated hypotheses are feasible. In particular, the two stated hypothesis are accepted and the conclusions are as follows. First, regarding the second hypothesis, it is observed an important "implementation" effect or "learning by trying" (Fleck, 1994) effect in which the acquisition of embodied knowledge require that the organization is reprocessed to couple the new technology. This result, predicted in the literature mainly through case studies (Fleck, 1994; Flowers, 2007; Leonard-Barton and Deschamps, 1988; Voss, 1988) is empirically confirmed and extended from a manifested empirical evidence of the positive combination of the embodied knowledge acquisition and the synchronous organization innovative activities to adapt the organization to the new type of knowledge, showing a positive and complementary effect on the process innovation performance. Complementary, this result also reinforce the evidence that the process innovation is related to the organizational one (e.g. Polder et al., 2010). Put differently, our paper confirms a hybrid innovation process form made of technological (process) and non-tech (organizational) activities (e.g. Damanpour and Evan, 1984). Our results confirmed those of Brynjolfsson and Hitt (2000) which pointed out the complementarities of IT investment in hardware and software, organizational change and economic performance. For example, Bresnahan, Brynjolfsson and Hitt (2000) found that greater levels of information technology investment are associated with changes in the work practices. Similarly, it is evidenced that organizational effects of computers depend on the extent to which firms couple computer investment with organizational redesign and other managerial decisions (Hunter et al., 2000; Murnane et al., 1999). Specifically, our results coincide with those of Polder, van Leeuwen, Mohnen and Raymond (2010) which pointed out the empirical evidence that organizational innovation is complementary to process innovation.

Using a cross-fertile theoretical framework which covers the management literature and the innovation management studies, the paper's additional conclusions are also important. First, the paper addresses an often neglected fact: the importance of non R&D innovators or "neglected" innovators. In fact, most of the process innovation performance is explained without R&D variables. This is in line with the literature about innovation which has showed that R&D activities are more frequently used to explain the product innovation activities than that of the process innovation (Arundel et al., 2008; Huang et al., 2010; Vaona and Pianta, 2008). In the innovation management literature, different scholars have worked without considering R&D intensity (Bougrain and Haudeville, 2002; Freel, 2003; Muscio, 2007) and confirming that the innovation process in low- and medium-tech contexts can be captured using non R&D activities (e.g. Santamaría et al., 2009). Put differently, the variables upon which the study is based are beyond those of intramural R&D, and the results show that "*…incremental problem solving and experimentation [which]take[s] place on the shop floor and are closely associated with production beyond well-defined R&D programmes…"* (Albaladejo and Romijn, 2000). Therefore, in contradiction to a large stream of research (e.g. Baldwin and Lin, 2002; Mairesse and Mohnen, 2005; Reichstein and Salter, 2006), R&D efforts are not important to explain firms' determinants to achieve better productivity levels by making process innovation efforts, confirming the study of Rouvinen (2002). Second, it is observed a strong dependence on external sources of knowledge to explain the process innovation performance, mainly through the acquisition of embodied knowledge, confirming the literature (Conte and Vivarelli, 2005; Edquist, 2001; Santarelli and Sterlacchini, 1990; Vaona and Pianta, 2008). Moreover, the results also suggested that informal external sources of knowledge from the industry and from other non-industry agents, in line with the literature (Cabagnols and Le Bas, 2002; Damanpour and Daniel Wischnevsky, 2006; Freel and Harrison, 2006; Hagedoorn, 2002; Rouvinen, 2002; Zeng et al., 2010) are also important for the process innovation activities, although the internal sources of knowledge also matter. External knowledge sources, in general, are drivers to explain the innovation process in firms, in line with other studies (Barge-Gil, 2010; Cabagnols, 1999; Escribano et al., 2009; Reichstein and Salter, 2006; Rouvinen, 2002; Vega-Jurado et al., 2008; Von Hippel, 1988).

Second, our findings pointed out that the process innovation are not influenced by product innovation activities. Therefore, there is no evidence about the effects that the product innovation activities exert on the process innovation activities performance, contradicting a body of literature which claim that there is not sufficient evidence on the separation (Damanpour, 2010; Fritsch and Meschede, 2001; Pisano et al., 1997; Reichstein and Salter, 2006; Walker, 2004) and confirming a different strand of the literature which predicted no effect due to the different nature of both technological types of innovation, in the sense that product innovations are pursued to respond to customers' demand for new products or executives' desire to capture new markets, whereas process innovations are pursued to reduce delivery lead-time or decrease operational costs (Knight, 1967; Martinez-Ros, 2000; Schilling, 2005). On this chain of thought, our conclusions confirmed those of Kraft, (1990) which evidenced that introducing process innovation does not act as a spur to product innovation. Nevertheless, the novelty on this work, beyond the majority of the literature, is the fact that the process innovation variable use is the effect or performance, not just the decision to conduct process innovation.

Lastly, the paper presents implications for scholars and policy makers. First, the policymaking efforts to foster process innovation should: (a) facilitate access to other innovative inputs in addition to R&D, (b) support organization or management innovation as a complement for implementing the technology and thus enhance the process innovation, producing synergies which expand the process innovation' s performance (c) incentive the acquisition of embodied knowledge through technology equipment to counteract the lack of internal resources, (e) promoting networking in order to search knowledge. Second, scholars should also include the effect of the process innovation activities beyond or complementary to the much more studied product innovation phenomena. In particular, scholars should also focus on non-R&D indicators, due to the facts that the R&D can not explain all type of innovation decisions and their effects. In addition, scholars should also refine and exploit the still black-box process innovation phenomenon.

The paper has some limitations. First, the sample is set in a technology-follower country (Spain) and it cannot be extended to other more technology advanced nations. Second, As Qian and Li (2003) pointed out, it is impossible to determine causality at a single time point. Nonetheless, this study assumes that independent variables have a causal relationship with the firm's innovative performance due to the lag period considered between the independent and dependent variables. For future studies, a more in-depth analysis of the role of non R&D innovators when studying the process innovation strategy should be done by especially comparing European Union countries.

Appendix A: robustness check In table A-1 it is showed the two-step Heckman procedure to control for selection problems in the subsample of the pure process innovators, when measuring process effects. As showed, there is not found any selection problem, that is, the Inv. Mill is insignificant.

Table A-1 Heckman procedures to check for selection problems for pure process innovators

	Probit model (INNO_PROCESS)		OLS Model Process_effect	
	Coef.	Std. Err.	Coef.	Std. Err.
constant	-1.695**	0.059	-0.641**	0.174
log (SIZE)	0.157**	0.009	.035*	0.014
group	0.061**	0.024	-.0758	0.035
Int_R&D_expend	0.019	0.015	.0002	0.024
Ext_R&D_expend	0.058*	0.025	.0411	0.041
Tech_expend	0.987**	0.027	.138**	0.037
Inno_organization	0.847**	0.019	0.095	0.050
Inno_product	0.786**	0.023		
process_industry	-0.148	0.136		
inno_problems	-0.467**	0.024		
Int. sources			.152**	0.012
Ext_sources_fact_Industry			.382**	0.014
Ext_sources_fact_Science			0.074**	0.016
Inv Mill			**.033**	**0.072**
Industry_NACE_code	yes		yes	
N	28649		4608	
chi2	10901			
R2	0.306		0.239	
Adjusted R^2			0.231	
Error			0.00	
F			29.83	

As Lager (2002) points out, one of the process development objective is also prompted by the needs or the company's own product development. Therefore, the introduction of new processes not only improves the needs of production but also produce effects on the products developed. The latter is almost neglected in the literature and this paper is going to shed light on it, as a way to offer a solid robustness check to the paper's main findings. Technological process innovation is the adoption of technologically new or significantly improved production methods, including methods of product delivery. These methods may involve changes in equipment, or production organization, or a combination of these changes, and may be derived from the use of new knowledge. The methods may be intended to produce or deliver technologically new or improved products, which cannot be produced or delivered using conventional production methods, or essentially to increase the production or delivery efficiency of existing products (OECD, 2005:32). Thus, the paper focuses also on product performance (measured through achieving wider range of product or services , increasing the market share or obtaining a higher quality of products or services). As done before for the *process_effects* variable, the same is repeated for *product_effects* of the process innovators, taking into account that the introduction of new processes can also affect the product effects, due to their interrelationship. The *Product_effects* variable captures the effects on products from the introduction of new processes by process innovators, although they may also introduce product innovations. Again, the resulting punctuations from a PCA represent this dependent variable and are obtained from three different variables from the CIS questionnaire.

As suggested before, we carry on the robustness check to control for the product effects achieved by process innovators in the general population (28,649) by conducting a Probit analysis to test whether the firm introduced or not new processes and then analyzing through OLS technique the product effects on the sample of process innovators (8,977). See table A-3.

Dependent variable: Product_effects	Process innovation factors effects on Product aspects of firms are the result from a PCA applied to the sample (KMO 0.6938; Variance explained: 74%). Resulting from the following variables measuring the effect on firms of process innovation on: - Wider range of product or services - Increase market share - Higher quality of products or services Each effect has been measured in a four range scale: no effect = 0; Low effect = 1; Medium effect =2; High effect = 3	Continuous, from punctuations from factor analysis

In this particular case, the single factor obtained from the analysis, through its punctuations, represents the second dependent variable which explains 74 % of the variance (KMO = 0.6938, p<0.01). Then, ordinary least squares (OLS) are used in the analysis for each dependent variable. Then, the selected dependent variables measure the innovation performance as the impact of technological innovation (process innovation) on firms. The only respondents to these questions are the technological innovators, therefore left censoring may arises either when many firms in our sample do not carry on process innovations. In any case since we select our sample based on a threshold (i.e. whether or not firms innovate on process), our results could suffer from additional sort of selection bias. In order to tackle this problem we run a Heckman's two-stage selection model where, in the first stage, the inverse Mills ratio is obtained from a Probit regression (to predict whether or not a firm innovate on process) using all available observations in the population (28,649 firms). For the second stage, the inverse Mill ratio is included, as an additional variable, so as to explain the variation in innovation performance of the selected sample (8,977 firms, the process innovators). The existence of the inverse Mill's ratio in the equation, when significant, control the coefficients obtained in the regression. When non-significant, has no any effect. We carry these analyses again for the Product_effect dependent variable. In this case (product_effects), the inverse Mill ratio turns out to be significant at the 5% level suggesting that the OLS coefficients have to be corrected for self-selection bias, therefore the inverse mills ratio is been considered in the OLS regression models when the dependent variable is Product_effects. Results are shown in the table A-3.

The specification used to predict the probability to innovate in process (Inno_process), but using product effects as dependent, includes the following variables: Int_R&D_expend, Ext_R&D_expend, Tech_expend, Inno_product, Inno_Organization, Size, Group, Industry_NACE_codes, Process_industry and Inno_problems (the latter related with facts which hamper innovation in process) . Other variables related with technological innovations such as internal and external sources of innovations are not included because only the technological innovators answer these questions in the survey.

Table A-3 Two-step Heckman procedure to control for selection problems.

	Probit model (INNO_PROCESS)		OLS Model Product_effect	
	Coef.	Std. Err.	Coef.	Std. Err.
constant	-1.695**	0.059	-0.441**	0.103
log (SIZE)	0.157**	0.009	-0.026**	0.008
group	0.061**	0.024	-0.057**	0.021
Int_R&D_expend	0.019	0.015	0.080**	0.012
Ext_R&D_expend	0.058*	0.025	-0.002	0.019
Tech_expend	0.987**	0.027	-0.004	0.019
Inno_organization	0.847**	0.019	-0.003	0.027
Inno_product	0.786**	0.023	0.443**	0.028
process_industry	-0.148	0.136		
inno_problems	-0.467**	0.024		
Int. sources			0.153**	0.008
Ext_sources_fact_Industry			0.334**	0.009
Ext_sources_fact_Science			0.104**	0.009
Inv Mill			-0.226**	0.043
Industry_NACE_code	Yes		yes	
N	28,649		8,977	
chi2	10901			
R2	0.306		0.4417	
Adjusted R^2			0.4386	
Error			0	
F			144.13	

Then, in table A-4 the product effects from the process innovators is showed. In this analysis, the inverse of the Mill's ration is used to correct coefficients from selection problems (technological innovators which carried out the introduction of new processes). In general, the overall fit is better than the previous cases, (R2 ranging around 0.43, $p<0.01$) as aforementioned and the general results vary remarkably showing key differences. First, the size variable is observed to be negative and significant ($p<0.01$) for all specifications (-0.026; -0.039 in the first and second specifications). Second, the intramural R&D expenditures are positive and significant in all specifications (0.080, 0.077, 0.079, $p<0.01$), meaning that the introduction of new processes produce effects on the product performance by investing in internal R&D activities (*Int_R&D_expend* variable). This is a really important results which differ from the previous one in which investment in intra-mural R&D does not produce any effect on process performance from the introduction of new processes. Third, the acquisition of embodied knowledge (*Tech_expend* variable) does not yield any effect in the product effects from process innovation (non-significant and negative sign). Then, the introduction of new management practices do not influence the product effects (all coefficients insignificant and negative, except for the second specification). Introducing product innovations do contribute to improve the product effects (0.0443, 0.419, 0.421, respectively for all specifications; $p<0.01$). The internal and external sources of knowledge affect in a positive way the product effects (similar to the results obtained in table 4) and the industry effect is also important. The control for the specific “process industries” does not yield any effect in the product effects.

Table A-4 OLS Model. Dependent variable: Product_Effects

	Specification 1		Specification 2		Specification 3	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
log (SIZE)	-0.026**	0.008	-0.039**	0.008	-0.028**	0.008
group	-0.057**	0.021	-0.081**	0.020	-0.059**	0.021
Int_R&D_expend	0.080**	0.012	0.077**	0.010	0.079**	0.012
Ext_R&D_expend	-0.002	0.019	-0.014	0.019	-0.003	0.019
Tech_expend	-0.004	0.019	-0.046**	0.018	-0.050	0.028
Int. sources	0.153**	0.008	0.155**	0.009	0.153**	0.008
Ext_sources_fact_Industry	0.334**	0.009	0.339**	0.009	0.333**	0.009
Ext_sources_fact_Science	0.104**	0.009	0.107**	0.009	0.104**	0.009
Inno_organization	-0.003	0.027	-0.087**	0.025	-0.042	0.032
Inno_product	0.443**	0.028	0.419**	0.026	0.421**	0.029
Inno_organization_x_Tech_expend					0.054*	0.024
Ext_sources_fact_ Industry x_Tech_expend						
Ext_sources_fact_Science_x_Tech_expend						
Industry_NACE_code	yes				yes	
Process_Industry			0.019	0.021		
Inv Mill	-0.226**	0.043	-0.360**	0.037	-0.268**	0.046
constant	-0.441**	0.103	-0.068	0.073	-0.346**	0.111
R^2	0.4417		0.4314		0.442	
Adjusted R^2	0.4386		0.4306		0.4389	
Error	0		0.000		0	
F	144.13		566.68		141.42	

Level of significance: 1% (**).

(*Industry_NACE_code*), including n-1 2-digit NACE-93 industry classification as dummies, ranging from the 14 to 74 codes. Code 55 is

The baseline. The variable *Industry_CNAE_code* has effect on the dependent variable. Industry dummies and their coefficients are not reported to save space but are available upon request. N=8923. In addition Process_industry control for typical process industries, as aforementioned in table 1.

On the other hand, the product effects show a completely different pattern of drivers and effects. First, the R&D activities matter and, despite the intense sources of external knowledge, the acquisition of embodied knowledge does not yield any product result, nor the introduction of new organization activities. On the contrary, the introduction of product innovation does contribute to the product effects. Obviously, it seems that firms which improve their product effects is because they have introduce product innovations. Overall, the most significant results show us how the co-adoption of technology acquisition together with the extensive use of external sources of knowledge from the industry and the organization innovation maintain its effects on the products.

On the contrary, following our findings it is evidenced that the product effects require the investment on R&D activities, confirming previous studies (Arundel et al., 2008; OECD, 2010; Huang et al., 2010; Hervas-Oliver et al., 2011) which pointed out that the product innovation requires R&D activities.

To what extent do process innovation objectives complement with the introduction of new products in firms? In this vein, there is a research stream which has discussed the product versus process innovation dilemma, at firm's level (see Damanpour, 2010 for a full revision). On the one hand, Soudes and Padmanabhan (1989) evidenced that this joint accomplishment is rather difficult. In fact, following Damanpour (1991) the rates of adoption of product and process innovations are different during the stages of the development of a business (Utterback and Abernathy, 1975) and firms also differ in their emphases on product or process innovation for providing competitive advantages (Ettlie, 1983; Hull et al., 1985). On the other hand, the stream of literature advocates for considering the product and process innovation process interdependent and complementary, getting complementarities from each other and permitting firms to gain more competitiveness and advantage (Baba, 1989; Collins et al., 1988; Gerwin, 1988). Thus, Reichstein and Salter (2006) analysed a large sample of UK manufacturing firms and found that that product and process innovation were interdependent. Similarly, Cabagnols (1999) studied the dynamics of product versus process innovation and vice versa taking into account its continuity and consistency finding that continuity was highest in the former and consistency similar in both. Martinez-Ros (2000) analysed a large sample of Spanish firms and found product and process innovation to be complementary and dependent basically on the market and firm's characteristics. Our results indicate that the process effects are not influenced by product innovators. Therefore, our evidence is in line with those studies which consider product and process independent. Nevertheless, our paper is not discussing whether the firm co-adopt product and process, but whether the effects of process innovators are influenced by undertaking simultaneously product innovation. And they are not. In addition, what we observed is that the product effects for process innovators are reinforced by undertaking product innovation. Finally, the results showed in Appendix A and B have pointed out how different are the process and the product objectives and their respective innovation patterns. The good thing is that our hypothesis for process innovators are sustained.

PURE As observed in table A-5, in general, the overall fit is good, (R2 ranging around 0.27 to 0.29, $p<0.01$) and the general results are pretty similar to the ones showed for process effects, with some key exemptions. First, in general, there is a similar pattern of innovation regarding the introduction of new management practices and the acquisition of embodied knowledge, together with the effects yielded by the external sources. The acquisition of embodied knowledge (*Tech_expend* variable) does yield product effects from the technological innovation (at $p<0.01$). Then, the introduction of new management practices does influence the product effects (all coefficients positive and significant, $p<0.01$). The internal and external sources of knowledge affect in a positive way the product effects (similar to the results obtained for process innovation) and the industry effect is also important, together with the "process industries", which yield a positive effect on the dependent variable (0.120, $p<0.05$). On the other hand, the differences are as follows. First, the size variable is observed to be negative and significant ($p<0.01$) for all specifications. The Group variable is negative and significant at $p<0.05$. Second, the intramural R&D expenditures are positive and significant in all specifications at $p<0.05$, meaning that the introduction of new processes produce effects on the product performance by investing in internal R&D activities (*Int_R&D_expend* variable). This is a really important results which differ from the previous one observed for the process effects in which investment in intra-mural R&D does not produce any effect on process performance from the introduction of new processes. Third, the interaction effect of introducing new management practices to complement the acquisition of embodied knowledge (Inno_organization x Tech_expend) does not yield any result. See results at A-5.

Table A-5 OLS Model. Dependent variable: Product_Effects

	Firms which only introduce new processes (not products): "pure" process inovators					
	Specification 1		Specification 2		Specification 3	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
constant	-0.304**	0.0791	-0.111*	0.0556	-0.303**	0.0794
log (SIZE)	-0.033**	0.0126	-0.043**	0.0125	-0.033**	0.0126
group	-0.069*	0.0333	-0.080*	0.0328	-0.069*	0.0333
Int_R&D_expend	0.075*	0.0227	0.071*	0.0214	0.075*	0.0227
Ext_R&D_expend	0.063	0.0391	0.037	0.0389	0.063	0.0391
Tech_expend	0.106**	0.0163	0.119**	0.0162	0.105**	0.0219
Int. sources	0.141**	0.0118	0.145**	0.0118	0.141**	0.0118
Ext_sources_fact_Industry	0.409**	0.0133	0.415**	0.0133	0.408**	0.0133
Ext_sources_fact_Science	0.149**	0.0151	0.165**	0.0150	0.149**	0.0151
Inno_organization	0.131**	0.0258	0.109**	0.0257	0.131**	0.0283
Inno_organization_x_Tech_expend					0.001	0.0314
Industry_NACE_code	yes				yes	
Process_Industry			0.120**	0.0327		
N	4608		4608		4608	
R^2	0.29187		0.2788		0.2987	
Adjusted R^2	0.2915		0.2773		0.2913	
Error	0		0.000		0.000	
F	41.32		177.74		40.450	

In this line of thought, we also control for selection process for the general sample (8,977 firms) , specifically in order to evaluate the *product_effects* variable in the pure process innovators (only technological adoption of process innovation, not product one, that is, 4,609 firms). As showed, the Inv Mill is not significant at 5% (>5%). See table A-6. Therefore, there is not selection process and the OLS for capturing the innovation pattern over the product effects (*product_effects* variable) is carried out without the Inv Mill ratio. The new dependent variable is obtained from a PCA, as aforementioned for other cases, restricted to the product effects, getting a single component which explains 74% of the variance (KMO= 0.7013). See table A-5 for analyzing pure process innovators and the product effects.

Dependent variable: Product_effects	Process innovation factors effects on Product aspects of firms are the result from a PCA applied to the sample (KMO 0.7013; Variance explained: 74%). Resulting from the following variables measuring the effect on firms of process innovation on: - Wider range of product or services - Increase market share - Higher quality of products or services Each effect has been measured in a four range scale: no effect = 0; Low effect = 1; Medium effect =2; High effect = 3	Continuous, from punctuations from factor analysis

Table A-6 Two-step Heckman procedure to control for selection problems.

	Probit model (INNO_PROCESS)		OLS Model Product_effect	
	Specification 1		Specification 3	
	Coef.	Std. Err.	Coef.	Std. Err.
constant	-1.695**	0.059	-0.041	0.167
log (SIZE)	0.157**	0.009	-0.042**	0.014
group	0.061**	0.024	-0.079*	0.034
Int_R&D_expend	0.019	0.015	0.070**	0.023
Ext_R&D_expend	0.058*	0.025	0.058	0.039
Tech_expend	0.987**	0.027	0.049	0.036
Inno_organization	0.847**	0.019	0.059	0.048
Inno_product	0.786**	0.023		
process_industry	-0.148	0.136		
inno_problems	-0.467**	0.024		
Int. sources			0.140**	0.012
Ext_sources_fact_Industry			0.406**	0.013
Ext_sources_fact_Science			0.146**	0.015
Inv Mill			**-0.123**	**0.069**
Industry_NACE_code	yes		yes	
N	28649		4609	
chi2	10901			
R2	0.306		0.239	
Adjusted R^2			0.231	
Error			0.00	
F			29.83	

Appendix A: robustness check

In table A-1 it is showed the two-step Heckman procedure to control for selection problems in the subsample of the pure process innovators, when measuring process effects. As showed, there is not found any selection problem, that is, the Inv. Mill is insignificant ($p>0.05$).

Table A-1 Heckman procedures to check for selection problems for pure process innovators

	Probit model (INNO_PROCESS)		OLS Model Process_effect	
	Coef.	Std. Err.	Coef.	Std. Err.
constant	-1.695**	0.059	-0.641**	0.174
log (SIZE)	0.157**	0.009	.035*	0.014
group	0.061**	0.024	-.0758	0.035
Int_R&D_expend	0.019	0.015	.0002	0.024
Ext_R&D_expend	0.058*	0.025	.0411	0.041
Tech_expend	0.987**	0.027	.138**	0.037
Inno_organization	0.847**	0.019	0.095	0.050
Inno_product	0.786**	0.023		
process_industry	-0.148	0.136		
inno_problems	-0.467**	0.024		
Int. sources			.152**	0.012
Ext_sources_fact_Industry			.382**	0.014
Ext_sources_fact_Science			0.074**	0.016
Inv Mill			**.033**	**0.072**
Industry_NACE_code	yes		yes	
N	28649		4608	
chi2	10901			
R2	0.306		0.239	
Adjusted R^2			0.231	
Error			0.00	
F			29.83	

As Lager (2002) points out, one of the process development objective is also prompted by the needs or the company's own product development. Therefore, the introduction of new processes not only improves the needs of production but also produce effects on the products developed. The latter is almost neglected in the literature and this paper is going to shed light on it, as a way to offer a solid robustness check to the paper's main findings. Technological process innovation is the adoption of technologically new or significantly improved production methods, including methods of product delivery. These methods may involve changes in equipment, or production organization, or a combination of these changes, and may be derived from the use of new knowledge. The methods may be intended to produce or deliver technologically new or improved products, which cannot be produced or delivered using conventional production methods, or essentially to increase the production or delivery efficiency of existing products (OECD, 2005:32). Thus, the paper focuses also on product performance (measured through achieving wider range of product or services , increasing the market share or obtaining a higher quality of products or services). As done before for the *process_effects* variable, the same is repeated for *product_effects* of the process innovators, taking into account that the introduction of new processes can also affect the product effects, due to their interrelationship. The *Product_effects* variable captures the effects on products from the introduction of new processes by process innovators, although they may also introduce product innovations. See table A-2 about the new dependent variable

Table A-2 Product effects when firms have introduced process innovations

Dependent variable: Product_effects (8,977)	Process innovation factors effects on Product aspects of firms are the result from a PCA applied to the sample (KMO 0.6938; Variance explained: 74%). Resulting from the following variables measuring the effect on firms of process innovation on: - Wider range of product or services - Increase market share - Higher quality of products or services Each effect has been measured in a four range scale: no effect = 0; Low effect = 1; Medium effect =2; High effect = 3	Continuous, from punctuations from factor analysis

In this particular case, the single factor obtained from the analysis, through its punctuations, represents the second dependent variable which explains 74 % of the variance (KMO = 0.6938, p<0.01). Then, ordinary least squares (OLS) are used in the analysis for each dependent variable. Then, the selected dependent variables measure the innovation performance as the impact of technological innovation (process innovation) on firms. The only respondents to these questions are the technological innovators, therefore left censoring may arises either when many firms in our sample do not carry on process innovations. In any case since we select our sample based on a threshold (i.e. whether or not firms innovate on process), our results could suffer from additional sort of selection bias. In order to tackle this problem we run a Heckman's two-stage selection model where, in the first stage, the inverse Mills ratio is obtained from a Probit regression (to predict whether or not a firm innovate on process) using all available observations in the population (28,649 firms). For the second stage, the inverse Mill ratio is included, as an additional variable, so as to explain the variation in innovation performance of the selected sample (8,977 firms, the process innovators). The existence of the inverse Mill's ratio in the equation, when significant, control the coefficients obtained in the regression. When non-significant, has no any effect. We carry these analyses for the Product_effect dependent variable. In this case (product_effects), the inverse Mill ratio turns out to be significant at the 5% level suggesting that the OLS coefficients have to be corrected for self-selection bias, therefore the inverse mills ratio is been considered in the OLS regression models when the dependent variable is Product_effects. Results are shown in the table A-3.

The specification used to predict the probability to innovate in process (Inno_process), but using product effects as dependent, includes the following variables: Int_R&D_expend, Ext_R&D_expend, Tech_expend, Inno_product, Inno_Organization, Size, Group, Industry_NACE_codes, Process_industry and Inno_problems (the latter related with facts which hamper innovation in process) . Other variables related with technological innovations such as internal and external sources of innovations are not included because only the technological innovators answer these questions in the survey.

Table A-3 Two-step Heckman procedure to control for selection problems.

	Probit model (INNO_PROCESS)		OLS Model Product_effect	
	Coef.	Std. Err.	Coef.	Std. Err.
constant	-1.695**	0.059	-0.441**	0.103
log (SIZE)	0.157**	0.009	-0.026**	0.008
group	0.061**	0.024	-0.057**	0.021
Int_R&D_expend	0.019	0.015	0.080**	0.012
Ext_R&D_expend	0.058*	0.025	-0.002	0.019
Tech_expend	0.987**	0.027	-0.004	0.019
Inno_organization	0.847**	0.019	-0.003	0.027
Inno_product	0.786**	0.023	0.443**	0.028
process_industry	-0.148	0.136		
inno_problems	-0.467**	0.024		
Int. sources			0.153**	0.008
Ext_sources_fact_Industry			0.334**	0.009
Ext_sources_fact_Science			0.104**	0.009
Inv Mill			**-0.226****	**0.043**
Industry_NACE_code	Yes		yes	
N	28,649		8,977	
chi2	10901			
R2	0.306		0.4417	
Adjusted R^2			0.4386	
Error			0	
F			144.13	

Then, in table A-4 the product effects from the process innovators are showed. In this analysis, the inverse of the Mill's ration is used to correct coefficients from selection problems (technological innovators which carried out the introduction of new processes). In general, the overall fit is better than the previous cases, (R2 ranging around 0.43, p<0.01) as aforementioned and the general results vary remarkably showing key differences. First, the size variable is observed to be negative and significant ($p<0.01$) for all specifications (-0.026; -0.039 in the first and second specifications). Second, the intramural R&D expenditures are positive and significant in all specifications (0.080, 0.077, 0.079, $p<0.01$), meaning that the introduction of new processes produce effects on the product performance by investing in internal R&D activities (*Int_R&D_expend* variable). This is a really important results which differ from the previous one in which investment in intra-mural R&D does not produce any effect on process performance from the introduction of new processes. Third, the acquisition of embodied knowledge (*Tech_expend* variable) does not yield any effect in the product effects from process innovation (non-significant and negative sign). Then, the introduction of new management practices do not influence the product effects (all coefficients insignificant and negative, except for the second specification). Introducing product innovations do contribute to improve the product effects (0.0443, 0.419, 0.421, respectively for all specifications; $p<0.01$). The internal and external sources of knowledge affect in a positive way the product effects (similar to the results obtained in table 4) and the industry effect is also important. The control for the specific "process industries" does not yield any effect in the product effects.

In general, table A-4 shows that the product effects show a completely different pattern of drivers and effects. First, the R&D activities matter and, despite the intense sources of external knowledge, the acquisition of embodied knowledge does not yield any product result (except for specification 2), nor the introduction of new organization activities (except for specification 2). On the contrary, the introduction of product innovation does contribute to the product effects. Obviously, it seems that firms which improve their product effects is because they have introduce product innovations. Overall, the most significant results show us how the co-adoption of technology acquisition together with the extensive use of external sources of knowledge from the industry and the organization innovation maintain its effects on the products.

Table A-4 OLS Model. Dependent variable: Product_Effects

	Specification 1		Specification 2		Specification 3	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
log (SIZE)	-0.026**	0.008	-0.039**	0.008	-0.028**	0.008
group	-0.057**	0.021	-0.081**	0.020	-0.059**	0.021
Int_R&D_expend	0.080**	0.012	0.077**	0.010	0.079**	0.012
Ext_R&D_expend	-0.002	0.019	-0.014	0.019	-0.003	0.019
Tech_expend	-0.004	0.019	-0.046**	0.018	-0.050	0.028
Int. sources	0.153**	0.008	0.155**	0.009	0.153**	0.008
Ext_sources_fact_Industry	0.334**	0.009	0.339**	0.009	0.333**	0.009
Ext_sources_fact_Science	0.104**	0.009	0.107**	0.009	0.104**	0.009
Inno_organization	-0.003	0.027	-0.087**	0.025	-0.042	0.032
Inno_product	0.443**	0.028	0.419**	0.026	0.421**	0.029
Inno_organization_x_Tech_expend					0.054*	0.024
Ext_sources_fact_ Industry x_Tech_expend						
Ext_sources_fact_Science_x_Tech_expend						
Industry_NACE_code	yes				yes	
Process_Industry			0.019	0.021		
Inv Mill	**-0.226****	**0.043**	**-0.360****	**0.037**	**-0.268****	**0.046**
constant	-0.441**	0.103	-0.068	0.073	-0.346**	0.111
R^2	0.4417		0.4314		0.442	
Adjusted R^2	0.4386		0.4306		0.4389	
Error	0		0.000		0	
F	144.13		566.68		141.42	

Level of significance: 1% (**).

(*Industry_NACE_code*), including n-1 2-digit NACE-93 industry classification as dummies, ranging from the 14 to 74 codes. Code 55 is

The baseline. The variable *Industry_CNAE_code* has effect on the dependent variable. Industry dummies and their coefficients are not reported to save space but are available upon request. N=8923. In addition Process_industry control for typical process industries, as aforementioned in table 1.

In this line of thought, we also control for selection process for the general sample (8,977 firms) , specifically in order to evaluate the *product_effects* variable in case of considering in our sample just the pure process innovators (only technological adoption of process innovation, not product one, that is, 4,609 firms). Following the same procedures, the Inv Mill is not significant at 5% (>5%), not observing selection process (coefficient -0.123, $p>0.05$; results available upon request). The new dependent variable is obtained from a PCA, as aforementioned for other cases, restricted to the product effects, getting a single component which explains 74% of the variance (KMO= 0.7013). See table A-5 for the new dependent variable and A-6 for analyzing pure process innovators and the product effects.

Table A-5 Dependent variable for evaluating product effects by the pure process innovators

Dependent variable: Product_effects (4,608 firms)	Process innovation factors effects on Product aspects of firms are the result from a PCA applied to the sample (KMO 0.7013; Variance explained: 74%). Resulting from the following variables measuring the effect on firms of process innovation on: - Wider range of product or services - Increase market share - Higher quality of products or services Each effect has been measured in a four range scale: no effect = 0; Low effect = 1; Medium effect =2; High effect = 3	Continuous, from punctuations from factor analysis

Finally, as observed in table A-6, in general, the overall fit is good, (R2 ranging around 0.27 to 0.29, $p<0.01$) and the general results are pretty similar to the ones showed for process effects, with some key exemptions. First, in general, there is a similar pattern of innovation regarding the introduction of new management practices and the acquisition of embodied knowledge, together with the effects yielded by the external sources. The acquisition of embodied knowledge (*Tech_expend* variable) does yield product effects from the technological innovation (at $p<0.01$). Then, the introduction of new management practices does influence the product effects (all coefficients positive and significant, $p<0.01$). The internal and external sources of knowledge affect in a positive way the product effects (similar to the results obtained for process innovation) and the industry effect is also important, together with the "process industries", which yield a positive effect on the dependent variable (0.120, $p<0.05$). On the other hand, the differences are as follows. First, the size variable is observed to be negative and significant ($p<0.01$) for all specifications. The Group variable is negative and significant at $p<0.05$. Second, the intramural R&D expenditures are positive and significant in all specifications at $p<0.05$, meaning that the introduction of new processes produce effects on the product performance by investing in internal R&D activities (*Int_R&D_expend* variable). This is a really important results which differ from the previous one observed for the process effects in which investment in intra-mural R&D does not produce any effect on process performance from the introduction of new processes. Third, the interaction effect of introducing new management practices to complement the acquisition of embodied knowledge (Inno_organization x Tech_expend) does not yield any result. See results at A-6.

Table A-6 OLS Model. Dependent variable: Product_Effects

	Firms which only introduce new processes (not products): "pure" process inovators					
	Specification 1		Specification 2		Specification 3	
	Coef.	Std. Err.	Coef.	Std. Err.	Coef.	Std. Err.
constant	-0.304**	0.0791	-0.111*	0.0556	-0.303**	0.0794
log (SIZE)	-0.033**	0.0126	-0.043**	0.0125	-0.033**	0.0126
group	-0.069*	0.0333	-0.080*	0.0328	-0.069*	0.0333
Int_R&D_expend	0.075*	0.0227	0.071*	0.0214	0.075*	0.0227
Ext_R&D_expend	0.063	0.0391	0.037	0.0389	0.063	0.0391
Tech_expend	0.106**	0.0163	0.119**	0.0162	0.105**	0.0219
Int. sources	0.141**	0.0118	0.145**	0.0118	0.141**	0.0118
Ext_sources_fact_Industry	0.409**	0.0133	0.415**	0.0133	0.408**	0.0133
Ext_sources_fact_Science	0.149**	0.0151	0.165**	0.0150	0.149**	0.0151
Inno_organization	0.131**	0.0258	0.109**	0.0257	0.131**	0.0283
Inno_organization_x_Tech_expend					0.001	0.0314
Industry_NACE_code	yes				yes	
Process_Industry			0.120**	0.0327		
N	4608		4608		4608	
R^2	0.29187		0.2788		0.2987	
Adjusted R^2	0.2915		0.2773		0.2913	
Error	0		0.000		0.000	
F	41.32		177.74		40.450	

Level of significance: 1% (**).

(*Industry_NACE_code*), including n-1 2-digit NACE-93 industry classification as dummies, ranging from the 14 to 74 codes. Code 55 is

The baseline. The variable *Industry_CNAE_code* has effect on the dependent variable. Industry dummies and their coefficients are not reported to save space but are available upon request. N1=4,608. In addition Process_industry control for typical process industries, as aforementioned in table 1.

Following our findings it is evidenced that the product effects require the investment on R&D activities, confirming previous studies (Arundel et al., 2008; OECD, 2010; Huang et al., 2010;

Hervas-Oliver et al., 2011) which pointed out that the product innovation requires R&D activities. Finally, the results showed in this appendix have pointed out how different are the process and the product objectives and their respective innovation patterns. The good thing is that our hypothesis for process innovators are sustained.

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¿ES POSIBLE HABLAR DE *MANAGEMENT INNOVATION* EN LA ADMINISTRACIÓN PÚBLICA?

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ABSTRACT

El sector público, salvo excepciones, parece ajeno al debate académico sobre la innovación en las organizaciones. Se piensa que innovar implica hacer lo mismo aplicando las TICs o diseñando un modelo de calidad que no siempre se pone en marcha. Por ello es importante que en el campo de la Gestión pública se transmita un conocimiento sobre las posibilidades de innovación en las organizaciones públicas, sea una innovación operativa o estratégica, con el deseo de que los empleados públicos puedan imponerlas o, al menos, intentar impulsarlas desde su actual o futuro puesto de trabajo. Este análisis plantea la secuencia de conocimientos necesarios para que estos actuales o futuros empleados públicos entiendan la posibilidad de cambiar nuestras organizaciones públicas poco a poco, pues en primer lugar la cultura de las organizaciones públicas necesita renovarse. Por ello concluimos que es posible incluir la Innovación en Gestión (*Management Innovation*) en el campo de la Gestión pública pero de manera realista y razonada.

Palabras clave:

Management innovation, sector público, estrategia pública, Nueva Gestión Pública.

1. INTRODUCCIÓN: EL MODELO DE NUEVA GESTIÓN PÚBLICA QUE DERIVA EN UNA NUEVA GOBERNANZA PÚBLICA

Algunas definiciones sobre lo que consistiría la actividad de "gestión pública" las encontramos en Pollit y Bouckaert (2010, p. 26), por ejemplo:

- La gestión pública como fusión de la tendencia normativa de la Administración pública y la tendencia organizativa de la gestión (cita de Perry y Kramer).
- La gestión pública como el punto de conexión bidireccional entre el Estado (implementación de políticas públicas) y la sociedad civil (demandas ciudadanas) (cita de Pierre).

Así podríamos distinguir en las organizaciones públicas dos "productos" que deberían estar totalmente compenetrados:

- Las políticas públicas, que implican un planteamiento de tipo estratégico.
- Los servicios públicos, que deben ser el resultado operativo de tales políticas.

En la actualidad, se atiende a la evolución de tres enfoques por los que se han gestionado y gestionan las administraciones públicas (De Miguel Molina, 2010):

- el paradigma de la Administración Pública o *Public Administration* (PA);
- el paradigma de Gestión Pública o *Public Management* (PM);
- el paradigma de Nueva Gestión Pública (NGP) o *New Public Management* (NPM), que deriva hacia la integración de la Gobernanza (*Governance*) en dicho modelo o *New Public Governance* (NPG), buscando la participación ciudadana.

Esta evolución no siempre supone la sustitución de un modelo por otro, sino que en ocasiones todos conviven a la hora de gestionar una administración pública concreta, con mayor o menor influencia dependiendo el lugar y organización que estudiemos (Figura 1).

El funcionamiento de las Administraciones públicas se ha basado tradicionalmente en el modelo burocrático weberiano (Weber, 1969 original de 1922). Es el llamado modelo de Administración Pública (AP) en la que el Derecho administrativo tiene un papel primordial a la hora de fijar el funcionamiento de las organizaciones públicas (Crozier, 1996).

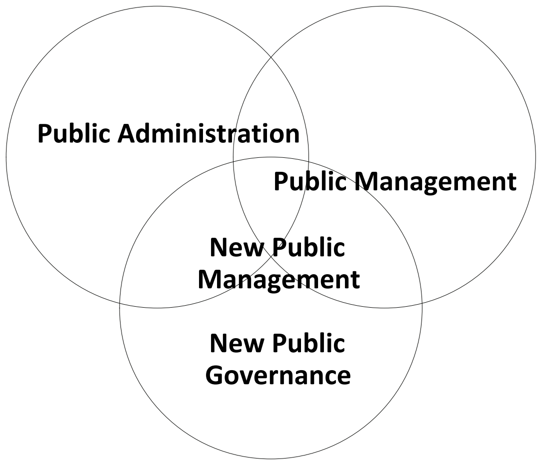

Figura 1. Confluencia entre los paradigmas de la Gestión pública.

Fuente: De Miguel, Herrero y Bañón (2011, p. 23).

Sin embargo, la crisis del petróleo de los años 70 hizo que el Estado del Bienestar, tal como se había creado para impulsar el avance económico de los países tras las dos guerras mundiales, y el modelo burocrático se pusieran en duda. En consecuencia, se comienza a acudir a las técnicas de gestión que se utilizaban en las empresas privadas, buscando la eficacia y eficiencia de las Administraciones públicas, surgiendo la llamada Gestión pública o gerencialismo (GP), en la que se intentan combinar *Management* y Derecho público (*Public Management*), pues en sus inicios su aplicación directa planteó graves problemas (Prats, 2005, p. 126).

Así, se va extendiendo un nuevo modelo de gestión pública, que será bautizado como el paradigma de Nueva Gestión Pública (NGP) y que, básicamente, analiza cómo la Administración Pública podría mejorar su legitimidad de cara a sus ciudadanos desde un punto de vista de gestión (Osborne y Plastrik, 2003, p. 16; Lynn Jr., 2005, pp. 27 y 43-4). Algunos de sus componentes principales serían (Ballart y Ramió, 2000, p. 73):

- Separación entre la decisión política y la ejecución.
- Énfasis en los resultados y en la capacidad para dar respuesta a los problemas de la sociedad.

- Diseño de mecanismos institucionales que incentiven el rendimiento organizativo.
- Cambio cultural centrado en la eficiencia, la competitividad, la orientación al ciudadano-cliente.
- Las administraciones como organizaciones con capacidad estratégica para la toma de decisiones.

En Europa, el primer paso político hacia la NGP fue tomado por el gobierno de M. Thatcher en el Reino Unido, y consistió en diversas reformas que se hicieron a través del llamado "Modelo Westminster", basado en la gestión mixta, pública y privada, y en la privatización de algunas empresas (Ramón Pin , 2009, p. 5). Numerosos autores integran diferentes elementos que compondrían en la práctica las reformas que se han producido bajo la NGP, aunque específicamente se han centralizado en:

- Gestión público-privada.
- Privatización.
- Transparencia (especialmente financiera).
- Orientación al ciudadano-cliente.
- Participación de empleados y ciudadanos en la toma de decisiones.
- Profesionalización de la gestión pública.

Sin embargo, existen grandes diferencias entre los países en función de sus antecedentes políticos y legales (Ferlie y Steane, 2002, p. 1461). Por otra parte, incluso aparecen diferencias entre las organizaciones públicas de un mismo país.

En los países que siguen el modelo jurídico francés, como España, donde la Administración Pública tiene su base principal en el Derecho administrativo, aún existe un modelo algo centralizado que no siempre ve con buenos ojos las nuevas técnicas de gestión (Torres, 2004, pp. 101-2). Salvo excepciones, en lugar de introducir reformas de gran alcance en las estructuras administrativas burocráticas o de evaluación de resultados, hay una tendencia general a implantar iniciativas operativas (cartas de servicios o uso puntual de las TICs) o a adaptar las normas a estos cambios específicos (Torres, 2004, pp. 106-9, Torres y Pina, 2004, p. 447). En consecuencia, España por ejemplo sigue ocupando una posición modesta en el ranking de países que han establecido los principios de la NGP (Ferlie y Steane, 2002, p. 1462).

Pollit y Bouckaert (2010, pp. 138-9) realizan una clasificación entre un grupo nuclear de países proclives a la NGP (Australia, Nueva Zelanda, Reino Unido y Estados Unidos) y otros países que han aplicado dichas reformas sin rechazar la visión tradicional del Estado (Finlandia, Países Bajos, Suecia, Bélgica, Alemania, etc.) a los que estos autores denominan "*neoweberianos*" y en los que las reformas se han centrado en añadir cambios al modelo weberiano original. Así la Dirección estratégica ha sido la base de esos cambios. Pero para ello es necesario que el liderazgo se lleve por profesionales preparados, ya que, por ejemplo, en países como España la selección de los empleados públicos está demasiado orientada al conocimiento legal de los candidatos, sin tener a menudo en cuenta sus habilidades de gestión (Torres y Pina, 2004, p. 462).

Pero hay que tener en cuenta que depende mucho de cada país. Incluso entre los mayores precursores de la NGP no ha habido unos cambios tan radicales como se pretendía (Pollit y Bouckaert, 2010, p. 141). Algunos conceptos como, por ejemplo, la *performance* o "el logro de resultados" pueden tener diferentes interpretaciones ("*resultados para quién, definidos por quién, con qué criterios y con miras al logro de qué objetivos*", p. 145).

Asimismo, el siglo XXI ha sido testigo de una gran difusión del concepto de "Gobernanza" (*Governance*), cuya inclusión reside en la necesidad de aumentar la participación de todos los interesados en la gestión de organizaciones públicas y privadas (Freeman, 1994; Rhodes, 1996; Freeman, 2004; Frederickson, 2005 y Rhodes, 2007), principalmente con una mayor implicación en la formulación de políticas públicas y un incremento de la transparencia de la gestión de estas organizaciones.

Pollit y Bouckaert (2010, p. 28) toman como definición de Gobernanza la desarrollada por Keohane y Nye, para quienes haría referencia a los procesos e instituciones, tanto formales como informales, que orientan y refrenan las actividades colectivas de un grupo. En este sentido, el gobierno quedaría como un subconjunto que actuaría con autoridad creando obligaciones formales.

Así, algunos autores creen que estamos iniciando una fase de post-NGP o fase de *Governance Network* (Osborne, 2006), en el que cada Administración Pública debe evolucionar de acuerdo con su propio entorno. La Gobernanza tiende a ir más allá de la política de coordinación, para mostrar un sector público que se coordina y coopera también con los agentes no estatales, como empresas y ONGs (Acevedo y Common, 2006, p. 396). A través de redes horizontales, por ejemplo, los ciudadanos pueden colaborar aportando ideas, conocimientos y búsqueda de consenso, siempre y cuando la participación sea constante (DeLeon, 2005, pp. 111-2).

Rhodes (1997, p. 29) y Osborne, McLaughlin y Chew (2010, p. 191) definen tres niveles. El nivel micro, se referiría a las relaciones entre diferentes actores, individuales o colectivos; el nivel meso, a las relaciones entre los grupos de interés y la Administración pública; y el nivel macro, a las relaciones entre el Estado y la sociedad civil.

Otros autores señalan que la Gobernanza es una extensión de la NGP y no un nuevo paradigma, sino una combinación de paradigmas en función del país y de la organización pública que se analice (Andresani y Ferlie, 2006, p. 417). Para Martín Castilla (2005, p. 6), "*una aproximación moderna a la Administración Pública desde la dirección estratégica nos induce a integrar tanto la visión externa de competitividad como la interna de la dirección de la organización*".

En definitiva, el detectar todos los grupos de interés al desarrollar políticas o programas públicos, así como conocer sus necesidades, sería un primer paso fundamental por parte de los gestores públicos. Para ello el *social network analysis* está basado en el estudio de la interacción entre diferentes actores sociales. Dichos actores pueden ser personas individuales, pero también grupos u organizaciones (Freeman, 2004), alcanzando en el plano político a actores públicos y privados, sean organizaciones o parte de la sociedad civil, individuales o representantes de un colectivo (asociaciones de empresas, sindicatos, ONGs, etc.) (Messner y Meyer-Stamer, 2000).

En definitiva, como hemos representado en la Figura 1, y siguiendo a Osborne (2010a; 2010b, p. 414) la Gobernanza no sería un nuevo modelo, sino parte de un triple modelo en que convivan la Administración Pública, la NGP y la Gobernanza (*New Public Governance* o NPG).

2. LA INNOVACIÓN EN EL SECTOR PÚBLICO: LA INNOVACIÓN EN GESTIÓN

Según el Manual de Oslo (OECD y Eurostat, 2005), la innovación sería la aplicación de un producto nuevo o significativamente mejorado (bien o servicio), o un proceso, un nuevo método de comercialización, o un nuevo método organizativo, lugar de trabajo o de relaciones exteriores. Y distingue tres tipos de novedad: una innovación puede ser nueva para la empresa, nueva en el mercado o nueva en el mundo. La innovación puede ocurrir en cualquier sector de la economía, incluidos los servicios públicos como la sanidad o la educación.

Sin embargo, la medición de la innovación se aplica fundamentalmente a la innovación empresarial (por ejemplo, en España el Panel de Innovación Tecnológica, Segarra et al. 2011), a pesar de que la innovación también es importante para el sector público (OECD y Eurostat, 2005, p. 16).

De acuerdo con Walker et al. (2011, p. 369), las tipologías de innovación más estudiadas han sido: (1) innovaciones en el producto/servicio versus innovación de procesos, (2) innovaciones tecnológicas versus innovaciones administrativas o de gestión y (3) innovaciones radicales versus innovaciones incrementales; siendo en su opinión las innovaciones de gestión las menos estudiadas en el sector público.

Éstas, las innovaciones administrativas o de gestión, pretenden el aumento de la eficacia y eficiencia interna de la organización y sus procesos administrativos, por lo que se referirían a cambios en su estructura, sistemas de gestión, gestión del conocimiento para evaluar el desempeño y las habilidades directivas que hacen que se consigan la eficacia y la eficiencia (Walker et al., 2011, p. 370). Los cambios en la organizaciones pueden deberse a muchas causas, si bien como objetivo general se supone que deberían buscar un mejor funcionamiento de las organizaciones públicas (Pollit y Bouckaert, 2010, p. 35).

Por otro lado, estas innovaciones en la gestión pública según Hansen (2011, p. 285) estarían en la actualidad incluidas en el modelo de Nueva Gestión Pública y serían de 9 tipos:

- Privatización y *outsourcing*.
- Modelo de co-gestión entre comprador y proveedor (que equivaldría a una gestión indirecta o mixta).
- Gestión por Contrato (*Management by Contract*: MbC).
- Elección libre por el usuario.
- Gestión por control presupuestario.
- Gestión por objetivos.
- *Benchmarking*.
- Gestión de la Calidad.
- Gestión del Cuadro de Mando Integral.

Pero el éxito de estas innovaciones en las administraciones públicas depende en gran medida de su propia cultura organizacional y especialmente la de sus gestores. En un interesante trabajo en las organizaciones públicas locales danesas (Hansen, 2011), se ha constatado que los gestores más experimentados del nivel local suelen ser los más reticentes a las nuevas ideas (p. 293). Por el contrario, los directivos públicos más proclives a las innovaciones son, sorprendentemente, aquellos que tienden a evitar las relaciones sociales (con los ciudadanos) y concentran su trabajo en cambiar los procesos, priorizar las relaciones políticas (incluso no siendo neutrales) y dar soporte a aquellos políticos visionarios y centrados en lograr objetivos (p. 304).

Precisamente, los obstáculos a la innovación y al cambio se dan a nivel interno de la organización. Entre ellos podemos encontrar (De Miguel, Herrero y Bañón, 2011, p. 106):

- Resistencia a la descentralización efectiva del poder de decisión.
- Miedo al abuso de la discrecionalidad y pérdida de autoridad.
- Falta de flexibilidad y autonomía de gestión.
- Miedo a posibles fracasos.
- Calendario político y ciclo electoral centrados en el corto plazo.

Comúnmente se piensa que en las organizaciones públicas los cambios culturales dependen exclusivamente de los mandos (políticos, altos funcionarios), sin embargo también es posible encontrar a otros empleados públicos (directivos públicos de nivel administrativo) que pueden innovar sin necesidad de los mandos "políticos". Diversos estudios han demostrado que hay gestores públicos tan motivados hacia la innovación como los hay en las empresas privadas (Rainey y Chun, 2005, p. 91). Sin embargo estos "innovadores" pocas veces tienen visibilidad y no siempre encuentran una recompensa a sus cambios, a no ser que se presenten a premios de innovación en las administraciones públicas (Mulgan, 2009, pp. 154-5).

Asimismo otros grupos externos han impulsado determinadas reformas: consultores, expertos independientes (*think tanks*) y el mundo académico (Pollit y Bouckaert, 2010, p. 39). De este modo, en ocasiones las innovaciones públicas pueden venir también impulsadas desde fuera, desde el mundo de la empresa, el académico o el de las ONGs (organizaciones no gubernamentales). Entre algunos ejemplos, encontramos (Mulgan, 2009, p. 156-7):

- Empresa: servicios al cliente desde la óptica del Marketing, impulso de algunas privatizaciones o gestiones indirectas.
- Academia: universidades que han investigado los campos de la salud y otros servicios públicos.
- Sociedad civil: principalmente organizaciones no gubernamentales que se han centrado en temas de asistencia social desde hace décadas o más recientemente asociaciones de defensa del medio ambiente, por ejemplo.

Por tanto, podríamos decir que existen tanto reformas impulsadas de "arriba-abajo" (*top-down*) como de "abajo-arriba" (*down-top*). La participación de los usuarios y ciudadanos en la formulación de políticas y la prestación de servicios puede lograr una mayor innovación en el sector público (OECD, 2010, p. 19). Al mismo tiempo, la Administración pública es un factor clave para alentar la innovación, tanto pública como privada, pues tienen capacidad de eliminar los obstáculos en el desarrollo de soluciones innovadoras para diversos problemas sociales (p. 23).

En la actualidad diversos temas suscitan el interés de las reformas que necesitarían las administraciones públicas, muchas de ellas fruto de un cambio cultural y organizativo:

- La visión estratégica de la Administración pública (frecuentemente sólo se planifica a 4 años vista).
- La necesaria responsabilidad ética individual de los directivos (políticos o administrativos) y de los empleados públicos.
- Nuevos mecanismos de participación ciudadana, más allá de los que han existido hasta la fecha.
- Evaluación de las políticas públicas, es decir, control de sus resultados.
- Vuelta a postulados pasados a raíz de la crisis económica: privatización versus nacionalización.
- Cambios en el modelo territorial: debate sobre las autonomías, eliminación de las diputaciones provinciales, uso de las mancomunidades y consorcios, disminución del número de municipios, etc.

El ponerlos en práctica no es un cuestión fácil, sino tremendamente compleja en las administraciones públicas. Los gestores públicos deben conjugar constantemente la legitimidad de sus acciones y decisiones con las presiones políticas y de los grupos de interés y, al mismo tiempo, lograr la mejora de la prestación de los servicios públicos (Denis, Langley y Rouleau, 2005, p. 451).

Asimismo es difícil medir la innovación pública debido a la multitud de tipos de organizaciones públicas y a sus competencias, pues no sólo encontramos diferentes tipos de administraciones territoriales sino, además, organizaciones con competencias generales y organizaciones especializadas. Por ello, es difícil establecer indicadores que nos permitan hacer comparaciones entre ellas.

Incluso a nivel de la Unión Europea es igualmente difícil la comparación entre países y administraciones públicas debido a los diferentes modelos territoriales que representa cada estado europeo (Comisión Europea, 2011). El Innobarómetro que desde hace algunos años coordina la Comisión Europea trata más bien de dar unos datos de innovación pública por países más que una comparación entre ellos. Entre sus conclusiones generales, podemos destacar (pp. 8-10):

- Innovación en la administración pública:

  - Está relacionada con el tamaño de la organización. Curiosamente, son más innovadoras las administraciones públicas grandes y centralizadas.
  - La innovación tiene un gran impulso a partir de la introducción de nuevas normas y reglamentos, seguido de nuevas políticas prioritarias y la implementación de servicios online.
  - Asimismo, no existe relación entre aumento en el presupuesto e innovación. Al contrario, los recortes han supuesto un mayor despegue de ciertas innovaciones.
  - Las fuentes de información que han generado mayor innovación han sido los empleados, los gestores y los usuarios, así como otras administraciones. Mientras que el desarrollo de estas innovaciones ha partido especialmente de los gestores (*top-down*) y algo menos del *bottom-up* (que, sin embargo, tiene mucha más incidencia en las innovaciones del sector privado y ONGs).
  - En cuanto a las barreras a la innovación, se mencionan la falta de recursos humanos y materiales, así como la rigidez de algunas normas.
- Efectos de las innovaciones:
  - Los efectos, en general, son positivos para las administraciones públicas.
  - Entre ellos se incluyen: la mejora del acceso a la información por parte de los usuarios, mejora de la satisfacción de los usuarios, servicios más personalizados, mayor rapidez en la distribución de los servicios, mayor difusión, simplificación de las tareas administrativas, mejora de las condiciones laborales y de la satisfacción de los empleados, así como reducción de costes.
  - Las organizaciones más innovadoras fueron las que tenían una mayor proporción de titulados universitarios.
  - La innovación tampoco parece que se relacione siempre con la construcción de equipos, si bien las administraciones más innovadoras formar equipos con un número pequeño de sus empleados.
  - La formación en innovación se ha introducido en muchas de ellas en los últimos años.
- Contratación pública:
  - Los proveedores más demandados para las innovaciones fueron los de TICs, eficiencia energética y reducción del impacto medioambiental.

- Tendencias de futuro:
  - La mayoría de administraciones públicas quieren continuar introduciendo innovaciones en los próximos años, relacionadas con la comunicación, el servicio o la gestión.
  - Para ello la mayoría piensan que deben basarse en las TICs, las demandas ciudadanas, la prioridad de nuevas políticas y nueva normativa.
  - En cuanto a los presupuestos, las expectativas se contradicen con la realidad. Mientras los gestores sugieren mayor presupuesto para acometer las innovaciones, los resultados muestran que los recortes han sido eficientes motores de las innovaciones.

En el caso de España, a partir de estos datos podemos concluir que el mayor número de innovaciones se ha dado en la oferta de servicios y cambios en los procesos de gestión a través de las TICs.

3. CONCLUSIONES

En este trabajo hemos querido poner de manifiesto la posibilidad de incluir el concepto de *Management Innovation* en las administraciones públicas, teniendo en cuenta sus propias características. Para ello es necesario conocer el paradigma de la Nueva Gestión Pública que, como hemos concluido, se relaciona en la actualidad con el concepto de Gobernanza.

En segundo lugar, en el estudio de la literatura sobre el tema, como hemos visto es necesario un cambio cultural general de la Administración pública para poder poner estas innovaciones en marcha, puesto que los cambios en diferentes niveles interactúan entre sí (Figura 2).

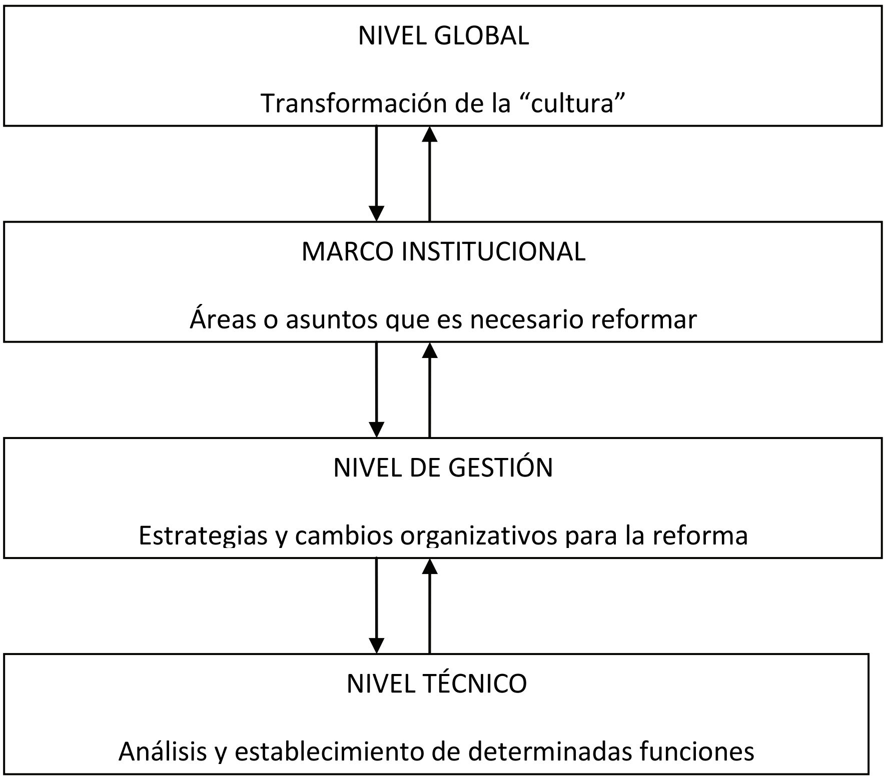

Figura 2. Cuatro niveles de reforma de la gestión pública.

Fuente: elaboración propia a partir de Pollit y Bouckaert (2010, p. 36).

Asimismo, como hemos podido observar, la medición de la innovación en gestión en la actualidad se centra especialmente en las empresas y no hay una medida común para medir y comparar la innovación en las administraciones públicas, recurriendo normalmente a mediciones de tipo sectorial por parte de las organizaciones internacionales (de servicios sanitarios, universidades, administración electrónica, etc.). Por ello la OCDE trabaja desde hace algunos años en localizar una serie de variables propias para las administraciones públicas. Sin embargo no es una tarea sencilla ya que hay que tener en cuenta la idiosincrasia propia de cada nivel territorial y las diferencias entre las administraciones generales y las especiales. En la Unión Europea el Innobarómetro da unos indicadores de innovación, pero realmente la propia Comisión no cree que sea posible hacer una comparación fiable entre los distintos países.

Sería por tanto interesante una nueva línea de investigación en este sentido, buscando las variables que puedan ayudarnos a una medición objetiva y general de la *Management Innovation* para comparar la innovación entre las administraciones públicas.

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ANÁLISIS DEL CONSTRUCTO CAPACIDAD DE ABSORCIÓN: HACIA UN MARCO DE INTEGRACIÓN[63]

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ABSTRACT

Las ideas novedosas pueden encontrarse tanto en el interior de las organizaciones como en su entorno, o en los agentes con los que se relaciona. Las organizaciones deben establecer flujos internos y externos de conocimiento para extraer el mayor valor posible de su potencial innovador. La capacidad de reconocer, valorar, asimilar y aplicar el nuevo conocimiento externo es una predicción significativa del éxito de la necesaria transformación organizativa. Este trabajo pretende contribuir a profundizar en la conceptuación, la aplicación práctica y la medición de la capacidad de absorción a través de su análisis en todas las fases y dimensiones que la componen.

Palabras clave:

Capacidad de absorción, conocimiento, conceptuación, medición

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1. INTRODUCCIÓN

En el nuevo contexto competitivo y económico, el grado de éxito que obtienen distintas organizaciones en los resultados de sus negocios y de las estrategias que los rigen, se pueden explicar a través del nivel y calidad del conocimiento y de las competencias de gestión asociadas a él (Zollo y Winter, 2002).

En los últimos años los estudios sobre la gestión del conocimiento han proliferado, debido a que se reconoce como un factor generador de productividad y crecimiento en las organizaciones (Jansen, Van den Bosch y Volberda, 2005; Kane, 2010). Por ello, la capacidad de reconocer, valorar, asimilar, transferir y aplicar el conocimiento novedoso adquiere una importancia estratégica crucial en el éxito de la necesaria adaptación organizativa mediante la reconfiguración de su base de recursos claves y como facilitadora de la reestructuración organizativa (Van den Bosch *et al*, 1999; Bergh y Lim, 2008; Hoang y Rothaermel, 2010).

Sin embargo, con entornos, tecnologías y reglas que rigen el mercado, sujetos a rápidos e importantes cambios, las organizaciones encuentran grandes dificultades a la hora de crear valor únicamente con fuentes internas de conocimiento (Camisón y Forés, 2010). Por todo ello, para contribuir a esta creación de valor, las organizaciones deben establecer flujos internos y externos para extraer el mayor valor posible de su potencial innovador y, para ello, se requiere que desarrolle la habilidad para reconocer el conocimiento externo valioso y su posterior transferencia y explotación eficiente (Flatten, Engelen, Zahra y Brettel, 2011).

Cuanto mayor sea esta capacidad, mayor será el nivel que se alcance en la capitalización de este conocimiento externo. A través de este proceso las empresas generan y desarrollan conocimiento explícito que, a través de su codificación y aplicación, mejora la toma de decisiones y desarrollan y/o renuevan las bases de conocimiento (Bergh y Lim, 2008). El conjunto de rutinas y procesos que contribuyen básicamente a este propósito conforman la denominada capacidad de absorción (Cohen y Levinthal, 1990; Zahra y George, 2002). En resumen, mantener y desarrollar esta capacidad de absorción condiciona la base de conocimiento de la empresa, su posterior uso y, por lo tanto, su supervivencia (Lane, Koka y Pathak, 2006; Flatten *et al*., 2011; Flor Peris, Oltra Mestre y García Palao, 2011).

El concepto de capacidad de absorción ha sido aplicado en una variedad de campos de investigación como la formulación de estrategias, la gestión de la innovación, la gestión de la cooperación o el aprendizaje organizativo (Tsai, 2001; Zahra y George, 2002: Camisón y Forés, 2010).

Se considera la creación y mantenimiento de la capacidad de absorción como un proceso interactivo y repetitivo de aprendizaje que puede ser aplicado en futuras tomas de decisiones (Bergh y Lim, 2008). Si bien desde un punto de vista teórico la gran mayoría de literatura previa concibe la capacidad de absorción como un proceso complejo (Cohen y Levinthal, 1989, 1990; Kogut y Zander, 1992; Lane y Lubatkin, 1998; Todorova y Durisin, 2007), su tratamiento empírico adolece de esta consideración, ya que se establece como una variable unidimensional que gira en torno al *stock* de conocimiento disponible en la empresa, y cuya medida más habitual se centra en el gasto en I+D (Cohen y Levinthal, 1990; Tsai, 2001, 2009). Sin embargo, este tratamiento es manifiestamente insuficiente, ya que no recoge la riqueza del constructo (Zahra y George, 2002; Jiménez Barrionuevo *et al*., 2010).

Por todo lo anteriormente expuesto, este trabajo pretende contribuir a profundizar en la conceptuación, la aplicación práctica y la medición de la capacidad de absorción a través de su análisis en todas las fases y dimensiones que la componen, tomando como base las fases presentadas en el trabajo de Zahra y George (2002).

2. EL CONSTRUCTO CAPACIDAD DE ABSORCIÓN: ANÁLISIS DE UN PROCESO COMPLEJO Y SU PAPEL EN LA GESTIÓN DEL CONOCIMIENTO

Aunque diversos trabajos habían prestado atención al estudio de la realidad de la adquisición de conocimiento externo en diversas áreas de conocimiento (Mowery, 1983; Kedia y Bhagat, 1988), gran parte de la literatura reconoce los trabajos seminales de Cohen y Levinthal (1989; 1990) como el origen de la conceptuación de esta habilidad organizativa. Estos autores acuñan un nuevo constructo multidimensional, la *capacidad de absorción*, que definen como "la habilidad de reconocer el valor de la nueva información, asimilarla y destinarla a fines comerciales" (1990, p.128). De esta manera, se mejora la capacidad colectiva de gestionar y explotar la base de conocimiento y, por lo tanto, la actividad innovadora. Encontramos una segunda definición en el trabajo de Mowery y Oxley (1995), quienes consideran, sin distinguir diferentes dimensiones, que la capacidad de absorción es un amplio conjunto de habilidades necesarias para gestionar el componente tácito del conocimiento que se desea transferir y, de este modo, mejorar la importación de conocimiento externo.

El modelo de capacidad de absorción propuesto por Cohen y Levinthal (1990) recoge tres dimensiones fundamentales a través de las cuales discurre el conocimiento. En primer lugar se hace referencia al reconocimiento del conocimiento valioso en el exterior de la organización, posteriormente a la asimilación interna y finalmente a su aplicación con fines comerciales. Tomando como base esta estructura del proceso de absorción, el trabajo de Zahra y George (2002) amplía el análisis de la literatura en este campo y propone una nueva definición del constructo, incorporando una cuarta dimensión en el proceso. Según estos autores, la capacidad de absorción puede ser expresada como una metacapacidad, ya que la definen como un conjunto de rutinas y procesos organizativos a través de los cuales las empresas adquieren, asimilan, transforman y explotan conocimiento con la intención de producir capacidades dinámicas organizativas.

En 1998, Lane y Lubatkin proponen la consideración de la capacidad de absorción de una organización de forma relativa, es decir en relación con otra empresa, y no con el entorno en general como en el trabajo de Cohen y Levinthal. Los autores consideran que el correcto funcionamiento de esta habilidad viene explicado por la proximidad y solidez de la relación mantenida entre el emisor y el receptor del conocimiento.

Por lo tanto, se considera esta transferencia como un flujo continuo, compuesto por rutinas interrelacionadas. La primera y última de estas etapas –adquisición y explotación– estarán fuertemente condicionadas por las relaciones de la organización con la entidad emisora del conocimiento y con el exterior, principalmente debido a las fuentes de conocimiento y a su complementariedad con el conocimiento previo que residía en la empresa receptora; por su parte, las dos restantes –asimilación y transformación– vendrán condicionadas por la relación que se establezca entre las subunidades o grupos internos, gestionados a través de los denominados mecanismos de integración social, que facilitan compartir el conocimiento y permiten una búsqueda de soluciones más participativa y creativa a los problemas que se originen en la gestión de este activo (Grant, 1996; Todorova y Durisin, 2007).

La *adquisición* hace referencia a la capacidad de la empresa a la hora de identificar y apropiarse del conocimiento crítico que se genera en el exterior. Por lo tanto, alcanzar un óptimo desarrollo en esta primera fase, supone el propio interés por absorber nuevo conocimiento y la capacidad para capturarlo de manera efectiva. Todorova y Durisin (2007) han llegado a considerar el *reconocimiento* del valor del conocimiento como una fase previa e independiente a la propia adquisición; estos autores afirman que la correcta identificación de la valía del conocimiento externo es un componente crítico de la capacidad de absorción.

La segunda y tercera dimensiones hacen referencia a la asimilación y transformación del conocimiento absorbido. La transferencia interna del conocimiento en la capacidad de absorción puede ser considerada como el proceso de apropiación multinivel -individual y colectivo- a través del cual una unidad se ve afectada por la experiencia de otra (Argote e Ingram, 2000; Zhao y Anand, 2009). Se ven implicados individuos, grupos y distintos niveles organizativos. Los individuos están relacionados con la compartición y reconocimiento del nuevo conocimiento; sin embargo, no debe olvidarse el papel que juegan otros elementos, tales como, los niveles organizativos, las rutinas, los procedimientos y el *know-how* de la organización (Volberda, Foss y Lyles, 2009), ya que son fundamentales en la comprensión del nuevo conocimiento de procedencia externa, que debe ser compartido internamente (Grant, 1996b; Matusik y Heeley, 2005). Esta transferencia puede medirse a través de la consideración del cambio en el conocimiento o en el resultado. Estas dos dimensiones guardan una sólida relación con las estructuras organizativas, ya que el conocimiento de una empresa no puede ser tratado independientemente de la forma en que ésta se organiza (Kogut y Zander, 1992).

La capacidad de *asimilación* hace referencia a las rutinas y procedimientos que permiten analizar, procesar, interpretar y comprender la información obtenida de fuentes externas (Szulanski, 1996). Sin embargo, no todo el nuevo conocimiento puede ser asimilado adecuadamente con las estructuras cognitivas vigentes. En este caso, éstas deben ser transformadas para adaptarlas a la idea o situación que no pueden asimilar (Todorova y Durisin, 2007). La *transformación* sigue al componente de la asimilación y permite a la organización desarrollar y mejorar las rutinas a través de las cuales se combina el conocimiento previo y el nuevo. Zahra y George (2002: 195) definen la capacidad de transformación como "el proceso de disociación que ayuda a la empresa a desarrollar un nuevo esquema perceptual o cambia los procesos existentes". Por lo tanto a través de estas dimensiones, la organización tiene que ser capaz de adaptar o reconfigurar el nuevo conocimiento y/o las estructuras organizativas a sus necesidades.

Por último, la capacidad o dimensión de *explotación* supone la habilidad en la utilización del conocimiento como un componente crítico que condicionará la capacidad de innovación de la empresa (Cohen y Levinthal, 1990). La explotación hace referencia a la capacidad de la empresa a la hora de aplicar comercialmente el nuevo conocimiento y alcanzar los objetivos organizativos planificados (Lane y Lubatkin, 1998). Por tanto, hablamos de rutinas que permitan a la empresa redefinir y/o extender las competencias que ya existen, y/o crear otras nuevas a través del conocimiento que se ha adquirido, asimilado y transformado previamente. Se logra de esta manera incorporar el conocimiento transformado a operaciones concretas (Zahra y George, 2002).

Pero no todo el conocimiento externo que se capture debe o puede ser objeto de explotación comercial directa, ya que es importante considerar la influencia el dinamismo del entorno o las características del mercado en la explotación del nuevo conocimiento generado (Weerawardena, O'Cass, y Julian, 2006). Para las innovaciones técnicas no incorporadas a los productos y servicios, se ha generalizado la concesión de patentes y, con una protección menos amplia, los modelos de utilidad. Ambas herramientas han permitido la protección de las ideas y activos más valiosos, garantizando el mantenimiento de ventajas competitivas a largo plazo. En las últimas décadas, han supuesto el indicador del resultado de la actividad tecnológica de más frecuente utilización (OCDE –Manual de Oslo–, 2005; Hernández Cerdán, 2002).

No obstante, actualmente el conocimiento protegido por patentes puede aplicarse posteriormente a productos o servicios de la empresa o comercializarse como un activo en un mercado de patentes. De esta manera, el proceso innovador desarrollado por las empresas adquiere una perspectiva más abierta, de tal forma que a través de la comercialización de estas patentes, se alcanzan valores adicionales y complementarios ya que, en determinadas circunstancias, no todo el conocimiento generado puede ser aplicado a productos y servicios propios (Teece, 1998; Kline, 2003; Lichtenthaler, Ernst y Hoegl, 2010).

Adicionalmente, en entornos turbulentos, los productos y servicios resultado de la capacidad de absorción podrían rápidamente converger a los estándares de la industria (Eisenhardt y Martin, 2000; Zahra y George, 2002), o resultar obsoletos rápidamente a las demandas (Sorensen y Stuart, 2000). En relación con esto, las unidades operativas necesitan ser selectivas con su capacidad de absorción y sólo explotar aquellos aspectos que supongan beneficios con una mayor probabilidad de realización en el mercado, bien de productos finales, bien de patentes o modelos de utilidad (Kline, 2003; Jansen *et al*., 2005; Lichtenthaler *et al.*, 2010).

3. LA APLICACIÓN DE LA CAPACIDAD DE ABSORCIÓN EN DIFERENTES CAMPOS DE INVESTIGACIÓN

La capacidad de absorción ha sido aplicada en una variedad de campos de investigación. En el presente trabajo nos centraremos en aquellos que más han sido explorados en el ámbito científico.

En primer lugar, se establece una estrecha relación entre el *aprendizaje organizativo* y la capacidad de absorción, ya que será a través de la absorción cómo la organización complete y mejore su aprendizaje organizativo a través de un mayor número de fuentes de conocimiento, de manera que se optimice el proceso de transferencia del conocimiento y, por lo tanto, se mantengan y obtengan ventajas competitivas (Lichtenthaler, 2009).

La capacidad de absorción permite a la organización reforzar, complementar y/o reorientar su base de conocimiento, identificándose por ello como un proceso fundamental en el continuo aprendizaje que garantice la supervivencia de las organizaciones a largo plazo. Por lo tanto, se considera como un proceso de aprendizaje secuencia que comprende la exploración, la transformación y la explotación (Lane, Koka y Pathak, 2006). En este sentido, Liao, Kickul y Halo (2009) establecen una relación entre ambas metacapacidades a través de una capacidad específica que denominan capacidad de integración que permite a la empresa absorber, adquirir y asimilar conocimiento externo e interno para configurar y reconfigurar la base de recursos de la organización. Consecuentemente, si se producen cambios externos a la organización que pongan en peligro el éxito de un proyecto de innovación, ésta será capaz de detectarlos rápidamente y adaptarse a ellos (Jiménez-Barrionuevo *et al*., 2010). Es decir, la capacidad de absorción y el aprendizaje son dos caras de la misma moneda, aquella que permite de forma complementaria un desarrollo, reconfiguración y renovación de los recursos y capacidades para lograr la adaptación a un entorno cambiante.

Las empresas basadas en el conocimiento pueden definirse aquellas organizaciones que consideran que el conocimiento es el componente principal de sus productos y servicios, y por ello desarrollan estrategias relacionadas con la gestión de este activo que permiten, a través de la interacción de los distintos colectivos implicados, crear y compartirlo, utilizando siempre una visión de conocimiento (Zack, 2003). La relación que se establece entre la capacidad de absorción y la *formulación y gestión de estrategias* se basa en el análisis de las estrategias, políticas y actividades, a todos los niveles organizativos, que permiten la gestión óptima del conocimiento que poseen las empresas, tanto tácito como explícito (Mas-Machuca y Martínez-Costa, 2008; Ruiz-Ortega, 2010). Determinadas estrategias favorecen el desarrollo de la capacidad de absorción. Por ejemplo, determinadas dimensiones de dicha capacidad se incrementa en empresas que se rigen por determinadas estrategias. Las empresas exploradoras favorecen la capacidad de adquirir conocimiento y las empresas exploradoras favorecen la capacidad de transformación y explotación del conocimiento (Flor Peris *et al*., 2010). La relación entre las estrategias y políticas organizativas y la gestión del conocimiento ha sido analizada en la literatura de una manera incompleta, al ignorar aspectos tan vitales como el efecto sobre dicha relación de las posibles correlaciones con otros factores como, por ejemplo, los culturales (Zheng, Yang y McLean, 2010).

Por otro lado, el papel que la capacidad de absorción juega en las *políticas de innovación* que desarrollan las empresas ha sido analizado en numerosos trabajos. Se ha demostrado una relación positiva entre la capacidad de absorción y el esfuerzo innovador. Incluso que el efecto que pueda tener sobre dicho esfuerzo puede ser mayor que el que tiene variables estructurales relacionadas con dicho concepto, como la oportunidad tecnológica (Nieto y Quevedo, 2005). El trabajo de Murovec y Prodan (2009) considera una doble dimensión en el constructo la hora de estudiar la habilidad de absorción, centrándose en la fuente de información en la que se apoya: (1) aquella que se basa en la información científica y (2) aquella que se basa en la información del mercado.

Escribano *et al.* (2009) analizan la relación entre la capacidad de absorción y la mejora en los resultados de la innovación considerando que esta relación no se produce de forma aislada, por lo que deben considerarse cuáles son los factores de contingencia clave a la hora de cuantificar el peso de esta relación. El trabajo se centra en dos tipos de contingencias las características del entorno y la apropiabilidad de los resultados obtenidos a través de los derechos de propiedad intelectual. El uso de instrumentos de apropiabilidad para proteger las innovaciones permiten mejorar la capacidad de integrar la nueva tecnología, es decir, las empresas que invierten en este tipo de instrumentos mejoran los efectos de la capacidad de absorción en el proceso de innovación (Arbussà y Coenders, 2007).

El actual entorno competitivo, sobre todo en sectores con un elevado componente tecnológico, exigirá a las empresas una optimización de la gestión del conocimiento y la innovación y, al mismo tiempo, una mejora en las curvas de aprendizaje. Si este aprendizaje se realiza de forma colectiva por parte de las organizaciones será fuente de ventajas competitivas y de sinergias, ya que se permitirá el acceso a recursos escasos de una manera más eficiente (Morcillo *et al.*, 2001). En este sentido, a través de los *acuerdos de cooperación* se generará un *stock* de conocimiento compartido que se alimenta de los flujos de información de distinto tipo –tecnológico, de procedimientos o de sistemas– (Urgal *et al.*, 2011). Por todo ello, se debe establecer alianzas con distintos tipos de socios –competidores, proveedores, clientes, etc., –, ya que los distintos tipos de alianzas en I+D permiten obtener distintos configuraciones de conocimiento que condicionará los resultados de las empresas (Quintana García y Benavides Velasco, 2010). Además, las condiciones del acuerdo de cooperación condicionará el éxito en la transferencia del conocimiento. Acuerdos de cooperación más equitativos favorecen dicha transferencia y, en ciertas alianzas, la capacidad de absorción facilitará la transferencia de la capacidad tecnológica (Mowery, Oxley y Silverman, 1996).

La integración de capacidad absorción y la *innovación abierta* se sustenta la existencia de un conocimiento interorganizativo procedente de las relaciones entre las empresas y los agentes externos, cuya consideración reconoce el valor de la innovación abierta. La innovación abierta asume que las empresas pueden y deben mantener estrechas relaciones con terceros agentes, tanto en el proceso de acumulación de conocimiento como en el de su comercialización (Chesbrough, 2006; Aylen 2010). En esta misma corriente de pensamiento, existen trabajos empíricos recientes que analizan el potencial del conocimiento externo, tanto desde una perspectiva de captación como explotación, en el proceso innovador (Carayannopoulos y

Auster, 2010; Fang, Lee y Schilling, 2010). Este conocimiento podrá ser reconocido, adquirido y asimilado cuando las empresas desarrollen nuevas capacidades de absorción que incluyan rutinas y cambien estructuras y culturas organizativas, por lo que también se facilitaría los procesos de innovación abierta (Dalander y Gann, 2007). Sin embargo, la capacidad de absorción y la innovación abierta aún no se han relacionado de una forma sistémica (Vanhaverbeke, Cloodt y Van de Vrande, 2008). Por todo ello, consideramos especialmente enriquecedor para este estudio la integración de ambas corrientes de investigación.

TABLA 1.- *Líneas de investigación relacionadas con la capacidad de absorción*

Línea de investigación	*Principales preguntas de investigación*	*Principales autores*
Aprendizaje	Existe una estrecha relación entre el *aprendizaje organizativo* y la capacidad de absorción, ya que será a través de la absorción cómo la organización complete y mejore su aprendizaje organizativo	Lane *et al*., 2006; Bergh y Lim, 2008; Lichtenthaler, 2009
Estrategia	Las estrategias empresariales condicionan la capacidad de absorción; La capacidad de absorción también condicionará el éxito de determinadas estrategias	Mas-Machuca y Martínez-Costa (2008); Bergh y Lim, 2008; Ruiz-Ortega (2010); Zheng *et al.* (2010); Flor Peris *et al.* (2011)
Innovación	La capacidad de absorción puede favorecer el éxito y/o desarrollo de determinados tipos de innovación	Caloghirou *et al*., (2004); Nieto y Quevedo (2005); Arbussà y Coenders (2007); Grimpe y Sofka (2009); Murovec y Prodan (2009); Rothaermel y Alexandre (2009); Lewin *et al*. (2011)
Cooperación	La capacidad de absorción puede favorecer el éxito en determinados acuerdos de cooperación	Mowery *et al*. (1996); De Jong y Freel (2010)
Innovación abierta	Relacionar la capacidad de absorción y la innovación abierta de una forma sistemática	Dalander y Gann (2007); Vanhaverbeke et al., (2008)

Fuente: Elaboración propia

4. LA MEDICIÓN DE LA CAPACIDAD DE ABSORCIÓN: UN CONSTRUCTO MULTIDIMENSIONAL

La naturaleza cualitativa del concepto capacidad de absorción dificulta su medición cuantitativa y se ha realizado en la mayoría de los estudios a través de diversos indicadores (Murovec y Prodan, 2009; Flatten *et al*., 2011; Lewin *et al*., 2011). Una parte importante de los estudios consideran la capacidad de absorción como un constructo unidimensional, siendo la ratio del gasto en I+D dividido entre las ventas anuales la medición más popular (Cohen y Levinthal, 1990; Tsai, 2001); trabajos recientes complementan el gasto en I+D con la intensidad en I+D (De Jong y Freel, 2010); algunas investigaciones utilizan variables proxy relacionadas con el área de recursos humanos como indicador de la capacidad de absorción. Mowery y Oxley (1995) utiliza la inversión en entrenamiento del personal científico y técnica y las políticas económicas que refuercen la competitividad. Keller (1996) utiliza los porcentajes de científicos e ingenieros y la inversión en personal relacionado con I+D. Grimpe y Sofka (2009) capturan la capacidad de absorción a través del gasto en I+D y con la experiencia de los trabajadores, ya que consideran que es un proceso que se desarrolla por acumulación a lo largo del tiempo. Por último en otros casos, se relativiza el gasto en I+D en función del número de empleados (Tsai, 2009) o según los gastos de otras áreas funcionales (DeJong y Freel, 2010). Sin embargo, esta consideración es manifiestamente insuficiente, ya que no recoge la riqueza del constructo, que se refleja en sus distintas dimensiones (Zahra y George, 2002; Murovec y Prodan, 2009; Jiménez Barrionuevo *et al.*, 2010).

Aunque no se puede afirmar que las medidas propuestas por la literatura puedan considerarse unas superiores a otras, ya que debe contemplarse bajo qué circunstancias tiene lugar (Escribano *et al.*, 2009), se ha identificado múltiples dimensiones en la capacidad de absorción que deben ser consideradas a la hora de desarrollar una medida válida. Por lo tanto, es un constructo complejo que debe ser estudiado en distintos niveles –individual, organizativo e interorganizativo– (Volberda, Foss y Lyles, 2010). En este sentido, Van den Bosch, Van Wijk y Volberda (2003) consideran la capacidad de absorción como un constructo multinivel e interdisciplinar.

De forma adicional, hay otra característica que la mayoría de estudios empíricos no están reconociendo a la hora de analizar la capacidad de absorción. Si los trabajos no tratan este constructo como un proceso, su viabilidad puede verse afectada al no recoger la riqueza del constructo (Volberda *et al.*, 2010). En resumen, a través de la capacidad de absorción el conocimiento se transfiere desde el exterior de la organización a su interior y, una vez allí, debe ser sometido a una serie de actuaciones en distintos niveles y fases, que permita adaptar sus propiedades y usos a las necesidades de la empresa receptora. Sin embargo, las rutinas y procesos organizativos que constituyen la capacidad de absorción continua siendo una “caja negra” (Lewin, *et al*., 2011).

La capacidad de absorción se desarrolla de forma acumulativa a través de largos procesos que permiten investigar, obtener y acumular nuevo conocimiento (Jiménez-Barrionuevo *et al.*, 2010). Las cuatro dimensiones que conforman el proceso, analizadas en el epígrafe anterior, han sido agrupadas en dos dimensiones fundamentales –*capacidad de absorción potencial* y la *capacidad de absorción realizada*– (Lane y Lubatkin, 1998; Zahra y George, 2002).

La capacidad de absorción potencial se desarrolla en las dimensiones de adquisición y asimilación de conocimiento externo (Lane y Lubatkin, 1998). Mientras que la capacidad de absorción realizada se obtendrá en función del desarrollo de las dimensiones de transformación y explotación (Zahra y George, 2002). Por lo tanto, para lograr que el proceso de desarrollo de la capacidad de absorción proporcione el nivel máximo de ventajas competitivas a la organización, ésta debe ser capaz de transformar en gran medida su capacidad de absorción potencial en real.

Recientes trabajos están considerando las cuatro dimensiones que conforman la capacidad de absorción potencial y realizada a la hora de diseñar las escalas a través de las cuales medir de forma más completa esta capacidad dinámica (Jansen *et al.*, 2005; Camisón y Forés, 2010; Jiménez-Barrionuevo *et al.*, 2010). En este sentido, realizamos un análisis a través de las cuatro dimensiones estableciendo las perspectivas, rutinas y mecanismos organizativos que pueden ser aplicados en el funcionamiento de cada una de las dimensiones. Todo ello debe ser adaptado a las condiciones específicas de la empresa tanto aquellas relacionadas con las contingencias externas a la organización –dinamismo del entorno, nivel competitivo/ cooperativo de la industria, etc.,– como aquellas relacionadas con su propia naturaleza –edad de la empresa, resultados anteriores, etc., –.

En la primera fase del proceso, *la adquisición*, adquieren gran importancia las relaciones que mantiene la organización con terceros agentes. A través de estas relaciones se realiza un aprendizaje exploratorio que permite a la empresa reconocer y comprender el valor potencial que el conocimiento externo tiene para ella (Lane, Koka y Pathak, 2006). En este sentido, Lane y Lubatkin (1998) proponen la consideración de la capacidad de absorción de una organización en relación con otra empresa, y no con el entorno en general como en el trabajo de Cohen y Levinthal. De esta forma, los autores definen un constructo, denominado *capacidad de absorción relativa*, a través del cual el éxito viene explicado por la proximidad y solidez de la relación mantenida entre el emisor y el receptor del conocimiento.

Por otro lado, respecto a la fase de asimilación dentro de la propia organización, existen dos perspectivas o corrientes –cognitiva y organizativa– centradas en la comprensión o entendimiento del conocimiento externo que previamente ha sido adquirido.

Los factores relacionados con la perspectiva cognitiva centran su interés en la parte humana de la gestión del conocimiento. Zahra y George (2002) consideran la asimilación como el proceso a través del cual el conocimiento nuevo puede ser interpretado y comprendido desde las estructuras cognitivas existentes. Que el proceso se realice de forma efectiva depende de la ecología social de la organización (Gupta y Govindarajan, 2000). Para Minbaeva *et al.* (2003), la capacidad de absorción se trata de un constructo a nivel organizativo que reside en sus empleados, por lo que el papel de los individuos de la organización resulta crucial para la utilización y explotación del conocimiento. Para ello, el establecimiento de procesos y la selección de personas y líderes resultan fundamentales (Rasli, Madjid y Asmi, 2004), ya que el nivel educativo de los empleados es un factor clave en la capacidad de absorción (Vinding, 2000). Para que una empresa asimile el conocimiento en las condiciones adecuadas, debe poseer un número suficiente de especialistas técnicos cualificados, científicos e ingenieros (Rothwell y Dodgson, 1991).

Desde la perspectiva organizativa se analizan las estrategias, políticas y actividades, a todos los niveles organizativos, que permiten la gestión óptima del conocimiento que poseen las empresas, tanto tácito como explícito (Mas-Machuca y Martínez-Costa, 2008; Ruiz-Ortega, 2010). La relación entre las estrategias y políticas organizativas y la gestión del conocimiento ha sido analizada en la literatura de una manera incompleta, al ignorar aspectos tan vitales como el efecto sobre dicha relación de las posibles correlaciones con otros factores, como los tecnológicos (Zheng, Yang y McLean, 2010).

Una vez asimilado, la organización debe incorporar este conocimiento externo a sus rutinas y procesos, proporcionando los fundamentos sobre los que acometer la renovación de aquéllos que sean necesarios. De esta forma, se ayuda a la empresa a desarrollar un nuevo sistema perceptual que permitirá hacer propio el conocimiento externo para una posterior explotación eficiente de la base de conocimiento en forma de innovaciones (Zahra y George, 2002).

Las decisiones organizativas que deben seguirse en la fase de transformación han de desembocar en la obtención de determinadas capacidades responsables del desarrollo y mejora del panel de rutinas que faciliten combinar el conocimiento previamente asimilado con la base de conocimiento existente (Flor *et al.,* 2011). Por todo ello, se deben establecer sistemas organizativos y tecnológicos que permitan la puesta en funcionamiento de estrategias de recodificación y adaptación al nuevo conocimiento que ya ha sido asimilado. En este sentido, los denominados Sistemas y Tecnologías de la Información dan soporte a la organización, localización, distribución y compartición del conocimiento. Por todo ello, las competencias en TIC son consideradas como capacidades organizativas dinámicas que permiten, por un lado, crear y mantener ventajas competitivas y, por otro, generar innovaciones (Menor y Roth, 2007; Dibrell, Davis y Craig, 2008; Phang, Kankanhalli y Ang, 2008; Navarro Paule, Bustinza Sánchez y Romerosa Martínez, 2010).

Por último, a través de la explotación la capacidad de absorción permite aplicar comercialmente el nuevo conocimiento para alcanzar los objetivos organizativos planificados a través de su uso e implementación en productos, servicios o procesos. Por todo ello, la capacidad de absorción realizada influye en el logro y mantenimiento de ventajas competitivas (Lane y Lubatkin, 1998; Todorova y Durisin, 2007). Se incluirían, entre otras, prácticas de gestión que permitan mejorar la aplicación del conocimiento generado al proceso productivo de los outputs de la empresa.

Finalmente, cabe destacar la existencia de factores que afectan a la transferencia del conocimiento, y por lo tanto al resultado de la capacidad de absorción de las distintas unidades organizativas. Sin duda, entre los factores más analizados son los relacionados con el conocimiento. Entre ellos cabe destacar el nivel de conocimiento previo (Cohen y Levinthal, 1990; Todorova y Durisin, 2007), la fuente del conocimiento (Todorova y Durisin, 2007) o la naturaleza o tipo de conocimiento, relacionada con la dependencia del contexto y la ambigüedad (Gittelman y Kogut, 2004; Williams, 2007). No obstante, el establecimiento de un marco de integración, que comprenda los factores antecedentes y moderadores de la transferencia del conocimiento y sus implicaciones, se encuentra aún en estadios iniciales.

TABLA 2.- *Tratamiento empírico de la capacidad de absorción: medidas del constructo y efecto en resultados*

Autores	***Definición Capacidad de Absorción***	***Construcción variable capacidad de absorción***	***Campo de investigación relacionada***	***Metodología***	***Nivel de análisis***	***Resultados***
Caloghirou *et al*., (2004)	Habilidad de las empresas no solo para adquirir y asimilar la información, sino también para explotarlo	Cuatro variables. Para determinar la capacidad de la empresa al acceso y explotación del conocimiento y para el esfuerzo en la búsqueda de información	Innovación	Modelo de mínimos cuadrados ordinarios (OLS)	País y sector	Las capacidades internas y estar abierto a compartir el conocimiento es importante en la mejora de los resultados de la innovación
Jansen *et al*., (2005)	Reconocer nuevo conocimiento externo, asimilarlo y aplicarlo con fines comerciales. Capacidad de absorción potencial (PACAP) y realizada (RACAP)	Escala de siete puntos parcialmente basada en los ítems del estudio de capacidad de absorción de Szulanski (1996) y la orientación del mercado de Jaworski y Kohli (1993)	Mecanismos organizativos	Análisis de regresión jerárquica	País y empresa multiunidad	La habilidad de las unidades para crear valor a partir de su capacidad de absorción condicionarán su gestión de la PACAP y la RACAP
Nieto y Quevedo (2005)	Unión entre el *know-how* generado en el exterior de la empresa y el conocimiento generado internamente	Once factores significativos	Innovación	Análisis de regresión múltiple	Empresa	La capacidad de absorción tiene un efecto moderador entre la oportunidad tecnológica y el esfuerzo tecnológico
Arbussà y Coenders (2007)	Capacidad para escanear el entorno externo en busca de nueva tecnología y para integrar nuevo conocimiento externo en su proceso de innovación	Constructo formado por un grupo de variables para medir los dos tipos de capacidad (escanear e integrar)	Innovación	Modelo Logit multinivel	Empresa	Los efectos de la capacidad de absorción en las actividades de innovación son específicos de la industria y más fuerte en las empresas que invierten en los instrumentos de apropiación

Autores	***Definición Capacidad de Absorción***	***Construcción variable capacidad de absorción***	***Campo de investigación relacionada***	***Metodología***	***Nivel de análisis***	***Resultados***
Escribano *et al*., (2009)	Habilidad de reconocer el valor de conocimiento externo, asimilarlo y explotarlo con fines comerciales.	Constructo con cuatro dimensiones: El gasto interno en I+D, I+D permanente, el entrenamiento del personal de I+D y el ratio de científicos e investigadores.	Innovación	Modelo Logit	Empresa	Mayores niveles de capacidad de absorción permiten gestionar de forma más eficiente los flujos externos de conocimiento y estimular los resultados de la innovación. Importancia de los factores de contingencia.
Grimpe y Sofka (2009)	Habilidad para reconocer el valor potencial del conocimiento externo	Gasto en I+D y experiencia de los empleados	Innovación y acuerdos de cooperación	Regresión Tobit y Regresión de Clases Latentes	Empresa	La búsqueda de socios en industrias de bajo nivel tecnológico se centra en el conocimiento de mercado y en las de alto nivel en socios
Lichtenthaler (2009)	Habilidad para utilizar el conocimiento externo a través de un proceso secuencial (exploración, transformación y explotación)	Constructo multidimensional. Escalas para cada una de las tres fases (exploración, transformación y explotación)	Aprendizaje	Modelo de Ecuaciones Estructurales	Empresa industrial	La capacidad de absorción tiene una naturaleza multidimensional y ayudan a explicar las diferencias en las rentabilidades del conocimiento externo, sobre todos en contexto de de alto nivel tecnológico y en mercados turbulentos
Murovec y Prodan (2009)	Relación entre la capacidad organizativa interna para desarrollar y mejorar productos y la base de información y oportunidades externas	Constructo bidimensional según la fuente de información (científica y mercado)	Innovación	Modelo de Ecuaciones Estructurales	Empresa	Existencia de una doble tipología en la capacidad de absorción. Ambos tipos están positivamente relacionados con la innovación en producto y en proceso

Autores	*Definición Capacidad de Absorción*	*Construcción variable capacidad de absorción*	*Campo de investigación relacionada*	*Metodología*	*Nivel de análisis*	*Resultados*
Rothaermel y Alexandre (2009)	Permite a la empresa identificar y valorar el nuevo conocimiento que se origina más allá de sus fronteras y asimilarla e integrarla con el conoimiento existente	Gasto en I+D	Innovación y tecnología	Modelo de regresión	Empresa (sector manufacturero)	Altos niveles de capacidad de absorción permiten a la empresa capturar de una forma más completa los beneficios resultantes de la característica ambidextra de las fuentes tecnológicas (explorar y explotar)
Camisón y Forés (2010)	Capacidad dinámica sistemática con dos subcapacidades (PACAP y RACAP)	Constructo con varios ítems para cada dimensión de PACAP y el RACAP	Innovación	Análisis factorial confirmatorio	Empresa	Validez de la escala propuesta por el estudio
De Jong y Feel (2010)	Habilidad para identificar socios, transferir recursos y conocimiento y gestionar las relaciones separadas geográficamente.	Gasto en I+D e intensidad en I+D	Acuerdos de cooperación	Modelo de regresión	Empresa	Preferencia por los socios locales. Mayores gastos en I+D permiten mayores distancia geográfica entre los socios.
Kostopoulos *et al*. (2010)	Habilidad de reconocer el valor de conocimiento externo, asimilarlo y explotarlo con fines comerciales.	Sigue el procedimiento propuesto por Escribano et al. (2009) para construir un indicador	Innovación y resultados financieros	Modelo de ecuaciones estructurales	Empresas	La capacidad de absorción contribuyen, de forma directa e indirecta, en el desarrollo de la innovación y del resultado financiero pero en diferentes intervalos de tiempo
Flor Peris *et al.* (2011)	Conjunto de rutinas organizativas y procesos por los cuales las empresas adquieren, asimilan, transforman y explotan el conocimiento	Diferentes ítems para cada dimensión de la capacidad de absorción. Cada dimensión, con los ítems considerados, es un constructo unidimensional	Estrategia empresarial	Análisis de la varianza	Empresa	La capacidad de absorción de la empresa variará según sea la estrategia adoptada por esta. Determinadas dimensiones son mayores en empresas defensoras y analizadoras

Fuente: Elaboración propia

CONCLUSIONES Y FUTURAS LÍNEAS DE INVESTIGACIÓN

En el nuevo escenario competitivo las ideas novedosas pueden encontrarse tanto en el interior de las organizaciones como en su entorno, o en los agentes con los que se relaciona. Por ello, debe alcanzarse una gestión de los recursos óptima, considerando tanto los procedentes de fuentes internas como externas (Argote e Ingram, 2000; Bradley, 1997; Teece, 2000).

Las organizaciones deben establecer flujos internos y externos de conocimiento para extraer el mayor valor posible de su potencial innovador, y para ello, se requiere que desarrolle la habilidad para reconocer el conocimiento externo valioso y su posterior explotación eficiente. La capacidad de reconocer, valorar, asimilar y aplicar el nuevo conocimiento externo es un predicción significativa del éxito de la necesaria transformación organizativa (Hoang y Rothaermel, 2010).

Sin embargo, debe considerarse que la capacidad de absorción supondrá una ventaja competitiva siempre y cuando en su funcionamiento exista cierta ambigüedad causal (Lippmann y Rumelt, 1982), es decir cuando las relaciones causa-efecto que se establezcan entre los distintos mecanismos, rutinas y recursos que lo compongan y los resultados conseguidos no puedan ser establecidas en su totalidad por las empresas competidoras (Guerras Martín y Navas López, 2007). Sin embargo, existe la posibilidad de establecer ciertas reglas que pueden ser aplicadas en el funcionamiento de las distintas dimensiones o fases de esta capacidad dinámica. Estas reglas serían aplicables en determinadas condiciones, tanto contingencias externas a la organización como de su propia idiosincrasia. El establecimiento de metarutinas, y su expresión en forma de rutinas prácticas o mecanismos organizativos, permitirán hacer operativo el constructo capacidad de absorción (Jansen *et al*., 2005; Lewin *et al*., 2010) y deberán diseñarse según las contingencias anteriormente descritas. Adicionalmente, el desarrollo de una medida del constructo a través de las distintas fases y rutinas que lo componen, y que sea comúnmente aceptada por la comunidad científica, facilitaría la comparación de los resultados obtenidos en los distintos estudios (Flatten *et al*., 2011)

En conclusión, la generación y mantenimiento de capacidades de absorción es un proceso interactivo y repetitivo donde las empresas aprenden de sus experiencias, se relacionan con el exterior, y se almacena y codifica un conocimiento con vista a futuras aplicaciones.

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INNOVACIÓN ABIERTA EN SECTORES TRADICIONALES. EL CASO DE LA MULTINACIONAL LACTALIS FORLASA

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ABSTRACT

La mayoría de empresas no tienen su propio departamento de I+D, buscando soluciones a problemas surgidos y nuevas ideas que puedan ser aplicadas en los productos a fabricar por las industrias y buscando mejorar los servicios ofrecidos, hacen que la asociación o cooperación con otros intermediarios sea una de las formas más rápidas y económicas a la hora de innovar (Hagedoorn y Schakenraad, 1994). Las empresas mejoran su eficiencia y sus resultados al tener un abanico mayor de recursos y fuentes más diversificadas (Kranenburg, Hagedoorn y Pennings, 2004). El concepto de Innovación Abierta aborda este cambio de las empresas que buscan innovación y cambios mas allá de sus departamentos de I+D, pero vemos en la revisión literaria que se aborda siempre en sectores de alta tecnología. A través de este articulo demostraremos que el concepto es también desarrollado en empresas de baja tecnología, analizando a través de un estudio de casos que las empresas con productos agroalimentarias tradicionales de nuestra región también apuestan por este sistema de innovación que les aporta rapidez en el lanzamiento de productos y afianza lazos con agentes que intervienen en su cadena productiva. Este hecho demuestra que las pequeñas y medianas empresas deben confiar en nuevos modelos de innovación y cooperación para su desarrollo tanto nacional como internacional.

PALABRAS CLAVES

Innovación, Open Innovation, Cooperación, Empresas Tradicionales.

DO WE TEACH WHAT WE RESEARCH? UNFOLDING ABSORPTIVE CAPACITY, OPEN INNOVATION, MANAGEMENT INNOVATION AND CLUSTERS

1. INTRODUCCIÓN

Dentro de la nueva visión del proceso de innovación ha surgido en esta última década un nuevo concepto llamado innovación abierta. El término creado como tal por Chesbrough en 2003, sugiere ante todo la reorganización en la empresa de ideas internas y externas, la filtración de información, la colaboración horizontal en procesos comunes con otros socios y una rápida absorción del conocimiento y el máximo poder de aprendizaje (Lichtenthaler, 2009; Kostopoulos, Papalexandris, Papachroni y Ioannou, 2010; Chesbrough, 2003).

La cooperación de varios intermediarios de diversidad cultural y con diferentes propósitos hace que el proceso de innovación contenga mayor riqueza y sea más valioso en términos de ideas y productos. Todo ello dependerá de cómo se lidera esa asociación (Pisano y Verganti, 2008) y de si existen barreras a la propiedad intelectual (Aboites y Cimoli, 2005).

Cuando se habla de innovación abierta, es decir, aquella que proviene de la cooperación y colaboración de diferentes agentes externos a la empresa, suele asociarse, en mayor medida, con empresas de software libre y alta tecnología. Una de las principales conclusiones del estudio de Cotec del año 2010 señala que los patrones de adquisición de conocimiento externo dependen de la intensidad tecnológica del sector y de la estrategia de innovación de la empresa. Así, las empresas de sectores de mayor intensidad tecnológica tienden hacia patrones de cooperación abierta y subcontratación de I+D, mientras que las de sectores de menor intensidad tecnológica tienden a patrones basados en la adquisición de activos.

En este campo de menor intensidad tecnológica como la industria alimentaria de productos tradicionales no se tiene claro en cuál de estos sistemas de innovación se circunscriben las empresas aunque sí sabemos que se refieren a empresas de baja tecnología (Gracia y Stamm, 2010). El carácter innovador de éstas suele ir ligado a innovación incremental aplicada al proceso, envase o logística a través de estrategias de joint venture y en muy pocas ocasiones viene de innovación en colaboración con otros agentes como el propio Gobierno o la Universidad. En este caso, nos hemos interesado en las empresas queseras de nuestra región dentro del sector agroalimentario, ya que su producto es, en todos los sentidos, tradicional y de gran arraigo en Castilla-La Mancha, característico de la zona y con relevancia internacional gracias a la denominación de origen[64] conseguida desde julio del 1982. La incorporación de España a la Unión Europea y la capacidad cada vez más fácil de exportar estos productos ha hecho que Castilla-La Mancha sea conocida a nivel mundial por estos productos estrella. El beneficio de las empresas productoras dependerá del esfuerzo que realicen en sus exportaciones, de la rapidez de producción y del nivel competitivo en las ventas a nivel mundial. Los productos artesanos tradicionalmente españoles, entre ellos el queso manchego, son productos muy imitados por competidores sobre todo extranjeros, que no cumplen con las garantías de calidad exigidas en nuestro país y que al no ser producidos en nuestra región no pueden obtener la denominación de origen.

Las empresas de Castilla-La Mancha no realiza grandes inversiones en I+D en comparación con otras comunidades y tiene un porcentaje pequeño en el total de datos españoles (INE, 2009), yendo a la cola en gastos de I+D, aunque se observa que en estos últimos años ha habido un crecimiento paulatino por parte de algunos agentes como es la Universidad.

Conociendo los datos anteriores se abren múltiples cuestiones a las cuales prestar nuestra atención. En primer lugar, tras el surgimiento de este nuevo modelo de cooperación en *innovación abierta* que está funcionando con resultados positivos en otros países e incluso en España cuando se trata de sectores de alta tecnología, nos preguntamos si este modelo puede ser adaptado a sectores tan arraigados a patrones de producción tan tradicionales como son las empresas queseras castellano-manchegas y a pequeñas empresas con estructuras de propiedad principalmente familiar. Si esta nueva visión de la innovación les permitirá conseguir un crecimiento en las ventas en nuestro país o en el extranjero. En segundo lugar es interesante conocer qué tipo de relaciones son frecuentes en esta clase de empresas, las cuales pueden ayudar a la cooperación en la innovación y qué formulas funcionan para el plan de innovación exitoso. Por último, nos interesa saber si la aplicación de la innovación abierta les ayuda en el desarrollo de nuevos productos dentro de los límites marcados por el Consejo de Denominación de Origen en cuanto a sus requisitos sobre producción, elaboración y materias primas.

[64] La superficie amparada por la denominación de origen «Queso Manchego» es de 4.419.763 hectáreas, en una serie de municipios que abarcan parte de las provincias de Albacete (21,66% de la comarca), Ciudad Real (33,16%), Cuenca (22,13%) y Toledo (23,05%), que constituyen la comarca de La Mancha.

2.PROCESOS ABIERTOS PARA LA INNOVACIÓN

Dentro de las estrategias que permiten competir en los mercados se encuentra el desarrollo de la innovación propia. En muchos casos, la empresa a la hora de elaborar un plan estratégico concibe esta opción como una decisión de alto coste y de inciertos resultados a largo plazo lo que supone un riesgo que muchas empresas deben controlar. Las empresas optan por disminuir ese riesgo estableciendo alianzas o a través de la cooperación, lo que les permite compartir sus costes y aumentar la rapidez en la consecución de sus resultados ya que saben que la innovación es un factor crítico para la supervivencia de las organizaciones (Morcillo y Calderón, 2011). Estos mecanismos hacen que se distribuya un flujo de conocimiento adquirido en diferentes campos mediante la colaboración y la comunicación, pero dicho flujo siempre dependerá de los atributos propios de la empresa y sus empleados tales como la capacidad de absorción o el aprendizaje que harán variar los resultados (Cohen y Levinthal, 1990).

El éxito de la innovación cerrada explica su persistencia en un escenario de conocimiento cambiante y fue exitosa en el siglo XX, pero hubo una serie de factores que mostraron las evidencias de que la trayectoria de este modelo debía de desarrollarse. En primer lugar, la creciente movilidad de los empleados o fugas de cerebros (brain drain), que hace que las ideas "nacidas y cultivadas" dentro de la empresa se vayan casi en su totalidad con sus creadores, hace que la difusión del conocimiento sea inevitable y pueda incluso beneficiar a otras empresas que, invirtiendo menos recursos y tiempo, obtengan mejores resultados gracias al capital humano. Además, la existencia del mercado de capital riesgo, que provocaba que las grandes compañías que formaban a sus empleados y les daban a estos investigadores el material altamente cualificado para sus objetivos no se apropiaran de los resultados ya que estos trabajadores eran tentados por pequeñas empresas de similares sectores que repartían sus beneficios en participaciones o acciones a los trabajadores según los resultados obtenidos (Chesbrough, 2009). Estas propuestas produjeron la salida de los investigadores dirigiéndose a estas empresas para continuar con sus investigaciones en condiciones más ventajosas de retribución las cuales no podían ser mejoradas por las grandes empresas.

Figura 1. Factores que corrompieron la innovación cerrada

Fuente: Elaboración propia a partir de Chesbrough (2009).

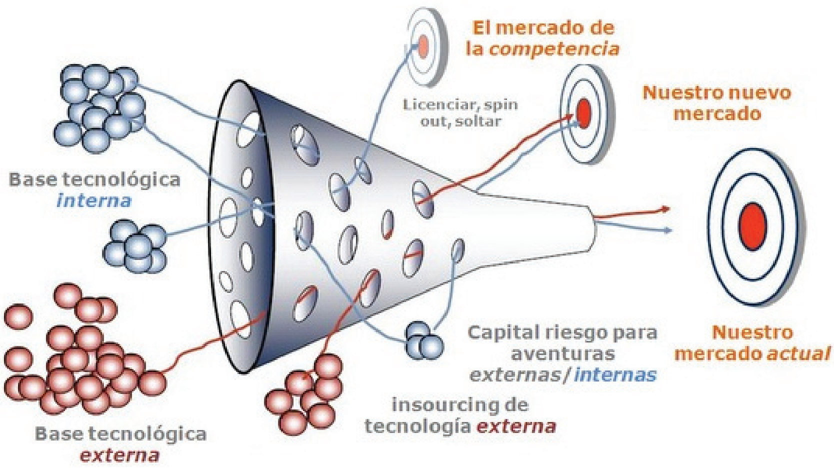
En tercer lugar, la selección de ideas y proyectos implica renunciar a muchas ideas surgidas que no se desarrollarán en ese momento, por costes o por no ser definida correctamente para que la dirección de la empresa las acepte. Este rechazo puede ser frustrante para muchos investigadores, que tentados por empresas de capital riesgo decidirán salir junto a su idea y que intentarán su lanzamiento en estas empresas que le ofrecen un empleo y lograr el éxito deseado.

Por último, la necesidad de acelerar los ciclos de desarrollo de productos o nuevos procesos se ha verificado como uno de los determinantes de la búsqueda de nuevos modelos de innovación. El tiempo se convierte en una variable estratégica en cuanto a innovación se refiere y las grandes empresas de alta tecnología observan cómo el desarrollo y producción de sus productos en poco tiempo y el lanzamiento de innovación incremental frecuente puede convertirse en una ventaja con respecto a la competencia (Cesar, Maccari y Abreu, 2011). De esta forma, si con anterioridad se seguían políticas de integración vertical gracias al surgimiento de proveedores especializados comenzaron a optar con la subcontratación que les permitía agilizar la elaboración de sus productos.

Desde la apertura de los mercados y la internacionalización de los negocios se ha planteado la comercialización, investigación y aplicación de la tecnología desde otro punto de vista. En muchos casos, los límites geográficos se han desvanecido captando así nuevas oportunidades mas allá de nuestras fronteras y antiguos conocimientos. Muchos de los trabajos teóricos revisados abogan por una innovación abierta que será más sencilla y rápida si las empresas utilizan el conocimiento externo (Chesbrough, 2003; Gassman y Enkel, 2005; González Sánchez y Fernández Muiña, 2011) y el retorno de la inversión en capital intelectual y de conocimiento será mucho mayor si las empresas comparten su conocimiento con otros. El movimiento hacia el *"Open Innovation"* tiene sus orígenes tanto "en la convergencia de diferentes campos científicos como en las ineficiencias de las actuales estructuras de los mercados de conocimiento" (Sandulli y Chesbrough, 2009). Además, la apertura del proceso de innovación es una necesidad por ambas partes: una parte que quiere comercializar y otra que quiere atraer ideas a su casa (Gassmann y Enkel, 2005). Las empresas no poseen todo el conocimiento que necesitan para desarrollar nuevos productos o mejorar sus procesos. Este problema es notoriamente significativo en aquellas empresas que operan en sectores industriales donde las teorías científicas se están unificando. Estas empresas necesitan buscar conocimiento externo en mercados donde la oferta y la demanda no son fácilmente visibles y esto puede permitir reducir efectos negativos de flaquezas internas potenciales de la empresa (Lichtenthaler, 2011).

La proliferación de bases de datos, plataformas web industriales, foros científicos, revistas científicas *online* combinados con el acceso a Internet, congresos a través de *streeming*, ha hecho que la información sea más económica y rápida de conseguir, y esa información nos lleve a nuevos conocimientos. En el proceso de innovación abierta, partimos de la figura de un embudo con membrana porosa donde se filtran los conocimientos internos, realizados en nuestros departamentos de I+D, mezclándose con los conocimientos externos en todas las fases de investigación y desarrollo del producto.

Figura 2 Modelo de Innovación Abierta.



Fuente. Javier Mejías de su blog www.javiermegias.es

Esta idea es una de las ventajas que puede obtener buenos resultados a través de este paradigma, ya que lo aplicamos a opciones reales (Vanhaverdeke, Van de Vrande y Chesbrough, 2008), como primera observación, podemos obtener beneficios cuando la empresa se encuentra en un ciclo de vida joven a la hora de captar nuevas oportunidades de negocios. En segundo lugar, podemos obtener ventajas al retrasar el compromiso financiero con la financiación de la propia empresa matriz. En tercer lugar, podemos obtener ventajas en la salida temprana de aquellos posibles fracasos que hace que las pérdidas no sean tan significativas para la empresa matriz. Y por último, a través de una estrategia de spin off podemos incluso desviar las posibles pérdidas generadas por estas pequeñas empresas no perjudicando directamente a la empresa principal.

Los beneficios obtenidos, si se produce el éxito, no son automáticos, ya que la empresa tiene que aprender nuevas habilidades y rutinas para desarrollar el potencial que permite la innovación abierta. Si no se puede disponer de un departamento exclusivo de I+D que tenga la máxima tecnología del mercado o no dispone del personal cualificado para un determinado proyecto o idea, se optará por realizar la subcontratación de una empresa externa que ayude en la investigación, es decir, "comprar" la I+D a otra empresa. El concepto de *hecho, comprado o ambos* dependerá sobre todo del sector en el que trabaje la empresa.

Cuando una organización utiliza este modelo de innovación en su negocio, empieza a conocer cuáles son los recursos valiosos de su empresa, y obtiene ventajas en la rapidez del desarrollo de nuevos productos (Chesbrough y Sandulli, 2009). El problema con este tipo de cooperación suele ocurrir cuando los intermediarios pueden ser posibles competidores. Por lo que el modelo suele ser exitoso cuando los recursos compartidos no son rivales para otros ni para la empresa, como por ejemplo la marca, el conocimiento tácito o la propiedad industrial.

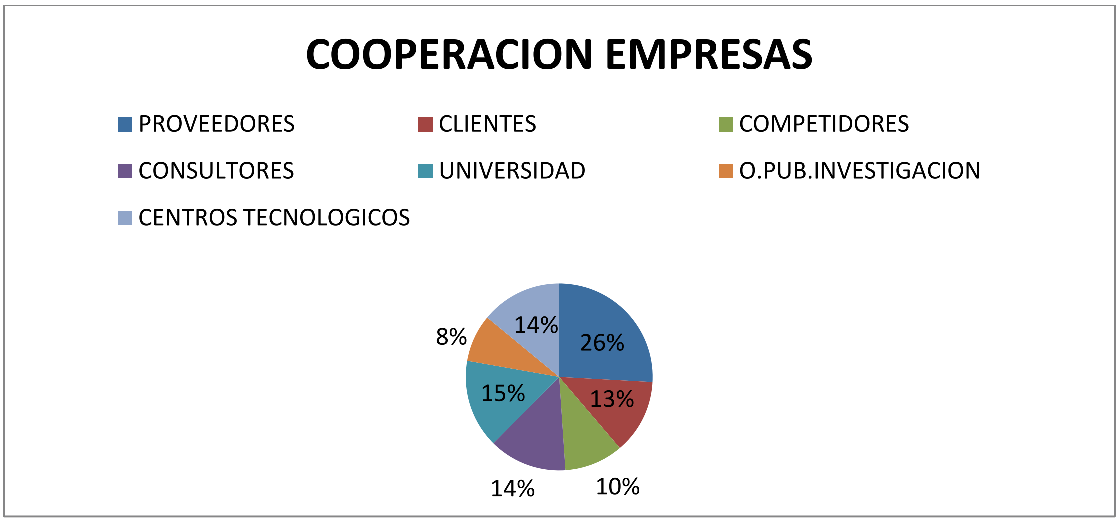
La apertura del modelo de negocio en las etapas de detección y validación de una oportunidad de trabajo está totalmente ligada a la innovación abierta, sobre todo por la aptitud positiva del empresario ante las novedades de desarrollo de nuevos productos y mejoras de los existentes en su portfolio.

3.DESCRIPCIÓN DE LA INNOVACIÓN EN SECTORES TRADICIONALES EN ESPAÑA

En nuestro país la innovación tecnológica está por debajo de la media europea. Gracias a los fondos europeos y a la creación de nuevas instituciones, hemos comprobado que ha aumentado la inquietud por invertir en innovación. Este hecho, junto al aumento de investigadores en las universidades españolas ha provocado un pequeño avance en nuestro país.

Las empresas españolas según los análisis empíricos suelen confiar más en la cooperación con sus agentes cercanos, es decir, proveedores y clientes (Figura 3) como fuente más segura y más conocedora de sus problemas. Pero en estos últimos años la Universidad ha realizado grandes aportaciones que las empresas han podido focalizar en sus negocios y en sus aplicaciones. Por ello, en estos momentos de crisis del sistema productivo es especialmente necesario redoblar los esfuerzos por parte de todos los agentes del sistema de innovación para lograr cuanto antes el objetivo establecido en el Pacto por el Desarrollo y la Competitividad de dedicar el 2% del PIB regional a los gastos en I+D y acercarse así al establecido en la Estrategia de Lisboa (Informe Socioeconómico de Castilla-La Mancha 2009, CES-CLM).

Figura 3. Cooperación de las empresas españolas en cuestión de innovación.

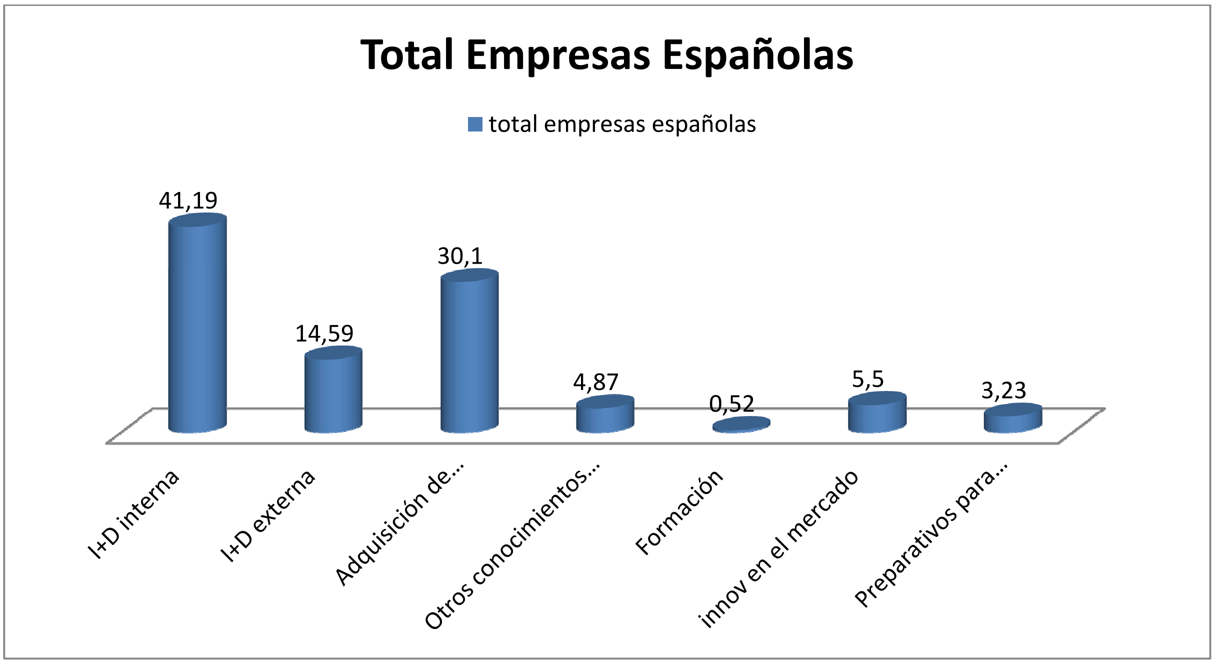


Fuente: INE (2009) Consejo Económico Social de Castilla-La Mancha.

Dada la importancia de analizar la región como lugar geográfico en donde se capta la innovación y se transfiere creemos que es necesario un análisis de cómo se encuentra nuestro país y qué datos presentan en sectores agroalimentarios para posteriormente analizar los datos del queso de denominación de origen como producto de referencia de nuestra comunidad y como estudio de producto tradicional familiar en nuestra región.

Las empresas españolas en su conjunto, confían en su mayoría en la innovación interna como fuente de conocimiento. Datos estadísticos del 2009 nos indica que casi un 41.19% del gasto de innovación se centraliza en la innovación interna frente al gasto de innovación externa que no supera el 15%. Para las empresas un gasto importante de innovación es la adquisición de maquinaria para mejorar sus procesos productivos. Es interesante destacar que la formación interna que mejora el reciclaje del personal y actualiza los conocimientos propios del personal es de solamente 0.52% del total del gasto[65] (Figura 4).

Figura 4. Distribución del gasto en actividades para la innovación tecnológica según clase de gasto en porcentaje



Fuente: INE (2009): Encuesta sobre Innovación en las Empresas.

Castilla-La Mancha se define como región intermedia dentro de la Unión Europea, caracterizada por una baja densidad de población y actividad económica (Méndez, Michelini, Romeiro, Sánchez Moral, 2009), y denominada así por situarse entre el 75% y el 90% de la media. Actualmente en España son región intermedia, además de Castilla-La Mancha, Andalucía, Murcia y Galicia las cuales percibirán ayudas de la Unión Europea, incluso después del 2012. La Comisión Europea ha propuesto destinar 39.000 millones de euros para apoyar durante el periodo 2014-2020 a las regiones

[65] Las **actividades para la innovación tecnológica** constituyen el conjunto de actividades que conducen al desarrollo o introducción de innovaciones tecnológicas. Incluyen las siete actividades siguientes: *Investigación científica y desarrollo tecnológico (I+D interna), Adquisición de I+D (I+D externa), Adquisición de maquinaria, equipos y software, Adquisición de otros conocimientos externos, Formación, Introducción de innovaciones en el mercado, Otros preparativos para producción y/o distribución (INE, 2009).*

de "transición", es decir, aquellas que no serán consideradas objetivo prioritario, pero cuya renta esté aún lejos de la media comunitaria, un PIB por habitante inferior aún al promedio y un comportamiento regresivo durante décadas, que sólo en fechas recientes ha invertido esa tendencia[66].

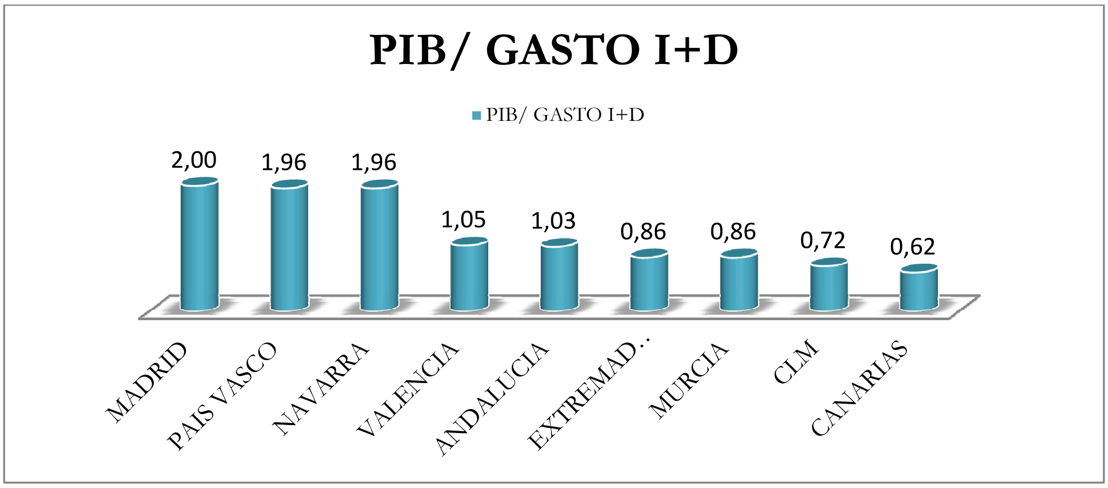
Castilla-La Mancha está aún lejos de ser considerada una región innovadora, en términos absolutos y comparando con otras comunidades autónomas. Aunque debemos indicar que esta región ha avanzado en todos los ámbitos gracias a las inversiones de los fondos estructurales europeos como FEDER, Fondo Social Europeo y Fondo de Cohesión que nos ha dado la posibilidad de aumentar nuestro I+D en la región. Lo que debemos preguntarnos es si esos fondos han sido bien repartidos y productivos. En estos años, Castilla-La Mancha junto a Extremadura, Andalucía y Galicia recibieron ayudas por su bajo PIB respecto a la media de Europa, pero hemos de indicar que esas ayudas han sido inferiores en nuestra región que en el resto de comunidades (por habitante y zona geográfica) y nuestro porcentaje de recursos humanos dedicados a la I+D es inferior que el del resto de comunidades (Guadalmillas y Donate, 2008).

El PIB de Castilla-La Mancha ha experimentado un continuo crecimiento entre los años 2001 y 2006, a un promedio anual del 3,5%, una décima por encima del crecimiento medio del conjunto de España, y claramente superior al 2% de crecimiento medio de la UE-25 y al 1,8% de la UE-15.

Si vemos la figura 5 que refleja el gasto de I+D con respecto al PIB de varias regiones indica que en España las regiones con mayor porcentaje son Madrid, País Vasco y Navarra. Estas regiones son precisamente las que implantan mayores iniciativas emprendedoras y en términos de innovación (CES, 2008). Las últimas regiones son Castilla-La Mancha, Canarias y Baleares que nos muestra en la región manchega una inversión de algo más de 229 millones de euros con respecto a la Comunidad de Madrid que invirtió 6.848 millones de euros o el País Vasco que fueron 1.780 millones de euros[67]

[66] www.elmundo.es. Consultado 5.07.2011.
[67] Datos del INE, informe publicado en diciembre del 2010 con datos definitivos del 2009, Encuesta sobre innovación en las empresas.

Figura 5. Gasto de I+D en porcentaje del PIB 2008 de varias comunidades autónomas



Fuente: Elaboración propia a partir de datos del INE (2009): Estadística de actividades del I+D.

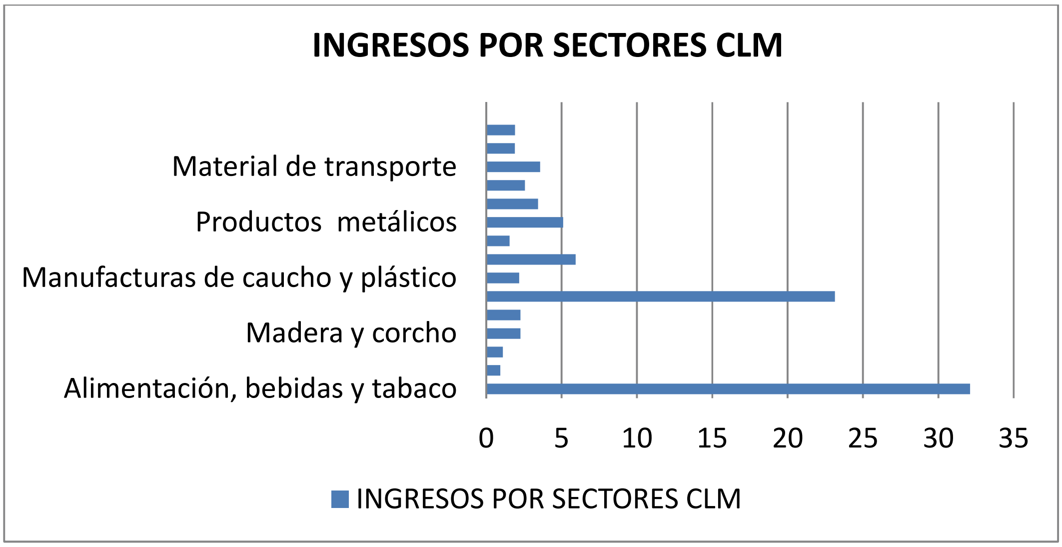
El sector agroalimentario en España representa el 18% del total de cifra de negocio del país y un 20% de las ventas netas totales que se realizan en el tejido empresarial nacional. Las empresas lácteas se encuentran entre los sectores de mayor negocio empresarial de estos últimos años con 9.439.105 miles de euros, un 1,9% del total del país (INE, 2009)[68].

La comparación de la composición sectorial de Castilla-La Mancha con la del conjunto de España mediante un índice de especialización relativa pone de manifiesto el alto grado de especialización de esta región en el sector alimentario (grupo 10,11,12) como uno de los tres sectores que nos dan mayores ingresos. En alimentación, con datos del INE (2009) en Castilla-La Mancha tuvimos unos ingresos de 5.584.662 euros. Un 32,1% del total de Castilla-La Mancha y respecto a España un 7,5%, una cuarta posición a nivel nacional por detrás de Cataluña, Valencia, Castilla León y Andalucía. El estudio de la descomposición sectorial de los intercambios comerciales permite extraer una primera conclusión: las compras y ventas a otras economías están concentradas en algunos sectores y ramas de manufacturas.

[68] Encuesta Industrial de Empresas 2009

En cuanto a qué partidas concretas de las producidas en Castilla-La Mancha son demandadas por el resto del mundo, el primer rasgo a destacar es la elevada concentración, aunque de magnitud algo más reducida a la del año 2008, pues sólo 20 producciones absorben el 50,9% de todas las exportaciones que realiza la región. Los sectores tradicionales destacan con mayor ventaja que el resto. Así el sector del vino sobresale como mayor demandado en 2009 por los consumidores extranjeros concentrando un 10,5% del total de ventas al extranjero. El queso y requesón (se encuentran ambos en el mismo grupo) se encuentra en el puesto 15 con un valor del 1,7 del total de ventas al extranjero.

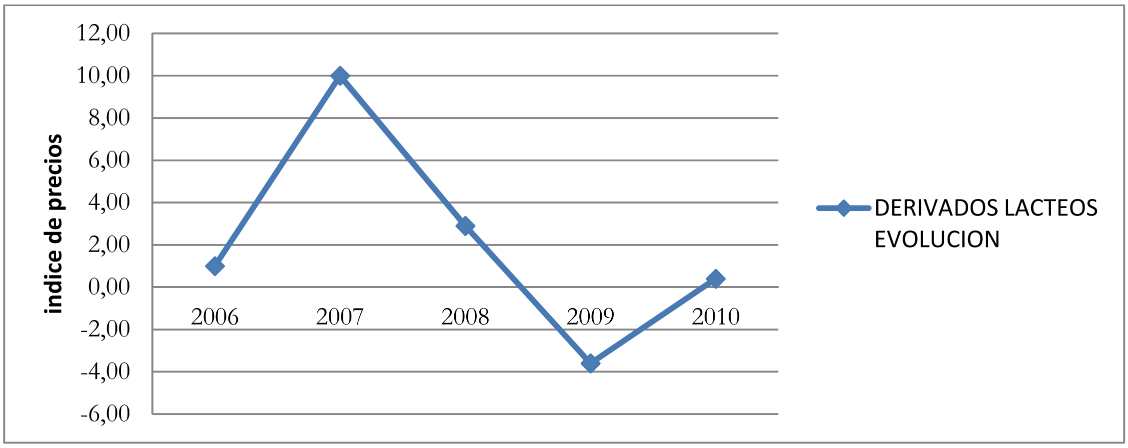
Figura 6. Ingresos en Castilla-La Mancha por sectores



Fuente: Elaboración propia a partir del INE (2009). Estadística sobre las actividades en investigación científica y desarrollo tecnológico (I+D).

La evolución del índice de precios de los derivados lácteos en estos últimos años (Figura 7) ha tenido una tendencia decreciente pero se prevé una remontada con respecto al año pasado que indica que se podrán incrementar las ventas con respecto a años anteriores aunque de forma más lenta y pausada.

Figura 7. Evolución del índice de precios de productos lácteos en España.



Fuente: Elaboración propia basado en datos de alimarket.com.

Si analizamos en sí el producto del queso manchego, como producto con denominación de origen, encontramos datos significativos y valiosos. En primer lugar, que la producción de queso manchego encabeza en producción total de quesos en España con denominación de origen, teniendo un 29,85% del total de producción española en sólo 75 queserías activas destinadas a ello. En segundo lugar, el queso manchego es el principal producto con denominación de origen vendido, no sólo en España sino también en Europa (siendo Alemania su mayor comprador) y otros países terceros (siendo EEUU su mayor comprador) y por último, es el producto lácteo con mejor valoración económica tanto a nivel nacional como en el extranjero

Por todos estos datos vemos la importancia de no perder cuota de mercado, ni bajar el ritmo de las exportaciones siendo el queso español mejor valorado.

En cuanto al contenido tecnológico, el sector de la alimentación está considerado como de baja tecnología (COTEC, 2010) y dentro del informe de transferencia tecnológica nos indica que las empresas de sectores de menor intensidad tecnológica tienden hacia patrones basados en la adquisición de activos y las empresas de sectores de mayor intensidad tecnológica tienden más hacia patrones de cooperación abierta y subcontratación de I+D. Del total de empresas alimentarias[69], 1.771 empresas,[70] podemos decir que 814 empresas utilizan la innovación interna para la mejora y

[69] Nos referimos a CNAE grupo 10,11 y 12; Alimentación, bebidas y tabaco. Ya que no se ha dividido en los resultados totales en los informes del Instituto Nacional de Estadística.
[70] INE 2009. Encuesta sobre Innovación en las empresas.

renovación de sus productos y solamente 459 empresas adquirieron innovación externa para desarrollo de su actividad empresarial, por debajo de la media de empresas españolas.

Cuadro 1. Datos principales de la producción de queso manchego en España

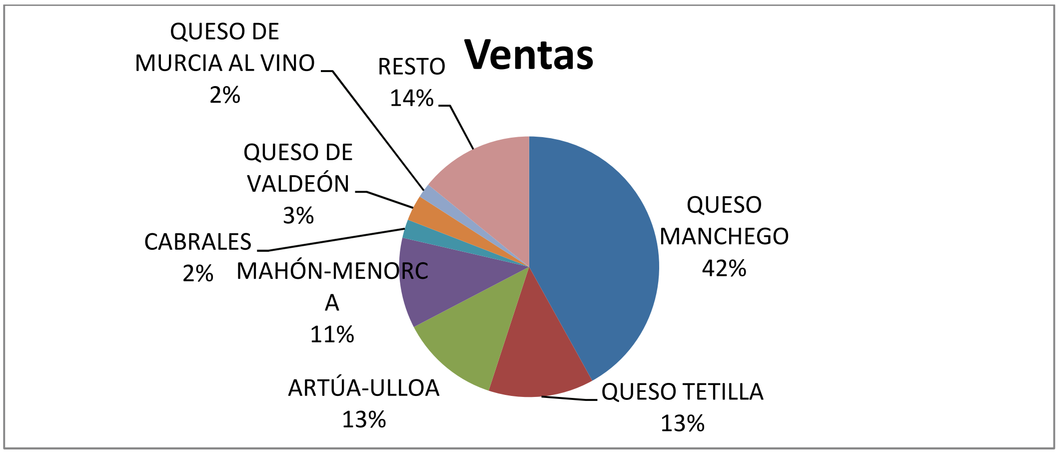
Producción	**Número de cabezas productivas**	**670.896**
	Industria explotación ganadera	1.553
	Empresas queseras	75
	Litros de leche procesada	44.075.070
	Litros leche destinada a la elaboración	34.000.230
	Kilos de queso total producido	8.341.691
Comercialización	Kilos vendido nacional	4.484.238
	Kilos vendidos a la unión europea	2.054.984
	Kilos vendido a otros terceros países	1.802.469

Fuente: Elaboración propia a partir de datos de Fenil 2008 (Federación Nacional de Industrias Lácteas)

La innovación en este campo debe ayudar a mejorar los datos económicos evidenciados o al menos contribuir a no reducir estos ingresos tan valiosos en nuestra comunidad, por lo que vemos importante este estudio para determinar si existe una cooperación abierta ante la innovación en un sector tan tradicional y tan valioso para nuestra región y aceptado de forma positiva a nivel mundial. En el Cuadro 1 vemos las características principales del queso manchego donde se mueve un gran volumen de kilos ya sea para la exportación como para el consumo nacional.

En la figura 8 que viene a continuación, se ve claramente la diferencia con otros quesos nacionales y la gran cantidad de valor económico que representa este producto, llevando la mayoría de la comercialización de quesos nacionales con denominación de origen. El conocimiento del queso manchego fuera de España, unido a los esfuerzos en promoción, divulgación y las acciones de internacionalización llevadas a cabo por las industrias han derivado en un continuo incremento de las exportaciones (López-Rey, 2007), por lo que creemos que las empresas productoras de queso manchego deben de mantener su producción con esfuerzos innovadores para mantener e incrementar el valor que la marca que ya es conocida e invertir en su distribución comercial.

Figura 8. Distribución de la comercialización total quesos D.O



Fuente: Elaboración propia a partir de datos de la Federación Nacional de Industrias Lácteas. 2008.

Como conclusión de los datos secundarios analizados podemos observar que en el segmento del queso manchego la inversión que se le está dando es inferior a otros productos alimenticios, incluso comparado con otros lácteos. Su influencia en ingresos obtenidos en la región de Castilla-La Mancha es considerable ocupando un séptimo puesto. Hemos detectado que existe un esfuerzo por parte de las empresas productoras lácteas de innovar y de acercarse a los gustos del consumidor y a los distintos estilos de vida, por lo que buscan satisfacer al cliente con nuevas mejoras. Por eso hemos tenido en cuenta en este trabajo la importancia de la colaboración de empresas pequeñas y medianas de producción con agentes externos que puedan ayudar a dar soluciones a sus problemas actuales.

4. EMPRESA LACTALIS FORLASA

Ante estos datos debemos aportar con nuestro método empírico la conducta que está llevando en nuestra región una empresa alimentaria que tenga una producción tradicional y familiar y su elaboración sea casi artesanal. Un producto conocido mundialmente y valorado de forma positiva a través de la exportación, tanto europea como en otros terceros países. Para el análisis de resultado proponemos el estudio de un caso concreto de nuestra provincia, donde el tema principal a tratar será el modelo de innovación utilizado en una empresa productora de queso manchego.

La información existente sobre la utilización del método de estudio de casos en investigación científica y sobre la forma de realizarse es bastante escasa (Martínez Carazo, 2006) además de ser una metodología utilizada con incertidumbre en la aceptación de resultados por su falta de credibilidad por muchos autores nombrado como “poco verídico y fiable” (Villareal y Landeta, 2010; Bonache, 1999). En cualquier caso una metodología empírica cuantitativa se basa en la confirmación de una hipótesis cuestionada mientras que un método cualitativo registra más las personas involucradas en el fenómeno y su actuación ante la situación que nos disponemos a estudiar. Con el método de casos, a medida que descubrimos nuevos hechos podemos cambiar los presupuestos teóricos iniciales y desarrollar unos nuevos. Según Yin (1989), el estudio de casos es un método apropiado para temas que se consideran prácticamente nuevos siempre que sigan unos criterios de validez y fiabilidad en sus resultados. Para la validez de las construcciones conceptuales este autor propone utilizar múltiples fuentes y establecer una cadena de evidencias y por último, hacer un borrador del caso que sea fielmente revisado por los “informantes” que sean expertos en el tema a tratar.

La empresa Lactalis Forlasa, está situada en Villarobledo (Albacete). Tiene una trayectoria brillante desde sus inicios en el año 1970 creada por Bernardo Ortega, padre de los últimos propietarios albaceteños, hasta la actualidad que ha sido absorbida en su totalidad el pasado 7 de julio del 2011 y empezó su fusión en Febrero del 2010, cerrando así una gama de productos completa para ser exportada a nivel mundial a través de la misma red logística que los productos originarios de procedencia europea. En estos momentos, forma parte de un grupo junto con otras empresas españolas situadas en diferentes partes del país dirigidas como filiales españolas, sus principales ejecutivos se encuentran en Madrid y la Junta de Administración y la empresa matriz se encuentra en Francia. Su actividad está inscrita como “La fabricación, transformación, exportación, importación, comercialización y distribución en los mercados nacionales y en los extranjeros, de queso, nata, mantequilla, yogurt, suero y todo tipo de productos lácteos…” (Informe de 2009. Registro mercantil).

Las ventas estimadas publicadas en el registro mercantil del año 2010 fueron de 137.574.843,01 euros. Las ventas reales del 2009 experimentaron un decrecimiento del 11,36% con un importe neto de ventas de 152.860.937 euros (-11,36% en porcentaje de crecimiento de ventas, la primera vez negativo desde el 2003). El número de empleados durante 2009 decreció un 1,97%. Consideramos estos datos totalmente normales debidos a la fuerte crisis económica iniciada en el 2007, donde el enfoque para su salida está en las exportaciones a países que no han sido tan afectados y gracias a la buena logística de la empresa francesa actual hará llegar el producto del queso manchego a otros mercados. Este es el objetivo principal de la empresa francesa que apuesta por la distribución en todos los países y por dar a conocer el producto con denominación de origen a cualquier rincón del mundo.

Hemos seleccionado esta empresa láctea por varios motivos importantes: en primer lugar, la empresa actualmente, con la compra de varias empresas españolas, es líder en ventas y es líder mundial en fabricación de *Queso Manchego con Denominación de Origen* y uno de los líderes del mercado de queso prensado. En segundo lugar, la empresa cuenta en la actualidad con más de 320 empleados, desde sus orígenes como empresa pequeña y tradicional hasta la actualidad que se considera multinacional. La evolución nos lleva a cuestionarnos acerca de cuál ha sido el proceso, si la innovación ha sido importante para este crecimiento y si las ventas han mejorado debido a ello. Según explica el Sr. Aurelio Antuña**,** Director general de la filial láctea española, la compra de LACTALIS FORLASA confirma la intención de reforzarse en el mercado español "y supone una garantía de continuidad y una oportunidad de desarrollo exterior de las marcas, que se beneficiarán de la presencia internacional en más de 160 países"[71]. La multinacional Lactalis, tras la compra de Forlasa, moverá más de 785 millones de euros. Además, ha cerrado otro acuerdo con una multinacional muy importante en el sector lácteo a nivel mundial como es Nestlé, por lo que actualmente podemos decir que Lactalis es el líder en su sector.

El método utilizado para nuestro análisis partió de una entrevista en profundidad realizada en el mes de septiembre con preguntas de varios aspectos que agrupamos en cuatro bloques: El primero el relacionado con la persona que entrevistamos y su forma de trabajo en el departamento que ocupa. En esta parte se pretendía averiguar datos y características de la empresa y el entrevistado que nos puedan ayudar en nuestro estudio en referencia a nuestra investigación. Debido a la absorción por la multinacional francesa LACTALIS S.A.de la empresa FORLASA S.A queríamos averiguar sus cambios de forma de trabajar en el departamento de I+D. En la segunda parte enfocamos nuestras preguntas hacia el concepto de innovación y a la identificación de carencias propias en este aspecto así como en el conocimiento de las nuevas plataformas de innovación. En la tercera parte nuestra entrevista se enfocó a la colaboración y cooperación con los diferentes agentes propuestos, sus preferencias a la hora de colaborar y los resultados más exitosos con esa colaboración. Y por

[71] Noticia extraída de www.infohoreco.es. Visitado 17.07.2011.

último, desarrollamos nuestro cuestionario para conocer aspectos del mercado y en concreto, exportación y gustos actuales del consumidor.

Como información complementaria a la obtenida con la entrevista personal a la empresa objeto de estudio decidimos captar información de otras fuentes relacionadas con el ámbito de nuestro análisis y que podrían estar representando a otros agentes del sistema de innovación. Así, por un lado nos dirigimos a un grupo de investigación especializado en cuestiones relativas a la producción láctea y por otro, a la administración con competencias en innovación en el sector de la empresa estudiada.

5.ANÁLISIS DE RESULTADOS

Tras analizar las entrevistas en profundidad y siguiendo las pautas indicadas hemos obtenido los siguientes resultados. En primer lugar y relacionado con la innovación, vemos que la cultura de la pequeña empresa familiar del sector lácteo en Castilla-La Mancha no está caracterizada por su orientación innovadora, de hecho, los entrevistados ven dentro de su sector poca iniciativa innovadora, con escasas oportunidades al ser un producto regulado. Las operaciones y estrategias de la empresa se basan en el éxito conseguido en estas últimas décadas y en la búsqueda de la maximización del beneficio con poca inversión. La actitud del empresario ante la innovación y su capacidad de absorción hará que esa innovación sea o no efectiva (Spithoven, Clarysse y Knockaert, 2010). El problema ha surgido en los últimos tres años con la crisis económica y la apertura de los mercados, las pequeñas industrias no han podido sobrevivir al no tener ninguna estrategia de innovación de mercado, y poco a poco han ido desapareciendo.

Aquellos que apuestan por la innovación tienen además una serie de limitaciones por ser un producto regulado con denominación de origen. El pliego de condiciones de su fabricación es muy estricto, el coste de la leche de oveja es costoso, por lo que la innovación en su proceso productivo es muy controlada ya que así se mantiene la calidad exigida por el Consejo de Denominación de Origen. La innovación aplicada en esta parte de la cadena de valor del producto debe ser a través de la automatización de maquinaria y mejora de la ya existente. Los empresarios queseros que tienen mejores rendimientos son los que intentan innovar a partir del método de producción indicando que los mejores resultados se consiguen en los cambios de presentación y formato, es decir, en la forma de su comercialización. Intentan cubrir nichos de mercado con pequeñas variaciones. Ahí está la clave del éxito del sector quesero, que en estos momentos de crisis económica tienen que buscar la diferenciación para competir con el resto de productos lácteos nacionales e internacionales. La empresa Lactalis Forlasa sí que reconoce que el consumidor ha variado en su exigencia de calidad ante un producto tradicional. La cantidad de información que recibe el usuario final hace que tenga un porfolio mayor de elección de productos e incluso exige que la calidad en este tipo de producto artesano y tradicional sea correspondido al precio que paga.

La empresa Lactalis Forlasa, ha sabido combinar la innovación cerrada creando sus propios departamentos de Investigación y Desarrollo, y cierta colaboración externa (Chesbrough, 2003).

Para incentivar la innovación que surge de la propia empresa suelen realizar reuniones periódicas los departamentos de producción, calidad y comercial y en ellas exponen sus propias ideas reflejo de sus percepciones de posibles mejoras de su producto conjugándolas con las iniciativas de agentes que colaboran en su cadena de producción con ellos: como son los clientes, proveedores, laboratorios externos y universidad. La empresa considera que con la cooperación externa consiguen un ahorro de tiempo y recursos en el lanzamiento del mercado de un producto mejorado (Teece, 1989; Hagedoorn, 1993). En segundo lugar, hemos evidenciado que, dentro de las fuentes externas de innovación, la colaboración se realiza con agentes no anónimos, es decir, con agentes que conocen y tienen algún vínculo especial con ellos. La cooperación es de forma puntual o no continua, a veces de forma casual y suelen cooperar para encontrar una solución a un problema o necesidad de mejora de su producto.

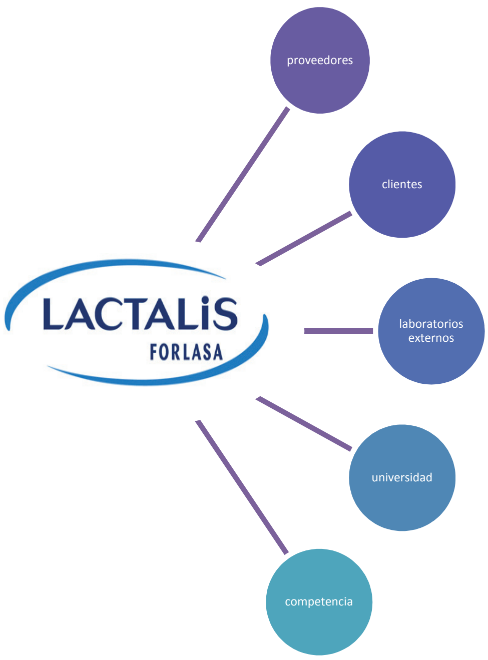
Los agentes colaboradores son de diferente índole, pero podemos resaltar como fuente de innovación a sus propios proveedores de suministro de maquinaria. Estos agentes externos son vínculos que permiten la validación y prueba de nuevas ideas, proyectos o forma de producción con beneficio para ambos colaboradores, ya que reducen los recursos necesarios para la puesta en marcha y amplían la escala y el alcance de sus experimentos(Sandulli y Chesbrough, 2009). La actitud por parte de los agentes proveedores es óptima a la colaboración ya que "ofertan" su conocimiento además de su producto que generará la innovación necesaria para avanzar en proyectos futuros. Si éste vinculo y sus resultados ante la innovación son positivos darán seguridad al proveedor en futuras relaciones.

También los clientes han acercado sus inquietudes a la empresa a través del departamento comercial. A través de los puntos de venta, ferias agroalimentarias o incluso página web han dejado sus comentarios que no han sido tomados en vano. Este vínculo es crucial para mejorar la comercialización en el queso manchego ya que el usuario indicará, con sus gustos, posibles cambios. Las propuestas implantadas ayudarán a mejorar la venta.

En tercer lugar, la relación con el Gobierno, en este caso, la Consejería de Agricultura, ha ayudado a desarrollar proyectos de innovación dando recursos financieros que ayudan a mejorar. Estas ayudas han dado un impulso en la producción, quizás por eso, la relación entre ellos suele ser para ambos positiva. Las administraciones intentan potenciar los proyectos que mejoran a las empresas agroalimentarias, y sus aportaciones son para todos, pero como hemos comentado depende en muchas ocasiones de la cultura innovadora que tenga la empresa.

Es frecuente que desde la administración se quejen de la falta de espíritu emprendedor por parte de este sector, e incluso algunas ayudas de cooperación no han sido otorgadas al ser un mercado en el que no se han creado novedades. Gracias a la contratación de asesorías o consultorías jurídicas que trabajan para la empresa quesera están al día del tipo de ayudas que pueden solicitar para la mejora de su producción y comercialización.

Figura 9. Cooperación abierta con agentes externos de Lactalis Forlasa S.A en orden según prioridad.



Fuente: Elaboración propia basado en las entrevistas a la empresa Lactalis.

Respecto a la cooperación con la Universidad es muy poca, sobre todo por la falta de información de la labor que ésta realiza. La empresa Lactalis Forlasa S.A colabora siempre que la universidad se lo pide en muestras de su producción para posibles investigaciones en laboratorios pero es por iniciativa de la Universidad que intenta contactar con ellos. La propia empresa no ve como agente colaborador permanente a esta institución ya que creen que existen otros agentes más cercanos a su problemática pero no ponen ningún inconveniente a los acuerdos con universidades e instituciones científicas que piden su opinión. Lactalis Forlasa observa que dentro de la formación académica que imparte la Universidad de Castilla-La Mancha, existe un vacío profesional para expertos en este sector, tan importante en nuestra región, que hace que muchos de los maestros queseros tengan que irse a buscar nuevos conocimientos o reciclaje de los mismos a otras regiones o países para conocer las nuevas investigaciones de este sector agroalimentario. Hemos identificado una fuente de información valiosa para la obtención de mejoras en las empresas del sector objeto de estudio. Se trata del grupo CLYDE dentro de la universidad de nuestra región, el cual viene realizando una intensa investigación en este campo y puede ser considerado un "proveedor especializado de conocimientos". El grupo CLYDE, es denominado así por dedicarse en su origen a la investigación sobre la "calidad de leche derivados", se dedican a la investigación agroalimentaria sobre todo del sector quesero. Sus investigaciones se han centrado en la caracterización de leche de oveja y derivados lácteos (queso manchego, yogurt, etc.), en la calidad higiénico-sanitaria de leche y en el diseño de nuevos derivados lácteos. A través de su *Planta Piloto de Procesado de Lácteos* mantienen y aumentan la transferencia tecnológica que el equipo científico que está realizando hacia distintas industrias lácteas, fundamentalmente de nuestra región. Para ello el equipo, perteneciente al grupo de investigación CALIMENTA, facilita al tejido empresarial lácteo de la región, principalmente PYMES, la posibilidad de participar en actividades de I+D[72].

La colaboración estrecha con este grupo incentiva al desarrollo de nuevos productos y mejora de los mismos dentro del marco de la producción láctea. Aquellos empresarios de este sector tan tradicional y artesano tendrían que ver este grupo como una oportunidad a la innovación accesible por sus recursos tan económicos y con la última tecnología. Además el grupo mantiene una estrecha colaboración con el Consejo Regulador de la Denominación de Origen Queso Manchego y con diversas asociaciones queseras, que han manifestado en varias ocasiones su interés en que la Universidad desarrolle actividades formativas para el sector, entre otros la formación a través de un curso para maestros queseros de la región de Castilla-La Mancha. Toda la información que compenden estos grupos hace que el conocimiento sea más rico y aprovechado por aquellas empresas que carecen de recursos para iniciar una investigación más profunda.

[72] Noticia de la página web de la UCLM. Visitada día 7 de julio de 2011. www.uclm.es

El consejo de denominación de origen que hemos mencionado es un nexo de unión perfecto entre las empresas queseras, instituciones públicas, universidad e incluso clientes. Es el órgano encargado de vigilar el uso de la Denominación de Origen Protegida, velando por que los quesos amparados por ella cumplan los requisitos de calidad y procedencia establecidos en sus especificaciones técnicas de calidad. Certifica que todos los quesos identificados como *Manchegos* reúnen las características técnicas para ser considerados como tales y promociona el producto, informando a los consumidores de sus cualidades y de la conveniencia de considerarlo como parte importante de su alimentación. La cooperación con este organismo de los múltiples agentes hace que exista flujo de información de las carencias de los maestros queseros y de lo que las instituciones públicas pueden ofrecer. Además el consumidor de este producto podrá comprobar cuales son las características específicas del mismo para evitará el consumo de imitaciones por parte de otras empresas tanto nacionales como internacionales.

Cuadro 2. Resultados obtenidos: Evidencias obtenidas

RESULTADOS OBTENIDOS
Innovación de producto escasa por su limitaciones regladas por el C.R.D.O.
Cultura del empresario tradicional con aversión al riesgo y al crecimiento.
Innov. de producto incremental y orientado en las presentaciones del producto.
Cooperación abierta con agentes externos con vínculos de confianza.
Cooperación preferente con proveedores de equipo y con clientes
Cooperación abierta con el Gobierno que facilita Recursos.
Desconocimiento de la Universidad como fuente de innovación.
Gran competencia en el sector quesero tanto nivel nacional como internacional.

Fuente: Elaboración propia.

La colaboración con empresas competidoras no entra dentro de sus opciones al poder dar pie a imitaciones y que las empresas seguidoras busquen a través de él nuevos conocimientos que a Forlasa no le interese mostrar.

En cuarto lugar, la valoración del producto a nivel mundial es una ventaja para la exportación, eso es visto tanto en Ferias como en la distribución de este producto, pero la rivalidad con otros quesos más económicos nacionales e internacionales [73] hace que el queso manchego de denominación de origen sea considerado como un *queso gourmet*. Lactalis Forlasa gracias a su extensa red de distribución por todo el mundo ha apostado por la exportación como producto *delicatesen* de este producto utilizando sus canales de distribución ya consolidado en mercados internacionales de este producto y de otros quesos de mezcla para conseguir así mejorar sus ventas.

La multinacional láctea apuesta por el modelo de innovación abierta y cree que la mejora de este producto tan reglado viene en la presentación del producto en sí, un formato que diferencie del resto de competidores de otros países con alta producción en este tipo de quesos. Con el comercio internacional aumentan las ventas en otros países cuando el consumo nacional ha caído. La orientación actual tiene que ajustarse el nuevo comprador que busca formatos reducidos y mayor comodidad en el consumo, pero conservando el modelo tradicional y de calidad del queso.

El modelo de innovación abierta es aplicable a los sectores tradicionales e incluso necesarios para la supervivencia del sector, ésta es una conclusión a la que llegamos tras el estudio de un sector tradicional que ve con la apertura de los mercados una barrera de crecimiento y un temor a la desaparición de las más débiles. Las empresas fuertes y bien posicionadas en el mercado ven a través de la exportación una nueva ventana que hará que su producto sea conocido en más países. Forlasa apostó, gracias a la fusión con la multinacional francesa Lactalis, en poder adelantar así a todos sus competidores y vio, gracias a una logística consolidada, el conocimiento de nuestro queso manchego más allá de nuestras fronteras. La empresa percibe que la innovación es necesaria e importante para seguir en los mercados alimentarios, ya que creen que toda empresa debe de estar en un proceso de reforma continúa, ya sea con conocimiento interno si existen recursos para ello y con colaboración externa si existe carencias de tales recursos. La combinación del conocimiento interno y externo hace que el producto sea exitoso ya que combina la innovación de nuestros propios departamentos y de nuestras limitaciones productivas con ideas de agentes que pueden asesorarnos tanto de dentro del sector como de fuera.

La estrategia de la bajada de precios, como plan agresivo de comercialización en este tipo de empresas es impensable si se quiere mantener la calidad. El éxito de los sectores agroalimentarios

[73] Los quesos de mezcla o producidos en su totalidad con leche de vaca son más económicos que los quesos manchegos realizados 100% con leche de oveja, esto es un hándicap a la hora de competir dentro de una selección de quesos que pueda mostrar una gran superficie.

con productos tradicionales será siempre la diferenciación mejorando la calidad de la presentación e incluyendo novedades en formatos para atraer a nuevos consumidores. Las pequeñas empresas deberán de potenciar la fidelización del cliente en este tipo de producto y el conocimiento de la marca que abrirá nuevas oportunidades en mercados extranjeros.

6.CONCLUSIONES GENERALES

El paradigma de la innovación abierta, nombrado así por Chesbrough en 2003, siempre ha llevado una connotación de aplicación a sectores altamente tecnológicos. Con este trabajo hemos identificado que también es aplicable a sectores tradicionales de baja intensidad tecnológica. La empresa logrará conseguir sus objetivos en el marco innovador a través del desarrollo de conocimiento interno de todos los departamentos de la empresa, incentivando la cultura innovadora y la comunicación de todos sus miembros. Además, deberán de tener en cuenta aquellas fuentes de innovación externas que se encuentran más próximas a ellos y que conocen su producto para captar ideas y así agilizar los tiempos de investigación. Si se lleva a cabo la colaboración y asociación con otros agentes externos obtendrán riqueza y soluciones efectivas no resueltas internamente. La cooperación externa debe de llegar de diferentes campos, pero serán aquellos en donde existen vínculos de alta confianza los que ofrezcan mayor fiabilidad para la empresa. La capacidad de absorción por parte de los recursos humanos y la actitud emprendedora enriquecerá todas las fuentes de innovación que ofrezcan sus conocimientos.

Hemos analizado empresas de nuestra región del sector agroalimentario, por ser un sector donde el contenido tecnológico no es un descriptor de su naturaleza productiva y nos hemos centrado en nuestro estudio en las empresas de producción láctea, en este caso, la producción de quesos manchegos con denominación de origen, los cuales tienen una producción ligada a normas de calidad estricta y difícil modificación. Como ya hemos señalado, la empresa productiva es el eje y núcleo central del sistema, puesto que es en ella donde se produce y radica la innovación para lo cual se nutre del aporte de intervenciones y actividades que se desarrollan en el curso del proceso innovador, incluidas las que se realizan en el seno de la propia empresa y de los mecanismos de orientación y apoyo que proporciona el Estado, la Universidad, y aquellos agentes que conforman su círculo de flujos de información, que con la incorporación de las nuevas tecnologías se ha hecho mayor y proporciona mayor riqueza en la comunicación.

7. LIMITACIONES DEL TRABAJO Y LÍNEAS FUTURAS DE INVESTIGACIÓN

Entre las limitaciones del trabajo podemos destacar las atribuibles al método del caso. En nuestro análisis se ha contado sólo con una empresa determinada y se ha complementado en algunas cuestiones con entrevistas a agentes relacionados con la innovación en el sector como la Universidad o la Administración. Aunque se ha utilizado información secundaria difundida por el Consejo Regulador, sería interesante tener también el punto de vista del Consejo Regulador del Queso Manchego como fuente primaria, para saber su opinión sobre la innovación y la colaboración en el sector quesero de la región manchega.

Por otro lado, también sería interesante entrevistar a proveedores de las empresas lácteas, desde ganaderos que suministran la materia prima, ingrediente principal de este producto, como a aquellos que suministran la maquinaria para la producción y estudiar la comunicación que establecen con las empresas y su actitud ante la investigación.

La empresa seleccionada para este estudio ha sido una empresa productora de queso manchego. Este producto, como hemos comentado, tiene denominación de origen registrada en esta comunidad. Hemos observado que las empresas lácteas manchegas además de desarrollar el queso manchego, elaboran otros quesos de mezcla con materia prima de otras ganaderías, así han abaratado costes y han podido tener mayores márgenes para la innovación con la posibilidad de modificar su composición. Las empresas han introducido variaciones en la composición de este tipo de quesos, aplicando mayor innovación y variedad sin la intervención por parte del C.R.D.O., desarrollado incluso una gama de productos muy acordes con los gustos del consumidor actual. Las empresas de fabricación de queso de mezcla podrían complementar nuestro análisis de casos aportando más riqueza y más datos interesantes para la innovación abierta en este tipo de producto.

Tras iniciar el estudio con Lactalis Forlasa s.a sería interesante poder desarrollar para futuras investigaciones un estudio longitudinal para analizar en la empresa si la situación en cuestión de innovación ha cambiado. Si se han desarrollado incursiones en las nuevas tecnologías y si ha mejorado la cooperación externa. En el caso de la empresa LACTALIS FORLASA veríamos la influencia de la multinacional en estos aspectos y desarrollaríamos un estudio sobre la innovación y la integración de otras culturas tras la absorción empresarial.

8. RECOMENDACIONES PARA LA UNIVERSIDAD Y EMPRESAS

Tras desarrollar nuestra investigación, hemos destacado unos aspectos que vemos interesantes a aportar a diferentes actores dentro del marco de la innovación. Hemos comprobado que la sociedad busca dentro de la educación carreras y estudios adaptados a las necesidades de cada región. En este caso, se busca un apoyo docente en el campo de sector agroalimentario, y formación específica en campos de la industria quesera, ya que las empresas lácteas necesitan renovar sus conocimientos y buscan recursos humanos preparados para ser maestros queseros dentro de Castilla-La Mancha. Los empresarios buscan capital humano que sepa responder a los retos del entorno global en el que nos movemos actualmente, y que sea conocedor de las nuevas tecnologías. No existe un plan de estudios específico para el sector lácteo que aportaría relevancia a nuestra comunidad y permitiría la transmisión del conocimiento de la universidad a aquellas industrias que se dedican a la elaboración tradicional del queso manchego.

En segundo lugar, hemos comprobado que un temor de los empresarios es la imitación de su producto de denominación de origen por parte de competidores extranjeros o empresas que no tienen reglada su producción. En este caso el Gobierno debe plantearse la opción de sancionar a aquellos que impulsan las imitaciones y comunicar al consumidor los detalles que revelarán cuando es original y cuando una copia. No podemos obviar este problema ya que el empresario de producción quesera tiene altos costes en materia prima y cualquier imitación compite en precio por abaratar los costes y el producto. Las empresas competidoras imitadoras e ilegales ante la falsificación no cumplen con la composición al no seguir el pliego de condiciones que el Consejo obliga para su sello de calidad y denominación de origen. Además, nuestra administración deberá de incentivar a las pymes que por su carácter familiar y artesanal, no destacan en su labor exportadora. Deberá estimular las ayudas de cooperación de la universidad y la empresa con medios que mejoren la capacidad de investigación con pequeñas inversiones.

En tercer lugar, tras nuestro contacto con este sector, hemos comprobado que, en general, los empresarios son muy reacios al cambio y tienen gran arraigo a las tradiciones. La cultura del empresario de este sector no ve la innovación como factor potencial del cambio y de la mejora de resultados. Pensamos que esta característica no es positiva, así, consideramos que el empresario deberá de perder la aversión al riesgo para poder hacer frente a los competidores y superar la crisis económica que hace que la venta cada vez sea más difícil. La mayoría de las empresas lácteas de nuestra región son muy pequeñas y familiares pero esto no es excusa para no prestar atención al desarrollo de un pequeño plan estratégico de innovación y de crecimiento de la empresa. Con este plan crearía unas pautas que le ayudaría a desarrollar los objetivos de la empresa, que se darían a conocer a su capital humano y permitiría la colaboración de todos para incentivar la innovación empresarial. Además, nuestros empresarios deberían ser receptivos a cualquier propuesta recibida de agentes externos a él como proveedores, clientes y empresas competidoras, ya que buscando la cooperación de pequeños grupos se podrían realizar pequeños cambios que ayudarían a la venta.

Vemos que los productos con denominación de origen tienen un margen muy pequeño para la novedad en su producto pero destacamos que muchas empresas con inquietudes realizan innovaciones incrementales que están dando grandes resultados. Este sector debe saber que el resultado de su esfuerzo no termina en la elaboración del producto sino que dependerá también de su trabajo comercial, de la presentación del producto y de los canales de exportación. Es decir, el papel del marketing es importante para un producto artesanal y tradicional que abrirá nuevas vías de mercado que incrementarán sus beneficios en la venta dentro y fuera de nuestro país en estos momentos tan difícilespara las Pymes.

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LA LÓGICA DOMINANTE DEL SERVICIO: UN PARADIGMA EMERGENTE QUE HA CAMBIADO EL PENSAMIENTO MODERNO DE MARKETING

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Resumen del artículo

El presente trabajo describe y analiza la perspectiva más moderna que nos ofrece la ciencia de marketing. Los entornos empresarial y científico han coincidido en el tiempo para identificar las necesidades del entorno empresarial, surgiendo así la Lógica Dominante del Servicio como una nueva perspectiva que integra y supera el previo paradigma de marketing relacional, dando un nuevo sentido a las relaciones y redefiniendo, desde una perspectiva moderna, conceptos clásicos como el valor, el producto o el papel del consumidor.

Palabras clave:

Marketing, nuevos paradigmas, marketing relacional, lógica dominante del servicio, innovación abierta.

Abstract

This study describes and analyses the most modern perspective offered by the science of marketing. The business and scientific environments have come together to identify the needs of the business environment, giving rise to service-dominant logic as a new perspective which incorporates and exceeds the previous paradigm of relational marketing, giving a new meaning to relationships and redefining, from a modern perspective, classic concepts such as value, the product and the role of the consumer.

Keywords:

Marketing, new paradigms, relational marketing, service-dominant logic, open innovation

1. INTRODUCCIÓN.

Los trabajos realizados en el Área de Marketing se han ocupado de resolver una cuestión aparentemente simple, ¿qué venden las empresas? Esta pregunta ha sido respondida de maneras diferentes a lo largo del tiempo. Existen distintos enfoques dentro de la disciplina que han abordado la pregunta basándose en premisas diferentes. Pero, sobre todo, las respuestas han cambiado como consecuencia de los cambios que experimenta el contexto en el que operan las organizaciones.

En la última década, el desarrollo de las tecnologías de la información y la comunicación ha originado nuevas condiciones para la generación de valor en la economía y el intercambio de valor entre las empresas y sus clientes. De manera consecuente, se aprecian cambios en las soluciones que las investigaciones en marketing ofrecen a la pregunta original planteada. De esta forma, planteamos una revisión de una selección de trabajos de máxima relevancia que inducen a plantear la posibilidad de la emergencia de un nuevo paradigma en el marco teórico del Marketing. La Lógica Dominante del Servicio (LDS) surge para reconsiderar algunos postulados básicos de lo que denominamos la Lógica Dominante de Bienes (LDB).

Estos trabajos coinciden en el tiempo con iniciativas empresariales orientadas a reformular sus estrategias desde la perspectiva de considerar servicio todo valor generado dentro de una organización.

En este artículo se describe la convergencia académica y empresarial en la descripción de los principales cambios que significa la LDS frente a la LDB. Igualmente, se destaca la necesidad de incorporar el nuevo enfoque en el diseño de los programas académicos impartidos en los grados universitarios.

2. DE LA LÓGICA DOMINANTE DE BIENES A LA LÓGICA DOMINANTE DE SERVICIOS.

El trabajo “Breaking free from product marketing”(Shostack, 1977), es considerado el punto de partida de la concepción del marketing de servicios como una línea de investigación diferenciada. Desde entonces y hasta iniciado el siglo XXI, se ha trabajado sobre la premisa de que bienes y servicios son productos diferentes y merecen ser gestionados de manera distinta. Durante este periodo de tiempo, las Universidades y Escuelas de Negocios han ido ampliando el espacio dedicado al marketing de servicios dentro de los programas académicos. Estos programas asumen que los servicios, a diferencia de los bienes, son intangibles, inseparables, heterogéneos y caducan con mayor rapidez (Zeithaml y Bitner, 2005; Grande, 2005).

Sin embargo, existe actualmente una línea de trabajo que cuestiona las diferencias entre bienes y servicios, y, especialmente, el hecho de que las características referidas sean exclusivas de los servicios. El trabajo de Lovelock y Gummesson (2004) cuestiona cada una de las características vinculadas de manera exclusiva a los servicios y concluyen que el debate "bienes versus servicios" que tiene su origen en los años 70 y se desarrolla en la década de los 80, fue útil y fructífero en aquél contexto. Sin embargo, la irrupción de Internet y las nuevas tecnologías de la información y la comunicación han cambiado por completo la forma de concebir los productos.

También en el año 2004, los profesores Stephen L. Vargo y Robert F Lusch, tras dos años en proceso de revisión y prácticamente una década de trabajo (según declaraciones del propio autor http://www.sdlogic.net/multimedia.html), publican en la revista Journal of Marketing, de la American Marketing Association, referencia mundial de la gestión e investigación de marketing, el artículo "Evolving to a New Dominant Logic for Marketing". En este trabajo, los autores hacen referencia por primera vez a la LDS y ponen de manifiesto la necesidad de que sea la perspectiva de los servicios, y no la de los bienes, la que explique el intercambio económico. Desde su publicación, éste artículo ha sido el más citado de la revista en la última década. Los investigadores científicos más prestigiosos del mundo en el ámbito del marketing de servicios han adoptado mayoritariamente esta teoría (Gummesson, 2010; Ballantyne, 2008, etc.); se han organizado foros a nivel mundial, entre los que resulta especialmente destacado el Ontago Forum sobre la lógica DS organizado por David Ballantyne en 2005, 2008 y la reciente cumbre de diciembre de 2011. Los profesores Stephen L. Vargo y Robert F. Lusch,en su trabajo "Evolving to a New Dominant Logic for Marketing", ponen de manifiesto la necesidad de adoptar un nuevo enfoque en Marketing, en el cual la perspectiva de servicios explique el intercambio económico. Así, los servicios no deberían considerarse procesos que complementan la entrega del bien creando un valor añadido, sino que son el principal valor del intercambio.

De manera paralela al terreno científico, desde el ámbito empresarial se ha percibido la necesidad de cambiar la manera de interpretar el intercambio de valor que propone a sus clientes. IBM ha sido pionera en el reconocimiento de la importancia de la perspectiva de servicios. En el año 2004, Jim Spohrer, responsable de crear un Departamento de Investigación del Servicio en la compañía informática, identificó problemas para incorporar candidatos que tuvieran formación en informática, ingeniería, gestión y ciencias sociales. Esta dificultad la compartió con Henry Chesbrough, profesor de la Universidad de Berkley y que había escrito en el año 2003 la obra "Open Innovation. The New Imperative for creating and Profiting from Technology". Chesbrough atendió a la solicitud de consejo, argumentando que IBM fomentó el desarrollo de la ciencia informática en los años 40 y 50 a través de la donación de ordenadores a las universidades y facilitando la formación para que los alumnos aprendieran a utilizarlos, así que, le respondió, "si IBM inició la ciencia informática, tú deberías iniciar la ciencia del servicio"[74].

Esta idea fue asumida por IBM con gran entusiasmo y en la actualidad existen 450 universidades de todo el mundo que ofrecen algún tipo de programa relacionado con la formación en gestión de servicios. Desde la Universidad de Berkley y Carnegie-Mellon University en Estados Unidos hasta el Karlsruhe Institute of Technology en Alemania, la Universidad Aalto en Finlandia y la Universidad Nacional Cheng Chi en Taiwan. IBM provee ayudas financieras y asigna investigadores que facilitan la implantación de sus programas en las Universidades.

IBM: *ORIENTACIÓN AL SERVICIO*

En los años 90 IBM toma conciencia de la necesidad de involucrar al cliente en el desarrollo de nuevas tecnologías. Con este fin crea la Organización de Servicios IT. En 2002 IBM compra la consultora PricewaterhouseCoopers, naciendo así IBM Global Business Services. Por otra parte IBM Research es pionera en la creación de la Ciencia del Servicio. Desde entonces, IBM ha incrementado su porcentaje de participación en negocios de servicios y software un 80 %. En el año 2009, creó el departamento de Business Analytics and Optimization Services con 4000 personas. El cambio de orientación supuso una recompensa inmediata: en 2010 IBM batió record de beneficios.

La creación de un centro de investigación en servicios y la difusión mundial de estos conocimientos no es altruista. Según los propios directivos de IBM, nacen de la necesidad de personal con esta

[74] *http://www.ibm.com/ibm100/us/en/icons/servicescience/*

formación para trabajar en su empresa. De la misma manera que, en su momento, se involucraron en la formación de estudiantes con conocimientos informáticos, IBM busca un tipo de profesional que entienda que el cliente ha de estar más implicado que nunca en todo el proceso de creación de valor de la empresa: desde la idea inicial hasta que el producto lega a manos del cliente. Así nace el concepto moderno de prosumidor que sustituye al tradicional "consumidor", introduciendo un valor colaborativo en su significado.

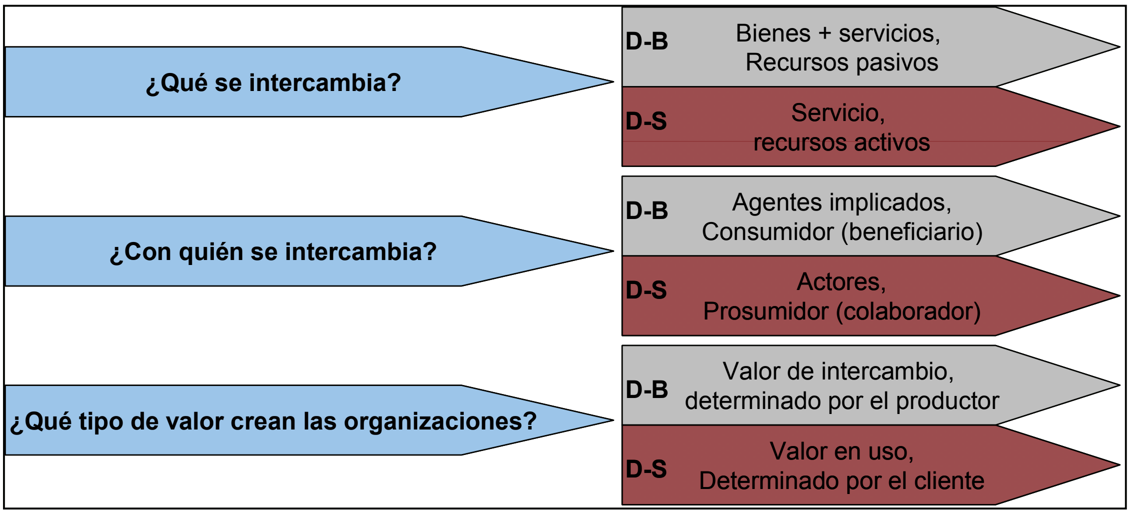
Así, el entorno profesional y científico han convergido en visiones similares, coincidiendo en la interpretación de los cambios referidos en cuanto a lo que se intercambia y cómo se intercambia en los mercados y, por lo tanto, indican la idoneidad de construir nuevos modelos de gestión adecuados a las condiciones del entorno actual.

3. CARACTERÍSTICAS DE LA LÓGICA DOMINANTE DEL SERVICIO

La LDS se presenta como un nuevo paradigma de carácter emergente cuya premisa de partida consiste en comprender que los servicios no son procesos que complementan la entrega del bien creando un valor añadido, sino que son el principal valor del intercambio.

Esta afirmación tiene numerosas consecuencias en la gestión de marketing, En primer lugar, se registran cambios conceptuales que derivarán en cambios de la terminología empleada. De igual modo, supone redefinir cuestiones tan fundamentales en la ciencia del marketing como ¿qué se intercambia? ¿con quién se intercambia? ¿qué tipo de valor crean las organizaciones? (Figura 1)

Figura 1. *Aspectos clave en la diferenciación entre la lógica D-B y la lógica D-S.*



Fuente: elaboración propia

- ***¿Qué se intercambia?***

Desde la LDB, el producto se considera "todo aquello que pueda ofrecerse en el mercado para satisfacer un deseo o una necesidad" (Kotler, 2006, p. 388), y supone la "unidad de intercambio". La nueva perspectiva interpreta, sin embargo, que el objeto del intercambio es el "servicio". Este concepto, en singular, es diferente a los "servicios" como una categoría de producto intangible. Actualmente, se entiende que el eje del intercambio es el servicio que Vargo y Lusch (2008, p. 26) lo definen como "la aplicación de competencias especializadas (recursos activos, conocimiento y habilidades) a través de actos, procesos y actuaciones para el beneficio de otra entidad o de la propia entidad". Por lo tanto, el resultado no son "unidades de output", sino que refleja el proceso de hacer algo que resulta mutuamente beneficioso para las partes que interactúan.

Desde este enfoque, bienes y servicios no son diferentes formas de producto. Si bien desde la LDB, los bienes eran considerados productos tangibles, desde la LDS son vehículos transmisores de servicio (conocimientos, habilidades de una organización). Así, el servicio es el denominador común del proceso de intercambio; siempre se intercambia servicio. Los bienes, cuando aparecen, son elementos que ayudan al proceso de provisión del servicio.

Este cambio es el resultado de una evolución del marketing de servicios al marketing relacional y del marketing relacional a la lógica D-S, más adaptada a interacciones e intercambios que aparecen con la irrupción de las nuevas tecnologías e Internet como herramienta de conexión.

El cambio de enfoque desde producto a servicio supone una nueva manera de entender los recursos. Desde la LDS los recursos son elementos activos, de tal manera que la creación de valor tiene lugar cuando un recurso potencial se transforma en beneficio para algún actor. La perspectiva tradicional de valor que se proyecta sobre un bien (materias primas) es un concepto antiguo: el valor de los recursos (tangibles o intangibles) reside en su potencial para crear valor para otros actores económicos. El conocimiento y los recursos humanos representan categorías especialmente importantes dentro de los recursos activos de la empresa. Desde esta perspectiva, los recursos no se adquieren sino que se crean y se integran en la organización.

- ***¿Con quién se intercambia?***

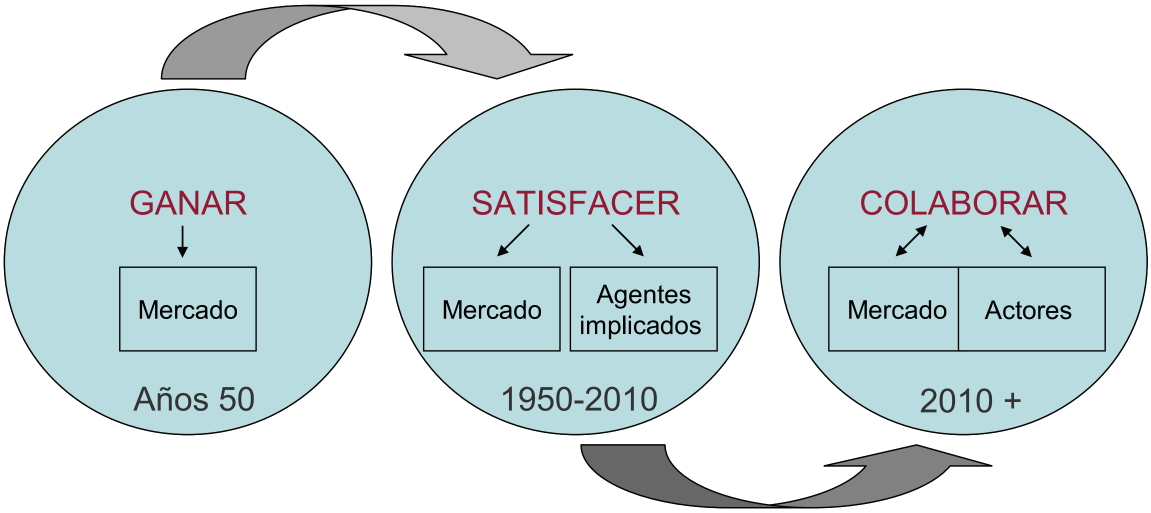
La respuesta a esta pregunta también supone un cambio sustancial que caracteriza la LDS. Si bien hasta ahora, se ha considerado el cliente como un elemento pasivo al que hay que conocer para satisfacer sus necesidades, el nuevo enfoque interpreta que todos los agentes de interés, denominados actores, aportan y reciben beneficios en las interacciones. Es decir, el cliente es un recurso activo, co-creador del servicio, que participa en el consumo, crea valor para sí mismo y para la empresa, y significa, por lo tanto, un recurso más que hay que incorporar a la gestión y las relaciones se entienden entre actores económicos activos.

Si la perspectiva de marketing relacional abogaba por la diferenciación entre diversas fórmulas de relación (B2B, B2C, etc.), la LDS entiende que todos los actores que operan en un mercado son susceptibles de crear y recibir valor: clientes, otros clientes, organizaciones públicas y privadas, etc. Desde esta perspectiva, Lusch, Frederik y Webster (2011) entienden que las organizaciones, más allá de buscar optimizar las ventas y/o beneficios y sus actividades, deben buscar el equilibrio de un sistema en el que todos ganen, ya que sólo así se mantendrá a largo plazo. Por supuesto, esta perspectiva cobra especial sentido en la medida en que existen las nuevas tecnologías e Internet. En esta línea es importante apreciar que el concepto de "relación" ha adquirido un significado diferente desde la aparición de internet y las redes virtuales. De hecho, se considera que la lógica D-S es especialmente útil en un mundo altamente conectado, en el que todos los actores se relacionan con medios que permiten un nivel de comunicación y de colaboración que facilitan que las decisiones de marketing, ahora más que nunca, se sitúen a nivel de dirección, que ha de ser el que guíe la colaboración de todos los agentes para conseguir el máximo beneficio para todos.

La consideración del cliente como un elemento activo implica la necesidad de generar el diálogo fluido entre co-creadores, basado en la confianza, el aprendizaje conjunto y la adaptación mutua. La lógica de la promoción como forma de comunicación se sustituye por la práctica del diálogo entre todos los actores.

La figura 2 refleja la evolución que ha experimentado el carácter de las relaciones con el cliente.

Figura 2. *Evolución del carácter de las relaciones con el cliente.*



- ***¿Qué tipo de valor crean las organizaciones?***

La incorporación del cliente y demás agentes como co-productores altera, como no puede ser de otra manera, la perspectiva ofrecida por la LDB de "valor de intercambio" para sustituirla por el concepto de "valor en uso", entendiendo que el valor es únicamente determinado por el beneficiario. Este cambio ya había sido apuntado por Normann (2001, p.99) cuando argumentaba que "el cliente es un creador de valor más que un destructor de valor". Esta misma perspectiva es la que adopta la LDS para concluir que la oferta ya no es el resultado de un proceso de manufactura o de la lógica de una cadena de valor, es un input que se incorpora a un proceso de creación de valor. Desde esta perspectiva, el cliente desempeña un papel activo, responsable de parte de proceso de creación de valor que pasa a denominarse "valor en uso".

En el mercado actual aún observamos una presencia mayoritaria de empresas en las que predomina la lógica DB, aunque las grandes pioneras ya hace tiempo que comprendieron que en el actual contexto, y muy especialmente desde la irrupción de las nuevas tecnologías, las relaciones con todos los agentes del mercado han cambiado. Algunos autores entienden que la perspectiva de marketing relacional ha sido el antecedente más directo en la creación de la lógica D-S. En esta línea Gummesson (2008, p.11) ya introducía sus valores en la definición de marketing como "el proceso en la sociedad y en las organizaciones que facilita el intercambio voluntario a través de relaciones colaborativas que crean valor recíproco a través del uso de recursos complementarios". Pero aún queda mucho trabajo por hacer en este campo, tanto en la teoría como en la práctica. Si entendemos que las redes de redes son una realidad, y que el cliente desempeña un papel cada vez más activo en el contexto de consumo actual, irremediablemente se ha de desarrollar una nueva estructura y unas nuevas herramientas de marketing. El marketing relacional fue el primer paso, la lógica D-S es el siguiente.

4. CONCLUSIONES

Los principios que basan la toma de decisiones en marketing necesitan evolucionar y adaptarse a las nuevas condiciones del entorno. El caso de IBM y su apuesta por la Ciencia del Servicio es un ejemplo de reacción del ámbito profesional ante las deficiencias que presentan los modelos actuales de formación. Curiosa coincidencia en el tiempo con la propuesta realizada por Vargo y Lusch (2004) en el ámbito científico. En otra época, el paso de la teoría a la práctica y viceversa se habría dilatado en el tiempo, pero las actuales técnicas de innovación en la empresa y en la investigación han permitido que el proceso se desarrolle simultáneamente.

En el artículo "Toward a Conceptual Foundation for Service Science: Contributions from Service-Dominant Logic" publicado en IBM Systems Journal, los autores Lusch, Vargo y Wessels (2008, pp. 7) ponen de manifiesto que para avanzar en la propuesta de IBM denominada "Ciencia del Servicio" se hace imprescindible una fundamentación conceptual contundente, y la Lógica D-S es la respuesta teórica que necesita.

Esa es la filosofía de la innovación: la apuesta por el desarrollo de estrategias colaborativas que tengan como fin conseguir relaciones que el marketing relacional denomina como ganador-ganador entre todos los actores (Gummesson, 2004). Entre todos los actores hay uno que ocupa un lugar privilegiado: el consumidor quien pasa a adquirir nuevas denominaciones (como prosumer o coproductor) que ponen de manifiesto el cambio de rol que se identifica en la nueva lógica D-S y la Ciencia del Servicio: el consumidor es un agente activo, que desempeña un papel importante en el consumo del servicio. Ya no existen bienes en el mercado, sólo existen servicios. Los bienes son sólo un vehículo para conseguir relaciones colaborativas positivas. La empresa vende un servicio, pero el cliente o prosumer también entrega un servicio a cambio: busca información, entrega información a la empresa, trabaja para decirle qué es lo que quiere y qué le dan otras empresas… el cliente puede ser inmensamente útil desde el punto de vista de la creación de valor.

Adoptando la filosofía descrita, este trabajo propone una reflexión sobre los temas actuales de debate en marketing y la identificación de nuevas tendencias que orienten el cambio en los programas de formación en escuelas de negocios y universidades.

Para concluir ofreciendo alguna respuesta a la pregunta planteada en el título, la manera de interactuar las organizaciones en con el resto de actores económicos cobra especial sentido en los casos en que nos enfrentamos a contextos en los que se actúa en red. Quizás en mercados menos desarrollados tecnológicamente, algunas de las ideas aportadas no supongan un cambio tan importante.

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DO WE TEACH WHAT WE RESEARCH? UNFOLDING ABSORPTIVE CAPACITY, OPEN INNOVATION, MANAGEMENT INNOVATION AND CLUSTERS

FORGET R&D – PAY MY COACH: YOUNG INNOVATIVE COMPANIES AND THEIR RELATIONS WITH UNIVERSITIES

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ABSTRACT

Young innovative companies (YICs) are attracting attention in their role of industry regenerators. However, we have little information about their relations with universities as sources of information. This chapter explores university-industry interaction involving YIC in the Valencian Community, using YIC founders' personal attributes and motivations as explanatory variables. The Valencian Community has a relatively high degree of university-industry interaction, but surprisingly little technological innovation. A survey of YICs in the region shows that, in their case, firm size does not affect the probability of contracting with universities, and that R&D intensity is not significant if we consider firm founders' personal characteristics and motivations. YIC founders exploiting market opportunities recognized in previous business activities, and necessity entrepreneurs, are the least likely to interact with universities. We highlight the role of external advisory services to appreciate the benefits of universities.

Key words:

Young innovative companies; university-industry interaction; motivations

DO WE TEACH WHAT WE RESEARCH? UNFOLDING ABSORPTIVE CAPACITY, OPEN INNOVATION, MANAGEMENT INNOVATION AND CLUSTERS

1. INTRODUCTION

In this chapter we discuss the determinants of university-industry interaction on the basis that they encompass the personal characteristics of the firm's creator as well as the usual firm characteristics, e.g. degree of openness and research and development (R&D) investment. Among these personal characteristics, we focus on educational attainment and motivations for setting up a firm. We explore this latter by combining elements of the strategy, psychology and entrepreneurship literature and provide a study which, in our view, extends the work on university-industry interactions.

We focus on young innovative companies (YICs) because they are important for transforming the industrial structure, and contribute to economic growth and innovation within a territory. The academic community and policy makers are devoting increased attention to YICs (BEPA 2008; Schneider and Veugelers 2010) and several EU member states have implemented programs to promote the establishment, consolidation and development of YICs (Veugelers 2009; Schneider and Veugelers 2010). However, many of these support measures are aimed at facilitating access to R&D funding sources and do not include other types of indirect actions such as advice and consultancy services.

Since we believe that these other types of firms and actions that facilitate technology transfer deserve further analysis, we focus on the determinants of YICs' interactions with universities. We find that, despite their different endowments, YICs' frequency of working with universities is similar to that of the typical innovative firm, although YICs are often very small and very R&D intensive. The existing evidence on YICs and other similar firms is limited and not conclusive about these aspects.

In a global economy, technology transfer from universities acts as a source of firms' innovation and competitive advantage. However, the innovative process is clearly influenced by the spatial dimension, according to the regional competitiveness approach, since highly innovative firms settle in highly competitive regions (Audretsch et al. 2010). Besides, some authors highlight the relevance of the regional entrepreneurship capital to explain the innovation behaviour of firms (Audretsch and Keilbach 2004). Specifically, the "coevolution" of regional knowledge production and university technology transfer (Hülsbeck and Lehman 2010) is supported by the empirical evidence on young and high-tech entrepreneurial firms in Germany (Audretsch et al. 2010).

Our study contributes to the literature in several ways. First, it provides a measure and explanation of the level of YICs' interaction with universities, including a comparison with other innovative firms.

Second, we analyse a particular regional context that is characterized by a relatively low technological level, but a high level of university-industry interaction, a rather surprising and underexplored combination that deserves especial attention according to the relation between regional settings and university technology transfer mentioned above. Third, the inclusion of founders' personal characteristics as explanatory variables in the estimation, offers some insights into the lack of significance of R&D intensity in this respect.

The chapter is organized as follows. Section 2 discusses our choice to study YICs compared to other firms, and the influence of firm characteristics and founders' personal traits on interaction with universities. Section 3 describes the regional context and Section 4 presents the data, method and variables used in the analysis. Section 5 presents the main results and Section 6 discusses some limitations of our study, offers some conclusions and suggests some managerial and policy implications.

2. HOW MUCH AND WHY DO YICS INTERACT WITH UNIVERSITIES?

There is evidence of the positive effects of links with knowledge centres for firm innovation (Radas and Bozic 2009; Wagner and Bukó 2005). However, there are some aspects that need further research, such as the degree of interaction between particular types of firms, such as YICs, and universities. We look at firm characteristics as the determinants of university-firm interaction and the influence of founders' personal traits on knowledge sharing (an important and understudied aspect according to Lin 2007).

3. UNIVERSITY-INDUSTRY LINKS: YICS VERSUS OTHER FIRMS

The focus in this chapter is on YICs. EU state aid regulations define a YIC as a small firm, aged six years or less, and certified by external experts on the basis of a business plan, as capable of developing new -or substantially improved- technological products or processes, but which runs the risk of technological or commercial failure.

Other terms are used in the literature to refer to other closely related types of firms. Some authors have studied what they call New Technology-Based Firms (NTBFs), which are young companies in high-tech sectors (see, e.g., Colombo and Grilli 2005). Our study covers a wider range of firms because it covers all productive sectors irrespective of their technological level. In our view, belonging to a high-tech sector should not be seen as synonymous with being an innovative company; many firms that operate in R&D intensive sectors are only adopters of already available innovations. YICs include young companies that also are active innovators. This definition is sufficiently flexible to allow for different degrees of innovation.

Several articles on collaboration among innovative firms refer to start-ups. However, we prefer the term YICs because it encompasses the dimension of innovation that does not necessarily apply to start-ups. For example, the start-up variable constructed by Cohen et al. (2002) defines a start-up as a young firm, with fewer than 500 employees in a baseline period, and typically as active in one industry.

A distinctive characteristic of a YIC is its length of establishment. Some studies that consider the influence of firm age on its contacts with universities show that younger firms are more likely to exploit universities, but the evidence is not conclusive. Audretsch et al. (2005) note that new firms often rely on external knowledge produced by other firms or by universities since they are less able than larger and more established enterprises to generate their own formal R&D. Similarly, Pérez and Martínez (2003) provide evidence that networking with universities and R&D centres was more intensive and more important during the early years of university spin-off foundation. Motohasi (2005), for a sample of Japanese NTBFs finds that young/new firms are more likely to interact with universities than firms of a similar size that are longer-established.

On the other hand, Cohen et al. (2002) in a study of US manufacturing industries report importance of university-firm interaction only for start-ups in the pharmaceutical sector, but not other sectors, and Laursen and Salter (2004) provide similar results for universities as a source of knowledge for UK manufacturing firms. Laursen and Salter include a variable to measure whether or not the firm is a start-up, but the results show that start-ups are not more likely to engage in contacts with universities.

YICs have been compared to the average firm, but in this chapter we compare them with other innovative firms.

4. YICS' CHARACTERISTICS AND THEIR INFLUENCE ON INTERACTION WITH UNIVERSITIES

To our knowledge, there are no studies that investigate the firm characteristics that determine interaction between YICs and university, and the evidence for start-ups is limited. Among the few papers that study R&D cooperation among start-ups, only Okamuro et al. (2011) investigate the determinants of cooperative R&D between start-ups and other organizations including universities. The more general literature, which includes some work on innovative firms and start-ups, highlights three firm characteristics: openness, R&D intensity, and size.

Openness, according to Fontana et al. (2006), refers to the set of activities that firms undertake to acquire knowledge from, voluntarily disclose knowledge to, and/or exchange knowledge with the external world. In other words, it refers to the firm's ability to network. It is clear that more open firms are more likely to enter into university-firm collaboration. This is confirmed by Laursen and Salter (2004).

There is evidence that more intensive firm R&D activity has a positive influence on R&D cooperation with universities (Fontana et al. 2006; Laursen and Salter 2004; Tödtling et al. 2009). These studies show that the propensity to cooperate with a university for innovation seems to depend positively on the firm's R&D intensity. However, Nakamura et al. (2003) report a non-significant relation for cooperation with universities. In a study of start-ups, Okamuro et al. (2011) report R&D intensity to be a non-significant variable and exclude it from their model; they find instead that R&D expenditure is significant.

The evidence relating to firm size indicates that it has a positive influence on the propensity to engage in cooperation and networking in the innovation process (Tödtling et al. 2009), and to interact with public institutions (Cohen et al. 2002; Laursen and Salter 2004; Levy et al. 2009), and this result applies to innovative firms in particular (Motohasi 2005). However, in the specific case of start-ups, the empirical evidence seems not to follow this general pattern: Okamuro et al. (2011) find that size is a non-significant variable.

Based on this empirical evidence, we hypothesize that:

Hypothesis 1 The characteristics of YICs that contract with universities are similar to those of other firms that use universities as external sources of knowledge. The more open the search strategy, the higher the R&D intensity and the larger the size of the YIC, the higher will be the probability that the firm will contract with universities.

5. EDUCATION AND MOTIVATIONS OF YIC FOUNDERS AS DRIVERS OF INTERACTIONS WITH UNIVERSITIES

Several authors have investigated the influence of the characteristics of university researchers (Ponomariov 2008; Grimpe and Fier 2010), and Lin (2007) argues that more research is needed into the influence of personal traits on industry-university linkages. In this study we focus on firm founders' education and motivations for setting up a firm. Colombo and Grilli (2005) examine the role of human capital in firm growth and Tödtling et al. (2009) identify employment of former university researchers as a key factor in the level of knowledge interactions with universities. Doloreux et al. (2008) show that knowledge-intensive business services (KIBS) in the R&D sub-sector in Quebec have a larger share of employees with at least a bachelors degree, than KIBS in other sub-sectors, and Radas (2005) shows that recruiting highly educated workers can be crucial for establishing more intense collaboration. She finds that if employees are au fait with the work of the university scientists they can bridge between the firm and the university.

While the above findings refer to firms' employees, Okamuro et al. (2011) show that in the case of start-up firms, the firms' creators have a crucial influence on their firms' strategies, including R&D cooperation. Colombo et al. (2010) include a set of characteristics of NTBF founders (including years of university education of founder) to control for the positive impact on firm growth of the human capital of the founding team.

In other words, highly educated firm creators may attract R&D partners and foster different forms of R&D cooperation. We therefore hypothesize that:

Hypothesis 2 Better educated YIC creators are more likely to enter into contracts with universities.

Next, we discuss the how the reasons for establishing a firm affect the interaction with universities (on the motivations for interacting with a university see, e.g., Arza 2010). In the work on entrepreneurship, which spans the fields of economics, psychology and sociology, there are several approaches aimed at identifying what motivates the entrepreneurial decision. We are interested in personal motivations, and we draw on this literature to link firm founders' motivations with university-firm interaction.

We consider motivations related to the so-called push and pull factors, and those related to the entrepreneur's previous experience. Shapero (1984) indicates that an 'entrepreneurial event' occurs when a potential firm creator establishes a firm based on a series of drivers which may be negative (or push factors) or positive (pull factors). An example of the former is the desire to make money. Chiesa and Piccaluga (2000) and Shane (2004) report this to be the motivation respectively for university spin-offs and a group of MIT entrepreneurs. The strongest push factor is probably the need for employment, described as 'necessity entrepreneurship' (Reynolds et al. 2005), which occurs when establishing a new firm is not necessarily the preferred option (Acs et al. 2007). Firm founders driven by push factors tend to adopt reactive strategies. They may not recognize market opportunities or seek out external sources of knowledge. We hypothesize that:

Hypothesis 3 YIC creators motivated by push factors such as creating employment for themselves or earning more money, are less likely to contract with universities.

At the other end of the spectrum are pull motivations, which are characterized by voluntary participation in entrepreneurial activities. Various studies show that there is a positive relationship between internal commitment to establishing a new firm and entrepreneurial activity (Amabile et al. 1994; Prabhu et al. 2008; Rauch and Frese 2007) and that it is linked (De Koning and Muzyka 1996; Herron and Sapienza 1992; Manimala 1996) to a greater capacity to identify and explore opportunities. Here, we focus on so-called 'opportunity entrepreneurship' (Kirzner 1973), where the entrepreneur detects a market opportunity which leads to the establishment of a new firm.

It is tempting to see pull factors as exactly opposite to push factors in terms of their effect on cooperation with universities. However, although pull factors are related to YIC creators more open to market opportunities, including cooperation, we cannot predict a preference for university-firm cooperation on this basis alone. The institutional context also plays a role and has different effects on different types of pull factors.

In relation to the firm founder's professional experience this set of motivations is related to socio-demographic features and predicts a certain entrepreneur profile (see Collins and Moore 1964, for a seminal study in this field, and Colette et al. 2003, for a more recent analysis). This approach identifies previous work experience as important.

We assume that the previous or main employment of the firm's founder may create a firm culture that determines collaborative interaction. Tödtling et al. (2009) indicate that more sophisticated innovations are likely to be based on scientific knowledge generated in universities and research organizations. Geiger (2010) identifies the 'informational challenge' (understood as the inability of firms to understand that external sources might help to resolve problems) as limiting university-industry collaboration. Besides Decter et al. (2007), Hertzfeld et al. (2006) and Siegel et al. (2003) report the existence of 'cultural' differences between business and university, which act as barriers to technology transfer. Rappert et al. (1999) report that university spin-offs tend to interact more with universities than non-university start-ups, showing that previous experience in academia may reduce these cultural barriers and foster linkages. We hypothesize that:

Hypothesis 4 YIC creators motivated by the pull factor of building on previous experience as university professors or researchers, are more likely to contract with universities.

If the firm founder has a business background, the cultural gap with academia may hinder interactions with universities. We hypothesize that:

Hypothesis 5 YIC founders motivated by the pull factor of previous business experience will be less likely to enter into contracts with universities than YIC creators motivated by the pull factor of building on previous experience as university professors or researchers.

Hypothesis 5 is the only one of our propositions that does not predict a purely positive or negative impact on interaction with academia; it predicts only a reduced likelihood of firm founders with a business background interacting with universities, compared to those with an academic background. The final sign will be determined by the opposing influences on university-firm relations: a proactive entrepreneur may seek out knowledge linkages, but the cultural gap may deter interaction with universities. The data demonstrate the relative strengths of these two influences.

6. RESEARCH CONTEXT

The Valencian Community is a European region with low absorptive capacity (Azagra-Caro et al. 2006). Some of its main technological and industrial features are of interest for this study, including:

- low-tech economic structure and high proportion of microfirms in services and traditional manufacturing;
- weak innovation; innovation mostly incremental in the form of machinery and equipment acquisition; low level of expenditure on R&D;
- lack of qualified personnel even in firms in the knowledge-intensive sectors;
- policy emphasis on increased technology transfer, to the level in high-tech regions or countries, but aligned to the Valencian industry (Fernández de Lucio et al. 2010), through the establishment of a strong network of technology institutes (TIs) in the early 1980s.

The TIs act as a bridge between firms and public research institutions and were founded mostly as industry-based firm associations. They were set up as private, non-profit associations with independent management (Mas-Verdú 2007).

There have been some pioneering actions related to the establishment of technology transfer offices, spin-off incubators, etc. located in universities, which have fostered academia-industry links. A report for the Valencian R&D Council (ACCID 2005), shows that 3% of Valencian firms' sales are based on product innovations that could not have been developed without the input of academic research. Other studies provide similar results for the US and Germany (see, e.g., Beise and Stahl 1999). The ACCID report shows also that industry funding of Valencian university R&D (6%-8%) was similar to the Spanish average and higher than the EU and OECD averages. The latest figures show this still to be the case and that Valencian firms tend to contract out low-tech, short-term oriented R&D to Valencian universities. There are some good academia-industry links because universities have adapted to the regional level of absorptive capacity.

Most university faculty are in favour of university-industry interaction (Azagra-Caro et al. 2006), but firms do not show the same willingness to interact with universities. Also, some Valencian universities have linkages outside the region (Azagra-Caro 2007a) which provides access to higher technology and larger firms (Azagra-Caro 2007b). Also, and contrary to the findings for leading innovative regions, there is an 'alocalization' effect in terms of knowledge flows (Azagra-Caro et al. 2009) and university-industry links (Todt et al. 2007). Therefore, the Valencian Community –five public universities– is an interesting case for the study of university-industry links.

7. DATA AND METHODOLOGY

The data are from a survey carried out by the Valencian Institute for Small and Medium Sized Enterprise (IMPIVA), a Valencian Regional Government organization created to promote innovation in small and medium sized enterprises. In 2009, IMPIVA began to compile a detailed directory of YICs in the region. Our cooperation in this endeavour provided allowed access to these firms and the opportunity to collect the necessary firm-level data to test our hypotheses. We designed a brief survey which was pre-tested and modified based on the feedback from experts and some randomly selected firms. The questionnaire was submitted to a target sample.

A crucial phase of the data collection process consisted of delimiting the population and sample. Identifying the population of firms was not straightforward because of the lack of an official list of such companies in the Valencian Community. After some consultation with academic (Belso-Martínez et al. 2011) and IMPIVA experts, we agreed on a number of sources of information to construct the target population. These included lists of academic spin-offs (provided by universities), business incubator centres, industry associations, applications from firms for public funding. We identified 210 YICs created during the period 2005-2008.[75] Note that the combination of different sources of information minimizes the risk of potential bias and distortions in our results. The process also ensures that almost all YICs established in the region at the time were identified.

Following this initial process, individual entrepreneurs were contacted, the profile of the company confirmed and the questionnaires administered. Of the total 210 distributed, we received 173 completed surveys. This high response rate (82.3%) was down to the IMPIVA monitoring process.

Despite some idiosyncrasies, our dataset includes a large and heterogeneous sample of YICs, spanning several mature industries. As well as those firms we initially identified as YICs, we included other innovative firms in the survey; the response to the question about their year of creation allowed us to decide whether they fitted the definition of a YIC. Only YICs went on to complete the questionnaire, but using this method we were able to obtain information on the characteristics of other innovative firms, which we use as a benchmark. Wherever possible, we present descriptive and econometric results for the full sample and distinguish between YICs and other innovative firms.

[75] The YICs analysed were 4 years or younger. As already indicated, EU state aid regulation defines a YIC as a firm established for less than 6 years. The literature on start-ups uses a range of 5 (Cohen et al. 2002) to 1.5 years (Okamuro et al. 2011). Thus, there is no clear cut off age for a 'young' firm.

8. DEPENDENT VARIABLE

One question in the survey asked: 'In relation to the gathering of technology and strategic information, have you signed any contract with some of the following institutions?' Responses were tick boxes corresponding to the categories listed in Table 1, including universities. On average, a large proportion of the full sample of innovative firms interacts to acquire technology and strategic information (42%). Among the organizations consulted, universities scored high and well above the average at 51%. This is consistent with Spain (and the Valencian Community in particular) having a very high share of business funding of higher education expenditure on R&D. (See Table 1)

Contracts with TIs is the only category that ranks higher than universities. This is peculiar to the Valencian Community with its strong network of TIs created in the early 1980s. Contracts with other institutions, such as public administration, chambers of commerce, business innovation centres, etc., are less frequent.

Therefore, our dependent variable is:

- University contracts, where the binary variable is 1 if the respondent ticked the box for universities and 0 otherwise.

Table 2 shows the average value is 0.52.[76] It also provides a first breakdown by whether the firm is a YIC. The difference between YICs (0.51) and other innovative firms (0.53) is not significant. (See Table 2)

Given the dichotomous nature of the dependent variable, we use a probit model for our estimations.

9. INDEPENDENT VARIABLES

The literature review shows that there are advantages from considering different types of explanatory variables. Here we consider firm characteristics, firm founder's personal characteristics (including education), and firm founder's motivations.

Table 2 presents the descriptive statistics for firm characteristics, which include those related to Hypothesis 1:

[76] It corresponds to 1 percentage point above the figure in the previous table because here 'don't knows' are excluded from the total.

- Openness: related to the question, 'In relation to the gathering of technology and strategic information, have you signed any contract with some of the following institutions?' The response choices (ranging from 0-3) include consultants, TIs, and other organizations. The average score of 1.20, indicates a degree of openness: most firms have interacted with at least one of these types of institutions;
- R&D intensity: this is proxied in the survey. Respondents were asked to classify their company according to one of the following labels: technology-based company (high R&D intensity), very innovative company (medium R&D intensity) and innovative company (low R&D intensity). This typology is familiar to Valencian innovative firms because it is used for applications for local public R&D grants. The classifications were validated by technicians from the regional innovation agency. Our variable takes the values 2, 1 and 0, respectively. The average firm in the sample is medium R&D intensive;[77]
- YIC: a dummy variable that is equal to 1 if the firm was created after 2005: 36% of the firms in the sample were YICs;
- Firm size: number of employees, in the categories: 0 (less than 10 employees), 1 (10-49 employees) and 2 (50 employees or more). This corresponds to Eurostat's distinction between micro, small, and medium/large firms. The average firm is between categories 0 and 1, i.e. even within innovative firms, microfirms predominate in the Valencian case.

When we differentiate between YICs and other innovative firms, we see that the former use more closed search strategies, are more R&D intensive and are smaller in size than the latter. Hence, YICs are interesting because, despite their different endowments, their frequency of contracts with universities is similar to the typical innovative firm.

Table 3 shows that the correlation between variables is small. (See Table 3)

The second group of variables refers to the personal characteristics of the firm founder:

[77] This classification is based on self-assessment, unlike studies that give precise numbers for R&D intensity. However, many studies using Community Innovation Survey (CIS) data or similar are based on self-assessments. Our results may be more reliable since offering a choice of category can be less prone to inaccuracies than asking for unaccounted numbers. Also, as a robustness check, we used two alternative variables: the budget of granted innovative projects and the budget of granted R&D projects, applied for by firms through competitive tenders. We chose this method because, according to the literature (Hyytinen and Toivanen 2005; Takalo and Tanayama 2010), being awarded financial support (subsidy) for innovative activity can be seen as reflecting the high quality of the innovative efforts made by the company. The results (available on request) did not change, in particular the lack of significance of R&D that we will see afterwards.

- Age of entrepreneur: an ordinal scale of four categories: 0 (less than 30 years), 1 (30-39 years), 2 (40-49 years) and 3 (more than 49 years);
- Sex: 1 if female;
- Education: an ordinal scale of three categories: 0 (no university degree), 1 (graduate university degree), 2 (post-graduate university degree).

While age and sex are control variables, education refers to Hypothesis 2.

The questions were addressed only to YICs. Table 4 shows that the average YIC founder is aged between 30 and 39 years and has a university first degree; 10% are women. (See Table 4)

The third group of variables, motivations (applying only to YICs), comes from a question in the survey asking firm creators their reasons for setting up their companies. We grouped the variables as follows:

- Self-employment push: 1 if the respondent chose 'I chose to create my own workplace', 0 otherwise.
- Monetary push: 1 if the respondent chose 'Expectations to gain money through an own business', 0 otherwise.
- (Both the above refer to Hypothesis 3);
- Academic pull: sum of two categories: 'To benefit from my specialist knowledge acquired from my activity as a university professor or researcher' plus 'application of doctoral thesis or university R&D project'. This refers to Hypothesis 4;
- Business pull: sum of five categories: 'To benefit from my specialized knowledge acquired from my R&D activity in my former company/work at technology centres/consultancy work/integration of several sources' plus 'Opportunity arisen in the professional environment'. This refers to Hypothesis 5.

Table 4 shows that business pull is the more frequent motivation. The means are not comparable among motivations because of the different range of variation for each variable, but a breakdown of business pull would still show that many of its single components are ranked first in the hierarchy of motivations. Academic pull motivations are ranked second if we sum the two components:

'university professor or researcher' and 'application of doctoral thesis or university R&D project'. Separately, each ranks below the two push motivations.[78]

Table 5 shows that the correlations between the variables in the YIC sample are small. (See Table 5)

We control for industry fixed effects. The survey distinguishes 27 economic activities, including manufacturing and services. Since some activities involved only a very few firms, we grouped the activities into seven sectors: three corresponding to Pavitt's (1984) taxonomy of industrial activities, plus four service sectors (ICT, R&D, Engineering, architecture, environmental services, and a fourth category of Other services).[79] We created dummies for each of the seven types listed in Table 6. (See Table 6)

According to Table 6, there is large variation in the percentage of firms that contract with universities, by economic sector. The highest shares correspond, as expected, to R&D services, followed by science-based and production-intensive manufacturing and ICT services. Supplier-dominated firms, 'engineering, architecture and environmental services' and 'other services' rank lowest. As for the aggregate, differences between YICs and other innovative firms are not significant, except for the case of supplier-dominated firms, where YICs are less likely than other innovative firms to contract with universities.

10. ECONOMETRIC RESULTS

THE DISTINCTIVE INSIGNIFICANT EFFECT OF YIC FIRM SIZE ON CONTRACTING WITH A UNIVERSITY

Table 7, column 1, shows that innovative firms with more open search strategies and are more R&D intensive, have more employees and are more likely to enter into contracts with universities. Notice

[78] For the estimations, we tried different breakdowns of the academic and business pull variables; the results did not change. We prefer to present the current aggregates because this results in models with more degrees of freedom. The descriptive and econometric results and the breakdowns are available from the authors on request.

[79] 15% of respondents chose 'other' rather than any of the 27 initial categories; they were required to make a qualitative response. This information and the response to another question about the firm's economic activity, allowed us to reclassify this 15% into the initial categories or to drop unclear cases. One of the authors with many years practical experience at IMPIVA, and direct contact with Valencian companies, helped in this reclassification exercise.

that in our case (similar to the case of start-ups in Laursen and Salter 2004) being a YIC is not significant. (See Table 7)

In column 2, we reproduce the model for the YIC sample (obviously, we drop the YIC variable from the model because it always takes the value 1). The coefficients of openness and R&D are still positive and significant (with R&D slightly less significant); firm size is not significant. The evidence only partially supports Hypothesis 1. For YICs, if we do not control for YIC founder's education and personal motivations, openness and R&D are as important for contracting with universities as for the average innovative firms, but size has no effect.

The results for non-YIC innovative firms are shown in column 3. They confirm the average behaviour: a significant, positive effect of openness, R&D intensity and size on contracts with universities.

It is questionable, perhaps, whether the observed lack of significance of size is an idiosyncrasy of the geographic origin of the sample. However, the fact that the aggregate and the non-YIC innovative firm samples follow the results for the UK sample in Laursen and Salter (2004) –including the significance of size– seems to indicate that this is not the case: it is the fact of being a young company rather than geography that is having an effect. Also, Okamuro et al (2011) find that the effect of size on interaction with universities is not significant for Japanese start-ups.

11. HOW DO ENTREPRENEUR'S EDUCATION AND MOTIVATIONS REDUCE THE SIGNIFICANCE OF R&D IN RELATION TO CONTRACTING WITH A UNIVERSITY

The first estimation includes YIC founders' personal and motivational characteristics (Table 8, column 1). Firm size is not significant, which is consistent with Table 7, column 2. However, that R&D intensity is also not significant is surprising. The higher value of the Bayesian Information Criteria (BIC) indicates that in spite of the higher pseudo R^2, the fit is worse than in Table 7, column 2, due to the inclusion of too many variables. In order to achieve a more parsimonious model, with more degrees of freedom, we perform a selection strategy. Starting from the model in column 1, we drop the insignificant variable with the lowest t-ratio and estimate a new model. We replicate the procedure successively until we achieve a model with only significant variables. (See Table 8)

The results are shown in Table 8, column 2.[80] The lowest value of BIC indicates also that this is the best model (compared to the models in Table 8, column 1 and Table 7, column 2). Openness is significant and R&D intensity is excluded from the model. Hence, when we control for the personal characteristics and motivations of the YIC founder, the effect of R&D intensity for the YIC is not relevant. Size is also insignificant and can be excluded from the model.

Two personal characteristics are dropped because of their lack of significance, leaving only a positive coefficient of education. This evidence supports Hypothesis 2. The better educated the firm founder, the more likely that his/her company will interact with a university.

Regarding motivations, self-employment tends to lead to less contact with universities, which supports Hypothesis 3, and earning money has no influence, which does not. Hence, there is only partial support for Hypothesis 3. If our data and methods are correct, the theory could be refined by establishing a ranking among push factors: YIC creators aiming at earning more money are not as reactive as necessity entrepreneurs in their collaborative efforts.

Benefiting from specialized knowledge acquired from academia promotes interaction with universities, confirming Hypothesis 4. Benefiting from specialized knowledge acquired from a former non-academic environment or from opportunities arising in the professional environment is detrimental for contracting with universities. This implies, first, that the business pull is less likely than the academic pull to foster interaction (confirming Hypothesis 5) and, second, that the negative effect of differences in the business and university cultures outweighs the positive effect of the pull motivation.[81]

12. CONCLUSIONS

This study explored the theoretical determinants of contracts between YICs and universities. It provides an empirical analysis of a sample of innovative companies in the Valencian Community to

[80] As a robustness check, we carried out another selection strategy: we introduced the independent variables separately into the regressions and retained only those with a significant effect in the joint model. The results were the same as Table 8, column 2.

[81] In the estimations, only 3 industry sector dummies are significant (see Table 8, column 2): Science-based manufactures, ICT services and R&D services. Although further development of this idea is beyond the scope of this study, it is in line with some evidence that the study of university-industry interaction should not be restricted to manufactures, but expanded to services (see D'Este and Camerani 2010).

compare YICs with older innovative companies and allows the inclusion of the personal characteristics and motivations of the firm creator as explanatory variables, as well as firm characteristics. To our knowledge, the use of this combination of variables is novel. Furthermore, this is the first empirical analysis of YIC cooperation.

First, we can highlight that current thinking about university-industry interaction is valid for YICs in relation to its positive influence, but that there are differences related to YIC size and R&D intensity. Size is not a determinant of YIC-university contracting and when we control for the personal characteristics and motivations of firm founders, R&D intensity is not significant. Our study extends the theory by examining the role of firm founders' education and types of motivations. The evidence confirms the hypotheses that higher education and the pull motivation of founders from academia increase the frequency of university interaction, while the pull motivation of founders from the business sector and push motivations lead to fewer contracts with universities. However, the empirical validation applies to necessity entrepreneurship not to the desire to make more money, which suggests a further refinement to the theory.

There are two main limitations to our study. First, the dependent variable, the binary answer to the question, 'have you signed any contract with universities' does not give any idea of the frequency, length, size or results of contracts with universities. It provides no information on when a contract was signed, which does not allow us to make dynamic comparisons among firms. However, this type of dichotomous variable does provide valuable information on university-industry links, as shown by Nakamura et al. (2003), Motohasi (2005) and Okamuro et al. 2011. Also, even with the broad formulation of the question, our variable shows high percentages for each possible outcome (yes/no). This fact and the high industry variation (e.g. the science-intensive manufacturing and services score higher) are signs of the appropriateness of the variable.[82]

A second limitation is that the number of YICs in the sample is small (less than 200 observations). However, due to our survey design, we are confident that the sample is very representative of the full population of this type of companies in the region. Also, comparison with the larger population of innovative firms that are not YIC suggests that our results are plausible. Finally, reduction of the

[82] It might be that studies based on more fine-grained information, e.g. variables with more points on a Likert scale, would be more useful. In our case, we included a question in the survey about satisfaction with services provided by universities to be ranked on a 5-point Likert scale, ranging from 'Not satisfied' to 'Very satisfied'. We found that most firms that had interacted with universities were 'very satisfied', while most firms with no experience of university contracting expressed an opinion of 'neither very satisfied or very dissatisfied'. Ordered models predict both outcomes, meaning they perform no better than a simple dichotomous variable.

econometric models to those with significant variables only shows that the estimations have sufficient degrees of freedom.

Nevertheless, we cannot claim that this study provides definitive evidence of what determines contracting between YICs and universities. Since this is new evidence, more research is needed using different data, in particular in other contexts where the technology transfer may be influenced by a different regional endowment. We believe that our analysis is useful; it has been argued that an increased level of university-industry cooperation would require changes to the motivations of faculty members (sometimes with no clear idea of the direction of change, Uyarra 2010). Our study highlights that change is needed in the motivations of firm creators, starting with YIC creators. Based on our findings, we can derive some implications for policy and corporate governance and provide tools for further methodological exploration.

Regarding the design of public policies, this research suggests that in a given region a relatively high degree of university-industry relation may coexist with low levels of technological innovation, when the entrepreneur's motivation for creating a YIC is not positively related to contracts with universities. We show that if the firm's founder is or was a university professor researcher, motivated by commercializing research results then it is likely that the firm will have high levels of interaction with universities. Other firm founder motivations are either negatively associated or not associated with firm-university interaction. For example, if the motivation for founding a firm is to make more money this does not necessarily lead to more contracts with universities. Policy should try to understand whether this is desirable. In terms of policy instruments to foster the growth of university-firm links that lead to major (as opposed to minor) technological innovations, in our view, the emphasis should be on indirect actions (i.e. advice and consulting services) rather than on direct actions such as R&D subsidies and fiscal incentives, even though provision of the former is less straightforward (Lerner 2009).

In order to improve corporate governance, in the cases of YIC creators who are not able to overcome the cultural gap with universities, they might expand their management teams with the addition of people with similar motivations (employment, exploit business opportunities, earning more money) who have learnt how universities can fulfil their needs. Firm creators could try to overcome the cultural gap by improving their abilities and competences through external advisory services, such as coaching. This is in line with the study by Cosh and Hughes (2010), which discusses the differential roles played by intermediaries between firms and universities, in the USA and the UK. US firms report fewer direct contacts with universities, use coaching services and, also, are more likely to commit resources to supporting innovation related to university interactions.

In this study, the questionnaires were addressed to firm founders. However, many studies that take the firm as the unit of observation administer surveys which are responded to by an employee. Hence, the real unit of observation in these studies is the employee who responded to the survey and not the firm. This means that it is necessary to control for the employee's individual characteristics when assessing the impact of the characteristics of the firm on any possible outcome. In line with this reasoning, our finding that firm R&D intensity is not significant for interaction with university could perhaps be extrapolated to firms in general. Although it may not be applicable, it would open a stimulating line of research and future innovation surveys that include the personal characteristics and motivations of the respondent.

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Table 1 Having contracted with an institution for getting technology and strategic information (n=520, don't knows=1%)

Institution	No	Yes
Consultants	55%	43%
Universities	48%	51%
Technological institutes	42%	56%
Other institutions	80%	19%
Average	56%	42%

Table 2 Descriptive statistics – independent variables and firm characteristics

	Full sample					YICs					Other innovative firms					Mean
	Mean	St.dev.	Min.	Max.	Cases	Mean	St.dev.	Min.	Max.	Cases	Mean	St.dev.	Min.	Max.	Cases	differences test
University contracts	0.52	0.50	0	1	514	0.53	0.50	0	1	185	0.51	0.50	0	1	329	N.s.
Openness	1.20	0.90	0	3	514	1.07	0.89	0	3	185	1.28	0.89	0	3	329	*
R&D intensity	0.96	0.90	0	2	509	1.18	0.91	0	2	184	0.83	0.87	0	2	325	**
YIC	0.36	0.48	0	1	521	-	-	-	-	-	-	-	-	-	-	-
Firm size	0.60	0.74	0	2	516	0.16	0.40	0	2	186	0.84	0.78	0	2	330	**

** Significant at 1%. * Significant at 5%. N.s. Not significant

Table 3 Correlation matrix – firm characteristics – full sample

	Openness	R&D intensity	YIC	Firm size
Openness	1.00			
R&D intensity	-.03	1.00		
YIC	-.10	.19	1.00	
Firm size	.23	-.14	-.44	1.00

Table 4 Descriptive statistics – personal characteristics and motivations

	Mean	Standard deviation	Min.	Max.	Cases
Age	1.41	0.81	0	3	189
Sex	0.10	0.30	0	1	189
Education	1.16	0.65	0	2	189
Self-employment push	0.19	0.39	0	1	189
Monetary push	0.18	0.39	0	1	189
Academic pull	0.26	0.57	0	2	189
Business pull	0.79	0.95	0	4	189

Table 5 Correlation matrix – YIC sample

	Openness	R&D intensity	Firm size	Age	Sex	Education	Self-employment push	Monetary push	Academic pull	Business pull
Openness	1.00									
R&D intensity	.00	1.00								
Firm size	.04	-.03	1.00							
Age	.02	.10	.10	1.00						
Sex	-.05	-.02	-.09	-.05	1.00					
Education	-.03	.12	-.07	.01	.08	1.00				
Self-employment push	-.14	-.07	-.09	.26	.18	-.16	1.00			
Monetary push	-.06	.00	.02	-.15	-.11	.07	.03	1.00		
Academic pull	-.08	.24	-.10	.06	.10	.38	.02	.05	1.00	
Business pull	.21	-.14	-.06	-.09	-.09	-.02	.05	.19	.02	1.00

Table 6 Average value of having contracted with universities (yes/no), by economic sector

Economic sector	Full sample	YICs	Other innovative firms	Mean differences test
Supplier-dominated manufactures	0.40	0.00	0.44	*
Production intensive manufactures	0.54	0.58	0.53	N.s.
Science-based manufactures	0.57	0.67	0.49	N.s.
ICT services	0.57	0.57	0.57	N.s.
Research and development services	0.70	0.65	0.79	N.s.
Engineering, architecture, environmental services	0.47	0.52	0.43	N.s.
Other services	0.41	0.31	0.48	N.s.
Average	0.52	0.53	0.51	N.s.

** Significant at 1%. * Significant at 5%. N.s. Not significant

Table 7 Probit model of having contracted with universities (yes/no) – YICs vs. other innovative firms

	1 Full sample	2 YICs	3 Other innovative firms
Number of observations	498	178	320
Log likelihood function	-294	-104	-182
Prob[$\chi2$ > value]	0	0	0
Pseudo R^2	0.68	0.70	0.68
	Coeff. (t-ratio)	Coeff. (t-ratio)	Coeff. (t-ratio)
Constant	-1.05 (-5.55) **	-0.68 (-1.82)	-1.13 (-5.24) **
Openness	0.52 (7.08) **	0.38 (3.15) **	0.61 (6.41) **
R&D intensity	0.25 (3.48) **	0.27 (2.17) *	0.23 (2.51) *
YIC	0.22 (1.51)		
Firm size	0.34 (3.54) **	0.18 (0.69)	0.32 (3.05) **
Industry sector dummies	Included (6)	Included (6)	Included (6)
BIC	656	261	422

** p<0.01; * p<0.05

Table 8 Probit model of having contracted with universities (yes/no) – the effect of education and motivations in YICs

	1	2
Number of observations	178	185
Log likelihood function	-90	-98
Prob[$\chi 2$ > value]	0	0
Pseudo R^2	0.74	0.72
	Coeff. (t-ratio)	Coeff. (t-ratio)
Constant	-0.87 (-1.69)	-1.07 (-3.59) **
Openness	0.48 (3.51) **	0.49 (3.92) **
R&D intensity	0.1 (0.75)	
Firm size	0.28 (1.01)	
Age	-0.14 (-0.97)	
Sex	0 (0.01)	
Education	0.38 (1.97) *	0.42 (2.37) *
Self-employment push	-0.79 (-2.38) *	-0.75 (-2.54) *
Monetary push	0.11 (0.37)	
Academic pull	0.62 (2.54) *	0.67 (2.9) **
Business pull	-0.28 (-2.17) *	-0.27 (-2.42) *
Industry sector dummies	Included (6)	Selected (3)
BIC	268	243

** p<0.01; * p<0.05

SALIENDO DE LA TORRE DE MARFIL: CAPITAL SOCIAL, GRUPOS DE INVESTIGACIÓN UNIVERSITARIOS Y TRANSFERENCIA DE CONOCIMIENTO EN LA INNOVACIÓN ABIERTA

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Resumen

Se analiza la transferencia de conocimiento (TC) de los investigadores universitarios desde el capital social y la innovación abierta (*Open Innovation*, OI). La teoría del capital social indica como las interrelaciones sociales determinan la forma en que las organizaciones y los individuos comparten conocimiento y generan nuevo conocimiento y cómo esto afecta a la innovación. El paradigma de la OI plantea como la innovación que tiene éxito es aquella que se realiza conjuntamente con otras empresas, instituciones o universidades. A pesar de la relevancia que se le da a la TC, sorprendentemente son escasos los estudios que se centran en la perspectiva del investigador y, por extensión, de los grupos de investigación, bajo ambas perspectivas. Se presentan los resultados de un estudio empírico de responsables de grupos de investigación universitarios españoles y se testan diversas hipótesis relacionadas con el capital social y la propensión de los investigadores a transferir conocimiento.

Palabras clave: Transferencia de conocimiento, innovación abierta, grupos de investigación, universidades.

Abstract

The individual perspective (researchers) of Knowledge Technology Exchanges (KTE) from universities is analyzed in the context of the social capital and social capital and open innovation (OI) frameworks. Social capital theory indicates how social interactions determine the way that organizations and individuals share knowledge and generate new knowledge and how this affects innovation. The paradigm of OI affirms that a successful innovation is that which is done jointly with other companies, institutions or universities. Despite the importance that it has been given to KTE, surprisingly few studies that focus on the researcher's perspective and, by extension, research groups, under both perspectives have been published yet. In this paper, the results of an empirical study of Spanish managing directors of university research groups are presented and several hypotheses linking the social capital of researchers and its propensity to engage in KTE processes are formulated and tested.

Keywords: Knowledge transfer exchanges, open innovation, research groups, universities.

1. INTRODUCCIÓN

El modelo de Innovación Abierta (*Open Innovation model*, en adelante OI) (Chesbrough, 2003a) se viene usando cada vez más para explicar el proceso de desarrollo de la innovación a través de la organización. Asimismo, se observa un interés creciente en la investigación en OI, con objeto no sólo de explicar el concepto a nivel teórico, sino de encontrar las mejores estrategias para llevarlo a la práctica. En este contexto, las universidades están experimentando un proceso de cambio en la actualidad, evolucionando hacia el concepto de universidad emprendedora (Etzkowitz, Webster, Gebhardt & Terra, 2000; Etzkowitz, 2003, 2004), lo que implica el gran desafío de evolucionar desde su papel de "torre de marfil" a convertirse en agente de conocimiento (Gassmann, Enkel & Chesbrough, 2010). Por tanto, dichas instituciones necesitan revisar el tipo de relación que están desarrollando tanto con la sociedad en general, como con el mundo empresarial en particular.

En el contexto de la OI, las universidades juegan un papel crucial ya que son instituciones que cooperan y comparten conocimiento con otras organizaciones a través de procesos de transferencia de conocimiento (TC). Existen diversos estudios que analizan los procesos de TC a nivel institucional y organizativo (Etzkowitz, 2003; Debackere & Veugelers, 2005; Bercovitz & Feldmann, 2006; Decter, Benett & Leseure, 2007; Fabrizio, 2006). Asimismo, se han encontrado también diversos estudios que muestran el nivel individual como área de investigación relevante (Chesbrough, 2006, West, Vanhaverbeke & Chesbrough, 2006; Perkmann & Walsh, 2007; Hoye & Pries, 2009; Du Chatenier et al., 2010; Gassmann et al., 2010). Sin embargo, los factores que afectan la implicación de los investigadores en procesos de TC no han sido analizados en la literatura de forma integradora (Jacobson, Butterill & Goering, 2004) ni centrándose en la relevancia del capital social en un contexto de OI. Es más, como se explicará en más detalle posteriormente, el capital social de los investigadores necesita ser estudiado con mayor detalle, ya que los investigadores son los únicos agentes que participan en todas las fases del proceso de TC (descubrimiento científico, registro de la propiedad intelectual, comercialización y obtención de beneficio) y su papel en el mismo tiene una especial relevancia. Por tanto, es fundamental comprender qué factores sociales determinan su implicación en procesos de TC en el contexto de la OI, en la cual se producen múltiples interacciones entre las distintas partes implicadas (centros de I+D+i, empresas, etc.), con objeto de compartir conocimiento e innovar colaborativamente.

Este trabajo trata de cubrir dicho *gap* de investigación analizando empíricamente qué factores del capital social son los más relevantes a la hora de propiciar la implicación del investigador en dichos procesos. El estudio se sitúa por tanto en el debate actual existente sobre el rol que ejerce el individuo en el contexto de la OI y en particular persigue responder a ¿cuáles son los principales factores del capital social que determinan, si lo hacen, el que un investigador se implique en procesos de TC? Para ello, el artículo presenta la siguiente estructura: tras revisar la literatura principal existente sobre OI y TC, se plantean las hipótesis relativas a la influencia del capital social en la implicación en procesos de TC por parte del investigador. Tras esto se presentan los resultados del estudio empírico y los análisis estadísticos realizados. Tras la discusión de los resultados, se describen las principales conclusiones, limitaciones y futuras líneas de investigación.

2. EL MODELO DE INNOVACIÓN ABIERTA

2.1 Innovación Abierta

Este trabajo se posiciona dentro del debate actual sobre el desarrollo de un marco teórico más amplio de OI y la búsqueda de evidencia empírica, con el fin de desarrollar aún más el modelo de OI. El concepto de OI fue descrito por primera vez por Henry Chesbrough en su libro *Open Innovation: The New Imperative for Creating and Profiting from Technology*, publicado en 2003 (Chesbrough, 2003a). La idea que propuso fue que desde las últimas décadas del pasado siglo, las empresas comenzaron a cambiar de un modelo de innovación cerrada, basada en un círculo virtuoso de innovación, hacia un modelo más abierto que implica la colaboración con agentes externos y la comercialización de ideas en diferentes maneras, como *spin-offs* y licencias. En la innovación cerrada, una empresa generaba, desarrollaba y comercializaba sus propias ideas. Sin embargo, en el nuevo modelo de OI, una empresa no sólo comercializa sus propias ideas, sino también las innovaciones de otras empresas. Además, se busca la manera de llevar sus propias ideas al mercado mediante la implementación desarrollando contactos y alianzas fuera de sus negocios actuales (Chesbrough, 2003b). En consecuencia, este paradigma de OI trata la investigación y el desarrollo (I + D) como un sistema abierto.

Como base, la OI asume que el conocimiento útil se encuentra ampliamente distribuido, y que incluso las empresas más competentes en I + D deben identificar, conectarse y aprovechar las fuentes externas de conocimiento como proceso clave para desarrollar la innovación (Chesbrough, 2006). Aunque anteriormente se consideraba el desarrollo de nuevas ideas como algo propio de las grandes empresas, en este nuevo paradigma se reconoce que dichas ideas pueden ser desarrolladas en una variedad de entornos, departamentos de I+D de la empresa, instituciones académicas, centros de investigación, *spin-offs*, etc. Sin embargo, el paradigma de OI no implica sólo una externalización de la actividad de I + D, sino más bien una integración de las competencias internas y externas. La OI contempla tanto el conocimiento tanto entrante como saliente de la empresa, así como la colaboración entre los diferentes actores implicados (Buganza & Verganti, 2009; Van de Vrande, de Jong, Vanhaverbeke & de Rochemont, 2009; Chiaroni, Chiesa & Frattini, 2010, 2011). Son numerosos los beneficios que aporta el nuevo enfoque de OI (Wallin & Krogh, 2010): reducción del tiempo de llegada al mercado de nuevos productos, acceso a conocimientos únicos externos a la empresa, reducción del coste de la innovación, mejor adaptación de los productos y servicios a las necesidades del cliente, utilización comercial de los conocimientos o la tecnología que de otra manera no hubiera sido posible, riesgo compartido en el desarrollo de productos y servicios y mejora de la imagen de la empresa y su reputación. Dicho esto, también es cierto que la OI sigue siendo un área de investigación relativamente nueva y como Gassmann et al. (2010) señalan, la era de la OI está en aún su infancia y sólo recientemente ha evolucionado de ser un área de investigación abordada minoritariamente a convertirse en un área cada vez más relevante. Por otra parte, se han publicado números especiales en diversas revistas dedicados exclusivamente a profundizar en la temática, incluyendo el *International Journal of Technology Management* en 2010a, 2010b y *R&D Management* en 2006, 2009, 2010. La creciente importancia otorgada a la OI por parte de los académicos está siendo asimismo seguida por el mundo empresarial. Por todo ello, el concepto de OI (Chesbrough, 2003a) es un área creciente de investigación, y se está llevando a la práctica en un número creciente de empresas.

A la luz de la revisión de la literatura realizada, se puede concluir que existen varias líneas de investigación relacionados con la OI. En uno de los números especiales más recientes publicados sobre la temática (Gassmann et al., 2010) se destacaron las principales líneas de investigación en el área identificándose nueve perspectivas relevantes: perspectiva espacial, estructural, de usuarios, proveedores, apalancamiento, proceso, herramientas, institucional y cultural. Sin embargo, a pesar de dicho desarrollo académico y de que la era de la OI ya es una realidad para muchas empresas, aún falta una clara comprensión de los mecanismos, tanto dentro como fuera de la organización, y de cuándo y cómo aprovechar plenamente el concepto (Enkel, Gassmann & Chesbrough, 2009). En este sentido, existe un área relevante de la literatura que analiza el papel de las redes entre organizaciones y redes estratégicas como motores de la innovación. Así, el contexto interorganizativo de la OI ha sido abordado en diversos estudios (Vanhaverbeke, 2006; Vanhaverbeke & Cloodt, 2006), que describen la necesidad de las empresas de colaborar con otros actores en los sistemas de negocio y crear redes entre organizaciones para apoyar la OI. Asimismo, el papel crucial que desempeñan las redes de relaciones entre empresas se ha destacado como un tema fundamental en la investigación sobre temas estratégicos (Gulati, Nohria & Zaheer, 2000). El proceso de innovación e intercambio de conocimientos a través de las redes de profesionales también ha sido analizada recientemente, junto con el papel de las comunidades en la creación, formación y difusión de innovaciones (Fichter, 2009; Igartua, Albors & Hervás-Oliver, 2010). Por su parte, Du Chatenier et al. (2010) destacan que en la literatura sobre la temática es ampliamente reconocido que los individuos desempeñan un papel crucial en los procesos colaborativos de creación de conocimiento. Por todo ello, el presente estudio se centra en la perspectiva de usuario, analizando el aspecto humano de la OI, sobre todo a nivel individual y la relevancia del capital social de los mismos para implicarse en procesos de TC.

2.2 Innovación Abierta y Universidad

El modelo de OI muestra cómo las compañías innovan en cooperación con otras empresas u organizaciones de investigación y desarrollo. La OI es un paradigma que asume que las empresas que buscan avanzar en su tecnología, pueden y deben usar tanto ideas externas e internas, junto con canales internos y externos hacia el mercado (Chesbrough, 2006). Entre esas organizaciones, las universidades juegan un papel vital en el proceso de innovación. En particular, la TC desde las universidades y centros de investigación se considera cada vez más crucial para el desarrollo económico de las regiones y países. La literatura sobre OI se ha centrado principalmente en las ideas y el conocimiento que fluye de una empresa a otra. Sin embargo, existe una segunda fuente importante de conocimientos e ideas útiles para los procesos de OI de las empresas: las universidades (Fabrizio, 2006). El concepto de OI, interactiva y en red, sugiere que realmente, las relaciones entre las universidades y la industria, en lugar de ser relaciones genéricas, deben jugar un papel más importante en la generación de innovaciones (Perkmann & Walsh, 2007). En consecuencia, entre las líneas de investigación principales sobre OI, está el nuevo rol de las universidades y su evolución desde la torre de marfil a agente del conocimiento (Gassmann et al., 2010). De hecho, existen diversos estudios que abordan esta relación específica entre OI y universidades, como Fabrizio (2006), Perkmann & Walsh (2007), Melese, Lin, Chang & Cohen (2009) y Johnston, Robinson & Lockett (2010).

Con el fin de poner en marcha con éxito el paradigma de la OI, las empresas deben desarrollar la capacidad de identificar, asimilar y hacer uso de conocimiento e ideas externas. En el caso del conocimiento procedente de la investigación universitaria, hacer un uso efectivo de este conocimiento requiere una inversión adicional por parte de empresas, ya que deben desarrollar tanto capacidades internas como redes de colaboración con científicos externos (Fabrizio, 2006). Además, mientras que la investigación sobre los vínculos entre universidad e industria se ha centrado tradicionalmente en la transferencia de propiedad intelectual, existen diversas formas en que la investigación financiada con fondos públicos beneficia a la industria y la economía, tales como: asociaciones de investigación, servicios de investigación, emprendimiento académico, transferencia de recursos humanos, interacciones informales, comercialización de los derechos de propiedad y publicaciones científicas (Perkmann & Walsh, 2007). En consecuencia, dado que la mayoría de la investigación en OI se ha centrado exclusivamente en la empresa, siguen existiendo necesidades de investigación en cuanto a la identificación de antecedentes y consecuencias de las redes individuales en el desarrollo de la OI (West et al., 2006).

2.3 Capital social

El capital social es un concepto que es cada vez más popular en las disciplinas de ciencias sociales y en particular en la Dirección de Empresas (Adler & Kwon, 2002). Se define como las normas y relaciones sociales insertadas en estructuras sociales de la sociedad que posibilitan que las personas coordinen acciones y consigan sus objetivos deseados (Molina-Morales & Martínez-Fernández, 2010). También se ha definido como el conjunto de recursos insertados en, disponibles a través de, y derivados de, una red de relaciones que posee un individuo o una organización (Inkpen & Tsang, 2005). La propuesta fundamental de esta definición es que las redes de relaciones son un recurso valioso (como lo es el capital) para el individuo y para la organización (Inkpen & Tsang, 2005).

La intensidad de las interacciones sociales de una organización puede usarse como indicador del capital social (Nahapiet & Ghoshal, 1998). La fuente del capital social reside en la estructura y contenido de las acciones sociales de cada actor, derivando sus efectos de la información, la influencia y la solidaridad que hace disponible al actor (Adler & Kwon, 2002). Los beneficios del capital social son (Adler & Kwon, 2002): la información, ya que el capital social permite el acceso a fuentes de información más amplias y mejora la calidad de la información, la relevancia y la oportunidad; la influencia, el control y el poder; y la solidaridad, ya que la existencia de normas sociales y creencias, asociadas a una red social fuertemente cohesionada, hacen que se cumplan las normas locales y costumbres y reduce la necesidad de controles formales. Las interacciones sociales son canales a través de los cuales la información y los recursos fluyen y posibilitan el que un actor tenga acceso a los recursos de otros actores (Molina-Morales & Martínez-Fernández, 2010). Las interacciones sociales se dan entre individuos de distintas organizaciones y forman parte de la naturaleza social del ser humano. El hecho de que los individuos interactúen voluntariamente alrededor de un tema hace que se desarrollen comunidades de compartición de conocimiento (Molina-Morales & Martínez-Fernández, 2010). Las interacciones sociales son muy importantes para la creación y difusión de la innovación, al igual que una organización, el hecho de que un individuo esté conectado y tenga un número suficiente de interacciones mejorará sus posibilidades de compartir conocimiento, combinarlo con conocimiento previo y crear nuevo conocimiento que le permitirá innovar.

En la literatura se ha analizado el papel del capital social en las redes interorganizativas y como se produce la TC entre las organizaciones miembros (Inkpen & Tsang, 2005). Por otro lado, Molina-Morales & Martínez-Fernández (2010) en base a una muestra de 220 empresas españolas encontraron que efectivamente las interacciones sociales de una empresa hacían a las empresas más innovadoras, tanto en innovación de producto como de proceso. Y finalmente, González-Álvarez & Solís-Rodríguez (2011), utilizando datos del informe GEM España, concretamente de 1.473 emprendedores activos, y realizando un análisis causal observaron el papel fundamental ejercido por las conexiones y redes sociales a la hora de emprender. Los resultados obtenidos mostraban que, si bien tanto los factores sociales como los factores cognitivos tienen una influencia directa sobre la decisión de emprender, los factores sociales también influyen sobre los factores cognitivos por lo que estos últimos actúan como variables mediadoras entre los factores sociales y la decisión de crear una empresa.

En el presente estudio se analiza el impacto que tiene el capital social del investigador a la hora de determinar su implicación en procesos de TC en el ámbito universitario, en el contexto de la OI. En el siguiente epígrafe se conceptualizan las variables medidas y se proponen las hipótesis de investigación.

3. MARCO CONCEPTUAL

3.1 Transferencia de conocimiento (TC)

Mitton et al. (2007) definen a la TC como un proceso interactivo que involucra el intercambio de conocimientos entre los productores y usuarios de la investigación, ya que la utilización eficaz del conocimiento requiere más que una comunicación unidireccional. Es necesaria también una verdadera interacción entre los investigadores, responsables, y otras partes interesadas, lo que coincide con lo mencionado anteriormente en relación con el modelo de OI. Además, los procesos de TC se desarrollan tanto a nivel individual como organizacional, principalmente a través de las interacciones entre las comunidades de investigación y usuarios, y que tienen como objeto estimular la productividad en el futuro, la prosperidad económica y las ventajas competitivas (Johnston et al., 2010). Como resultado de estas interacciones, nuevos conceptos, productos o procesos son transferidos de una organización a otra, para el beneficio comercial de ambas partes (Decter et al., 2007).

Asimismo, los procesos de TC en el ámbito universitario incluyen (McAdam, Kegh, Galbraith & Laurie, 2005; Bercovitz & Feldman, 2006): la financiación de proyectos de investigación, las licencias, la contratación de investigadores, y la creación de *spin-offs*. Estas relaciones incluyen tanto los mecanismos formales como informales de TC en el ámbito universitario (Link, Siegel & Bozeman, 2007). En este trabajo, los mecanismos formales de TC en el ámbito universitario se definen como la relación formal entre un investigador de la universidad y una empresa/institución pública basado en la firma de un acuerdo legal (aprobado por una Oficina de Transferencia de Tecnología de la Universidad, OTRI) o la licencia de una patente.

Por otra parte, los agentes relevantes para la TC universitaria, con motivaciones diferentes a la hora de implicarse en los mismos, incluyen el investigador que descubre las nuevas tecnologías y los directores de las OTRIs que administran los derechos de autor y los acuerdos con las empresas interesadas en los intercambios (Siegel et al., 2003). Estos agentes, junto con las empresas/empresarios capaces de comercializar las tecnologías desarrolladas por la Universidad, constituyen los agentes relevantes para la TC universitaria. Finalmente, el proceso de TC generalmente sigue estas fases (Siegel et al., 2003): descubrimiento científico, aseguramiento de la propiedad intelectual, comercialización de la propiedad intelectual y realización de beneficios. Curiosamente, el único agente efectivamente involucrado en todas las actividades es el investigador. Por lo tanto, la comprensión de los factores que influyen en su implicación en procesos de TC es de vital importancia.

3.2 Factores que determinan la implicación del investigador en procesos de TC en el ámbito universitario: capital social

En base a la experiencia de los propios autores en procesos de TC universitarios y en una revisión de la literatura específica, se determinaron los principales factores del capital social de los investigadores que podían afectar a su implicación en procesos de TC. La experiencia de los autores con respecto a la TC se traduce en la firma de 17 contratos de investigación y/o consultoría con empresas privadas e instituciones públicas llevados a cabo entre 2002 y 2010. El hecho de que los autores hayan participado activamente en estos procesos les ha permitido obtener un conocimiento útil, sobre todo en relación con los factores que facilitan o impiden la TC universitaria. Los factores considerados más relevantes para la consecución de TC exitosos, y que han sido analizados empíricamente han sido: el tamaño del grupo de investigación (Bercovitz & Feldman, 2006; Zhou & Zhu, 2008; Kim et al., 2009; Boardmand & Ponomariov, 2009), las relaciones interpersonales, los contactos con empresas y con la OTRI (Siegel et al., 2003; Link et al., 2007; Kim et al., 2009), y la facilidad de comunicación y habilidades sociales en general de los investigadores (Debackere & Veugelers, 2005; Landry et al., 2007; Link et al., 2007, Hoye & Pries, 2009; Du Chatenier et al., 2010; Johnston et al., 2010). Asimismo, siguiendo las indicaciones de Molina-Morales & Martínez-Fernández (2010) se considera la intensidad de las relaciones sociales del individuo con diversos agentes como un indicador de su capital social.

En cuanto al tamaño del grupo de investigación, en primer lugar, Bercovitz & Feldman (2006) consideran que la decisión del investigador de participar en TC viene determinada, entre otros factores, por el liderazgo que se ejerce dentro del grupo de investigación y por los efectos de cohorte. En este sentido, el comportamiento del jefe del departamento parece tener un efecto influyente: si el responsable del departamento participa activamente en procesos de este tipo, entonces es más probable que los otros miembros del departamento se impliquen en procesos de transferencia. Curiosamente, este comportamiento también está determinado por la experiencia de aquellos en una posición similar, en términos de rango académico y pertenencia al departamento. Si un investigador observa que los miembros de su departamento están implicados en TC, es más probable que él también se implique. En este sentido, diversos estudios señalan el tamaño del grupo de investigación como facilitador de los procesos de TC (Bercovitz & Feldman, 2006; Zhou & Zhu, 2008; Kim et al., 2009; Boardmand & Ponomariov, 2009), al posibilitar la generación de interrelaciones de valor. Por lo tanto, la siguiente hipótesis puede ser propuesta:

Hipótesis 1: A mayor tamaño del grupo de investigación mayor propensión a implicarse en procesos de TC.

Sobre el capital social de los individuos, en el contexto de la OI, este es de primordial importancia para el éxito de la innovación. De ello, se desprende que las redes sociales de los investigadores, sean factores importantes a considerar. Como Link et al. (2007) pusieron de relieve, las redes sociales juegan un papel importante en la TC universidad-industria. Estas redes incluyen a científicos académicos e industriales, responsables universitarios, directores de las OTRIs, y directivos/empresarios. En este sentido, como barreras que impiden la TC en el ámbito universitario, se han destacado las barreras culturales y de información entre los tres principales agentes implicados (autoridades universitarias, académicos y empresas), la rigidez burocrática, los sistemas de recompensa mal diseñados, y la gestión ineficaz de las OTRIs (Siegel et al., 2003). Por su parte, Kim et al. (2009), tras llevar a cabo una extensa revisión bibliográfica sobre la transferencia de tecnología universitaria, propusieron una lista de las características de la universidad que podrían influir en el proceso de TC, entre las que destacan: misión de la universidad y objetivos de TC, su reconocido prestigio académico e investigador, el tamaño de la universidad, el tamaño de la OTRI y su experiencia en TC. En estos trabajos se destaca como las OTRIs juegan un papel fundamental como facilitadoras de procesos de TC, al poner en contacto empresa y mundo académico, facilitando las interacciones entre ambos. Por ello, se considera que las relaciones entre investigadores y OTRIs, así como el tiempo efectivo dedicado a dichas interacciones pueden considerarse como un componente del capital social de los investigadores, jugando un papel determinante en su implicación efectiva en procesos de TC. Consecuentemente se proponen las siguientes hipótesis:

Hipótesis 2: El contacto con la OTRI de su Universidad por parte del investigador se relaciona positivamente con su participación en procesos de TC universitarios.

Hipótesis 3: El tiempo semanal dedicado a contactos/interacciones con la OTRI de su Universidad por parte del investigador se relaciona positivamente con su participación en procesos de TC universitarios.

Finalmente, en cuanto a la facilidad de comunicación y habilidades sociales en general de los investigadores, Johnston et al. (2010) destacaron la importancia de los procesos sociales y las interacciones en redes para la superación de las barreras a la hora de poner en práctica procesos de TC. También señalaron que, aunque en muchos casos las relaciones y sinergias entre las universidades y la industria están en todavía en una primera etapa de desarrollo, una perspectiva a largo plazo debe ser adoptada para permitir el aprendizaje mutuo y la creación de comunidades de conocimiento a largo plazo. Del mismo modo, Landry et al. (2007) señalaron la importancia fundamental de los factores relacionales, argumentando que, en un contexto de asimetría de información, es poco probable la transferencia de conocimientos si los investigadores y usuarios de la investigación no tienen interacciones frecuentes. La creación de vínculos entre investigadores y usuarios de la investigación puede superar esta asimetría de la información y facilitar la utilización de las posibilidades y oportunidades que proporciona la investigación. .Asimismo, los efectos de participar en este tipo de redes son beneficiosos para ambas partes, los académicos pueden aumentar sus resultados de investigación (por ejemplo, publicaciones) y los directivos pueden mejorar las capacidades de innovación de sus empresas. De ello se desprende que la TC depende de las oportunidades creadas por los vínculos entre los investigadores y los usuarios de la investigación. Además, trabajar en un contexto de OI es (en algunos aspectos) diferente a trabajar en la innovación cerrada o en otros contextos y por lo tanto, requiere algunas competencias específicas (Du Chatenier et al., 2010). En un estudio empírico con profesionales de OI en Holanda se encontró que las competencias más relevantes eran las capacidades de intermediación y ser socialmente competentes y por lo tanto estas deben recibir mayor atención en la investigación (Du Chatenier et al., 2010). Por su parte, Hoye & Pries (2009) observaron que entre el personal académico existía una especie de "comercializadores frecuentes", que representaban una parte enorme de las tecnologías comercializadas derivadas de la investigación universitaria. Se observó que los comercializadores frecuentes mostraban una actitud favorable respecto a la comercialización, eran investigadores altamente productivos e intervenían en una amplia gama de interacciones con la industria durante largos períodos. Estas interacciones entre universidad e industria incluían: ofrecer seminarios, cursos y talleres para la industria, realización de contratos de investigación para la industria, consultoría, participación en conferencias y exposiciones comerciales, años sabáticos en la industria, participando en los comités y grupos de profesionales, y mantener el contacto con estudiantes y colegas que se habían trasladado a la industria. Además, encontraron que las relaciones con profesionales del mundo empresarial parecían ser un factor importante en el desarrollo de sus habilidades de comercialización, por ejemplo, en el reconocimiento de las oportunidades para la transferencia de tecnología. En concreto, los contactos con investigadores externos ha sido estudiado por Debackere & Veugelers (2005), mientras que la decisión conjunta sobre los proyectos de investigación ha sido estudiado por Landry et al. (2007), Link et al. (2007) y Hoye & Pries (2009). Como consecuencia de todo lo anterior, las siguientes hipótesis pueden ser planteadas:

Hipótesis 4: La interacción con investigadores externos del investigador se relaciona positivamente con su participación en procesos de TC universitarios.

Hipótesis 5: El tiempo semanal dedicado a los contactos/interacciones con investigadores externos se relaciona positivamente con su participación en procesos de TC universitarios.

Hipótesis 6: La decisión conjunta con empresas de las líneas de investigación por parte del investigador se relaciona positivamente con su participación en procesos de TC universitarios.

Hipótesis 7: El tiempo semanal dedicado a realizar contactos/interacciones con empresas para decidir conjuntamente las líneas de investigación por parte del investigador se relaciona positivamente con su participación en procesos de TC universitarios.

4. METODOLOGÍA

Existen diversos estudios empíricos que analizan la participación de profesores universitarios en procesos de TC en distintos países: Estados Unidos (Siegel et al., 2003, 2004; Link et al., 2007.), Estados Unidos y Reino Unido (Decter et al., 2007.), Canadá, (Landry et al., 2007; Hoye & Pries, 2009) y China (Zhou & Zhu, 2008). En dichos trabajos, la metodología de recogida de la información se basó en el desarrollo de encuestas, apoyadas en algunos casos con el desarrollo de entrevistas con agentes claves. Dicha metodología se utilizó como base para definir el método de recolección de información en el presente estudio. Para recabar la información se realizó un estudio empírico en diez universidades situadas en Andalucía. Respecto a la situación en España respecto a los procesos de TC en el contexto universitario, desde los años ochenta todas las universidades españolas han tenido una OTRI. La legislación española reconoce la posibilidad de que los científicos universitarios/investigadores firmen un contrato de transferencia con empresas privadas/instituciones públicas. De las tres principales posibilidades (contrato formal, explotación de una patente, creación de una *spin-off*), el contrato formal gestionado por las OTRIs es el más utilizado en la TC. La metodología específica del estudio empírico consistió en, a partir de la revisión de la literatura y basado también en la experiencia de los autores, construir un cuestionario web para medir los diversos factores del capital social considerados. Se realizó un pre-test con cuatro investigadores con distinta experiencia previa en TC con el fin de mejorar la estructura y la claridad del cuestionario, lo que dio lugar a cambiar varias preguntas. Por último, una entrevista en profundidad con el director de una OTRI permitió precisar más el tema. Este proceso dio lugar a una depuración de la lista inicial y una selección de los temas considerados más adecuados para la medición y posterior contraste de las hipótesis. El cuestionario fue dirigido a los responsables de los grupos de investigación, es decir, los encuestados fueron los investigadores que dirigían un grupo de investigación compuesto por un mínimo de tres doctores y cinco graduados (que es el tamaño mínimo de un grupo de investigación de acuerdo con la regulación autonómica). Estos grupos de investigación son en su mayor parte dependientes de las universidades, que llevan a cabo la mayoría de las investigaciones en la región. El número de cuestionarios válidos debidamente cumplimentados fue de 382. La tasa de respuesta a los cuestionarios enviados fue del 24,13%. El tamaño de la muestra (382 encuestas válidas) tenía una fiabilidad del 95,5 para una población de 1823 responsables de los grupos de investigación registrados oficialmente, por lo que el error máximo de muestreo fue del 4,55%. Con el fin de verificar que la muestra obtenida era de hecho representativa de la población, se analizó el sesgo de no respuesta. Se utilizó el método de extrapolación lo que supone que los sujetos que responden al final del proceso de recolección de datos son representativos de los que no respondieron (Amstrong & Overton, 1977). Por lo tanto, los datos obtenidos de los investigadores que respondieron al principio se compararon con los que respondieron al final. Después de esto, se realizó una prueba U de Mann-Whitney con el fin de probar la diferencia de medias en todas las variables del cuestionario. Se observó que no existían diferencias significativas en las diferentes variables analizadas entre los dos grupos de encuestados, por lo que el sesgo de no respuesta no afectaba a los datos de este estudio. En cuanto a los métodos estadísticos, el análisis estadístico se realizó en dos etapas para probar las hipótesis mencionadas. En primer lugar, se llevó a cabo un análisis de correlación (Spearman) con los diversos ítems considerados. En segundo lugar, se realizó un análisis de regresión con el fin de identificar qué componentes del capital social explicaban, de manera causal, la implicación del investigador en procesos de TC.

5. RESULTADOS

5.1. Resultados descriptivos

El promedio de edad de los encuestados fue 50,66 años (desviación estándar 7,9 años). La antigüedad media en la universidad fue de 24 años (desviación estándar 8,54). Por otra parte, el 44,7% de los entrevistados había estado trabajando en la universidad más de 17 años. El tamaño del grupo de investigación, en general, no era excesivamente elevado: el 23,9% de los grupos entrevistados tenía siete u ocho miembros, con un promedio de 11,15 (desviación estándar 3,48). En cuanto a la composición de los grupos de investigación, el 48,8% de los grupos no contaba con miembros pertenecientes a organismos públicos distintos de la universidad, mientras que el 72,7% no incluía miembros que estuvieran trabajando en la empresa privada. En cuanto a la participación de los investigadores en los procesos de TC desde la Universidad (medida como la obtención de una patente o firma de un contrato formal), sólo el 11,8% habían realizado ambos tipos de transferencia. Centrándose en las patentes, sólo el 17,5% de los grupos de investigación había registrado una patente, mientras que el 52,9% de los grupos de investigación habían firmado contratos para TC (48,7% de los contratos se firmaron con las empresas, seguido por las instituciones públicas y otras instituciones privadas).

5.2 Análisis de correlaciones

En este estudio, la TC se ha considerado como la relación formal entre un investigador universitario y una empresa/institución pública basada en la firma de un acuerdo legal (aprobado por la OTRI) o licencia de una patente. Los elementos considerados para la medición de los factores del capital social fueron: número de miembros del grupo de investigación, contacto con la OTRI, tiempo semanal dedicado a dichos contactos/interacciones (OTRI), interacción con investigadores externos, tiempo semanal dedicado a dichos contactos/interacciones (investigadores externos), decisión conjunta con empresas de las líneas de investigación y tiempo semanal dedicado a dichos contactos/interacciones (empresas). En primer lugar, se realizó un análisis de correlación utilizando el coeficiente de Spearman. Dicho coeficiente es una medida no paramétrica de la dependencia estadística entre dos variables categóricas y su valor puede variar de menos uno a uno. Uno negativo indica una correlación negativa perfecta, mientras que uno más indica una correlación positiva perfecta. La importancia (probabilidad) del coeficiente de correlación se determina a partir del estadístico t, que indica si la correlación es significativamente diferente de cero (siempre que el nivel crítico bilateral sea menor que 0,05). Se estimaron los estadísticos de correlación entre dichos ítems y todos se encontraron significativamente correlacionados ($p < 0{,}05$) (Ver Tabla 1).

5.3. Regresión logística

Con el fin de explicar mejor la participación del investigador en los procesos de TC y analizar causalmente el efecto de los diversos ítems del capital social considerados, se realizó un análisis de regresión. El modelo de regresión fue formulado de la siguiente manera:

TC = β0 +β1 TAMAÑO GI +β2 CONTACTO_OTRI +β2 TIEMPO_CONTACTO_OTRI +β3 INVESTIGADORES_EXTERNOS +β4 TIEMPO_INVESTIGADORES_EXTERNOS +β5 DECISIÓN_CONJUNTA_EMPRESAS+β6 TIEMPO_CONTACTOS_EMPRESAS DECISIÓN_CONJUNTA +□

Como la variable dependiente era dicotómica, se empleó el procedimiento de regresión logística binaria utilizando SPSS Statistics 18 IBM PASSW. La principal ventaja de este método, a diferencia de otros métodos de regresión (análisis discriminante), es la disponibilidad de las pruebas de bondad de ajuste del modelo: -2 log de la verosimilitud, bondad de ajuste estadístico, Cox y Snell R^2, Nagelkerke R^2 y prueba de Hosmer-Lemeshow. Tras estimar la regresión se observó que el 71,2 por ciento de los casos fueron clasificados correctamente por el modelo. Los coeficientes de bondad de ajuste aparecen reflejados en la tabla 2. (Ver Tabla 2)

Las pruebas de bondad de ajuste indican la idoneidad del modelo y lo bien que encaja con los resultados reales. El R^2 de Cox y Snell no sigue un intervalo entre 0 y 1, por lo que suele utilizar el R^2 Nagelkerke (Nagelkerke, 1991) que si oscila entre estos valores. Se observa que el modelo estimado explica un 29,4% de variabilidad de los datos. La bondad de ajuste se puede estimar también con la prueba de Hoesmer-Lemeshow, donde la no significatividad del valor de la Chi cuadrado es un indicador de la bondad de ajuste. En este caso, $p > 0{,}05$ indica que el modelo se ajusta bien a los datos. En este contexto, el problema potencial de auto correlación debe ser mencionado, en la medida en qué puede afectar a los resultados obtenidos en la regresión. Como una aproximación para la detección de las pruebas de auto correlación se puede ejecutar varias, siendo una de las más utilizadas el estadístico D de Durbin Watson. Este método fue utilizado para probar la presencia de auto correlación en los datos. Si el valor de D es cercano a 2 no hay auto correlación. Tras ejecutar la prueba para todas las variables analizadas se encontró que estaban cerca de 2 (1,96-2,09). En consecuencia, puede afirmarse que no hay auto correlación en los datos examinados. (Ver Tabla 3)

Los resultados de la regresión se resumen en la Tabla 3. En ella, los coeficientes de regresión estandarizados Exp (B) permiten valorar la importancia relativa de cada variable independiente dentro de la ecuación de regresión. Se observa como los únicos coeficientes significativos ($p<0,05$) fueron: el número de investigadores del grupo de investigación, la decisión conjunta con las empresas de las líneas de investigación, el contacto con la OTRI y el tiempo dedicado a los contactos con OTRI y empresas. De acuerdo con los valores observados de los coeficientes Exp (B), se puede observar que los predictores más fuertes de la participación en TC eran el contacto con la OTRI y la decisión conjunta de las líneas de investigación.

6. DISCUSIÓN Y CONCLUSIONES

6.1 Discusión de los resultados

En primer lugar, en el análisis de correlación se observó que el número de miembros del grupo de investigación estaba correlacionado con la implicación en procesos de TC. Esto refleja el tamaño de la unidad de organización donde se realiza la investigación, un hallazgo en línea con Landry et al. (2007), y una variable relevante en el caso de Zhou & Zhu (2008). Asimismo, en dicho análisis se observó que los diversos ítems propuestos como medidas del capital social (decisión conjunta de líneas de investigación, contacto con OTRI y empresas, tiempo dedicado a dichos contactos y decisión conjunta de líneas de investigación), se encontraron significativas, al igual que encontraron autores como Landry et al. (2007) y Hoye & Pries (2009). Por otra parte, los resultados del análisis de regresión reflejan que, de las variables correlacionadas significativamente, solo cinco tenían una relación causal con la transferencia de tecnología y actuaban como predictoras de dicho comportamiento. De acuerdo con este análisis, puede concluirse que la implicación en la transferencia de tecnología del investigador está parcialmente explicada por la influencia del número de investigadores que conforman el grupo de investigación, los contactos con la OTRI, el tiempo dedicado a estos contactos y la decisión conjunta de las líneas de investigación, así como el tiempo dedicado a ello. Por tanto, se rechazan las hipótesis 4 y 5, relacionadas con las relaciones con investigadores externos y el tiempo dedicado a ello. Y se aceptan 1, 2, 3, 6 y 7, relacionadas con el tamaño del grupo de investigación, el contacto con la OTRI, el tiempo dedicado a ello y la decisión conjunta de las líneas de investigación con empresas, así como el tiempo dedicado a ello. Estos hallazgos son consistentes con muchos estudios previos que han puesto de relieve la importancia de estas relaciones para la TC (Link et al., 2007; Landry et al., 2007). Estos resultados también están en la línea con los obtenidos por Siegel et al. (2004), que destacaron el factor relacional como un factor clave para la TC. En consecuencia, tener la capacidad de administrar este tipo de redes es esencial y altamente beneficiosa, ya que potencialmente pueden reforzar los efectos indirectos de la red y conducir a una mayor innovación (Almirall & Casadesus-Masanell, 2010). Por lo tanto, los resultados del trabajo proporcionan evidencia empírica de que diversos aspectos del capital social del investigador, concretamente sus relaciones con la OTRI y con empresas, determinan su participación en los procesos de TC.

6.2 Conclusiones

El presente estudio ha analizado la relevancia del capital social a la hora de determinar la implicación de los investigadores universitarios en los procesos de transferencia de tecnología en el contexto de la OI. En él se ha profundizado a nivel teórico en la conceptualización del tema y se ha aportado evidencia empírica sobre una serie de hipótesis que relacionan la implicación de los investigadores en la transferencia de tecnología y diversos aspectos de su capital social. Se ha evidenciado como el tamaño del grupo de investigación, el contacto con la OTRI de su Universidad por parte del investigador, el tiempo semanal dedicado a contactos/interacciones con la OTRI de su Universidad, la decisión conjunta con empresas de las líneas de investigación por parte del investigador y el tiempo semanal dedicado a realizar contactos/interacciones con empresas para decidir conjuntamente las líneas de investigación por parte del investigador conllevan una mayor propensión a implicarse en procesos de TC. Sin embargo, no todos los factores considerados del capital social tienen esta influencia causal. Así, la interacción con investigadores externos del investigador y el tiempo semanal dedicado a los contactos/interacciones con dichos investigadores externos no se relaciona causalmente con la participación del investigador en procesos de TC universitarios.

De los resultados de este estudio se derivan algunas recomendaciones a nivel institucional e individual. Para las instituciones, dada la importancia del capital social y las interacciones sociales, las universidades deberían promover que sus investigadores participen en grupos de investigación de mayor tamaño, tengan buenas relaciones con las OTRIS, establezcan contactos con empresas, incluyendo la organización de oportunidades para que se reúnan ya sea de manera formal o informal con los grupos de usuarios (a través de jornadas u otros) y proveer además con formación en habilidades como comunicación y comprensión de los contextos del usuario (Jacobson et al., 2004). Otra recomendación sería que las OTRIs tomen más la iniciativa en cuanto a los contactos con empresas e investigadores, ya que, de acuerdo a los hallazgos de este estudio, los contactos en entre la OTRI y los investigadores afectan positivamente a la implicación en la transferencia de los investigadores/directores de grupos de investigación. Para los investigadores, el hecho de implicarse en la TC requiere un cambio de comportamiento, ya que se ha constatado la importancia de los factores sociales (contactos con las OTRIs, empresas, etc.), lo que indica que los investigadores tienen que salir de la denominada torre de marfil universitaria y acercarse al mundo de la empresa. Adaptarse a este cambio no es nunca fácil, que ya normalmente se presentan resistencias como resultado de las creencias tácitamente asumidas por los investigadores en los cuales la evolución de estas nuevas ideas requiere un tiempo considerable (Martín & Cuenca, 2002; Jacobson et al., 2004).

Finalmente, este trabajo presenta al menos cuatro limitaciones. En primer lugar, se trata de un estudio exploratorio con resultados limitados. Debido a la falta de investigación en el área específica de los factores que afectan al investigador, este estudio podría considerarse como un primer intento para proporcionar un marco de investigación surgido de la revisión de la literatura y presentar alguna evidencia empírica para ser desarrollada posteriormente. Sin embargo, se ha podido construir y testar un modelo de siete hipótesis con conclusiones interesantes que reflejan las posibilidades de esta área para seguir investigando en el futuro. En segundo lugar, este estudio está limitado a una región de España, por lo que podría haber diferencias entre las actitudes de los investigadores de esta comunidad comparado con otras partes de país o de otros países. Sin embargo, el tamaño de la muestra aleatoria analizada y la propia diversidad de la comunidad autónoma y de sus universidades, hace pensar en una representatividad adecuad. En tercer lugar, hay una limitación unida al instrumento de medida (un cuestionario auto administrado en web, enviado por correo electrónico), que solo considera evaluaciones cuantitativas a las preguntas, mientras que la TC es una cuestión tan compleja que la información cualitativa seria también interesante para obtener resultados más detallados. Además, aunque el cuestionario se basó en la revisión de la literatura y en la propia experiencia de los autores en procesos de TC, la medición del capital social debería ser mejorada en fututos estudios para tener una mayor fiabilidad. Una cuarta limitación es el hecho de que el estudio está basado en datos de carácter transversal que se refieren a un momento determinado en el tiempo. El uso de datos longitudinales podría haber permitido analizar cuanto cambian las actitudes de los investigadores en el tiempo, y su relación con modificaciones legales u organizativas.

Como futuras líneas de investigación se pueden sugerir las siguientes. Primero, sería útil mejorar la medida del capital social. Además, el marco de investigación mejorado debería ser testado de una forma confirmatoria, realizando un estudio empírico basado en datos longitudinales que podría posibilitar la comparación entre las actitudes de los investigadores hacia la TC a lo largo del tiempo. Finalmente, considerando que este estudio se centró en una región específica, extender el ámbito de análisis sería interesante para asegurar la generalización de los hallazgos obtenidos.

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Tabla 1: Análisis de correlaciones

ITEMS	Coeficiente de Spearman	Significación	Existencia de correlación significativa
TAMAÑO_GI	0,128	0,012	Aceptada
CONTACTO_OTRI	0,316	0,000	Aceptada
TIEMPO_CONTACTO_OTRI	0,343	0,000	Aceptada
INVESTIGADORES_EXTERNOS	0,352	0,000	Aceptada
TIEMPO_INVESTIGADORES_EXTERNOS	0,141	0,006	Aceptada
DECISIÓN_CONJUNTA_EMPRESAS	0,253	0,000	Aceptada
TIEMPO_CONTACTOS_EMPRESAS_DECISIÓN_CONJUNTA	0,219	0,000	Aceptada

Tabla 2: Bondad del ajuste de la regresión logística binaria

Tests de bondad del ajuste del modelo			
Paso	–2 log-likelihood	R2 de Cox y Snell	R2 de Nagelkerke
1	424,103	0,218	0,294
Estadístico de bondad del ajuste de Hosmer-Lemeshow			
Paso	Chi cuadrado	Grados de libertad	Significación
1	7,069	8	0,529

Tabla 3: Resultados de la regresión logística binaria

Variables en la ecuación								
	B	E.T.	Wald	gl	Sig.	Exp(B)	I.C. 95,0% para EXP(B)	
							Inferior	Superior
TAMAÑO_GI	**,061**	**,024**	**6,482**	**1**	**,011**	**1,063**	**1,014**	**1,115**
CONTACTO_OTRI	**1,356**	**,248**	**29,829**	**1**	**,000**	**3,880**	**2,385**	**6,311**
TIEMPO_CONTACTO_OTRI	**,522**	**,194**	**7,213**	**1**	**,007**	**1,685**	**1,151**	**2,466**
INVESTIGADORES_EXTERNOS	,045	,045	,967	1	,325	1,046	,957	1,143
TIEMPO_INVESTIGADORES_EXTERNOS	-,124	,222	,314	1	,575	,883	,571	1,365
DECISIÓN_CONJUNTA_EMPRESAS	**,677**	**,294**	**5,298**	**1**	**,021**	**1,968**	**1,106**	**3,503**
TIEMPO_CONTACTOS_EMPRESAS_DECISIÓN_CONJUNTA	**,335**	**,159**	**4,413**	**1**	**,036**	**1,398**	**1,023**	**1,911**
Constante	-2,442	,442	30,563	1	,000	,087		

CAPITAL SOCIAL COGNITIVO, ADQUISICIÓN DE CONOCIMIENTO Y RESULTADO DE LA INNOVACIÓN EN LOS DISTRITOS INDUSTRIALES: EL PAPEL MODERADOR DE LA CAPACIDAD DE ABSORCIÓN

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RESUMEN

Este trabajo aborda los factores que inciden en la heterogeneidad en el acceso al conocimiento y su explotación a través de la innovación entre las empresas aglomeradas. La perspectiva dinámica y secuencial de la capacidad de absorción, junto a las aportaciones de la teoría del capital social y el enfoque basado en el conocimiento constituyen la base teórica del trabajo. Con este estudio profundizamos en el papel de los componentes de la capacidad de absorción –identificación y combinación- en el proceso que conduce a las empresas de los distritos industriales con capital social cognitivo a obtener innovaciones efectivas a través de la adquisición de conocimiento. El análisis empírico realizado sobre una muestra de 166 empresas localizadas en los distritos del sector del calzado en España, nos permite comprobar que la capacidad de identificación impulsa la adquisición de conocimiento relevante a partir de la interacción de la empresa con agentes del distrito con los que comparte visión, metas y cultura. Los resultados también indican que la capacidad de combinación fortalece el camino del conocimiento novedoso adquirido para desarrollar y explotar innovaciones de éxito. Las conclusiones del estudio nos ofrecen implicaciones para las empresas y las instituciones de los distritos industriales.

Palabras clave:

Capacidad de absorción, capital social cognitivo, conocimiento, innovación, distrito industrial.

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1. INTRODUCCIÓN

La literatura económica ha atribuido tradicionalmente ventajas derivadas de la aglomeración territorial de empresas (Marshall, 1925). En los distritos industriales se generan flujos de experiencias, información y conocimiento que circulan libremente entre los agentes que pertenecen a los mismos (Becattini, 1979). En esta atmósfera industrial se ha defendido el carácter publico y común de recursos relevantes de conocimiento para los miembros del distrito (Becattini, 1990). Sin embargo, diferentes autores indican que los flujos de conocimiento son accesibles sólo para determinadas empresas (Molina-Morales y Martínez-Fernández, 2009). Nosotros proponemos indagar en los factores que inciden en la heterogeneidad en el acceso conocimiento y su explotación a través de la innovación entre las empresas aglomeradas (Giuliani and Bell, 2005; Inkpen and Tsang 2005; Muscio, 2006).

La teoría del capital social ha ido adquiriendo en las últimas décadas un creciente protagonismo para explicar las redes sociales interorganizativas (Nahapiet y Ghoshal, 1998; Koka y Prescott, 2002). El capital social, entendido como la estructura y el contenido de las relaciones, puede facilitar los flujos de conocimiento valioso entre agentes, limitando los problemas de coordinación y los costes de transacción en contextos de aglomeración de empresas (Lin, 2001). Sin embargo, determinados autores han señalado que la excesiva densidad y confianza de las redes sociales pueden generar problemas de aislamiento y bloqueo, restringiendo la capacidad de detectar y acceder a nuevas ideas y otros recursos de conocimiento (Uzzi, 1997)[83]. Frente a las limitaciones detectadas en las anteriores dimensiones del capital social -estructural y relacional, respectivamente-, destaca la relevancia que puede tener el capital social cognitivo para acceder a flujos de información (Bolino, Tunley and Blodgood, 2002). Esta dimensión del capital social, vinculada con el grado en el que las personas y las organizaciones comparten metas, valores y cultura (Nahapiet y Ghoshal, 1998), ha sido escasamente abordada en la literatura. A pesar del amplio soporte teórico existente, son muy limitadas las aportaciones empíricas sobre la influencia de los factores relacionales en la adquisición de conocimiento a partir de los intercambios entre organizaciones (Dyer and Hatch, 2006). Nosotros pretendemos profundizar en cómo afecta el capital social, específicamente su dimensión cognitiva, a la adquisición de conocimiento de las empresas pertenecientes a los distritos industriales.

Por otro lado, se ha destacado la presión y la motivación para innovar de las empresas que compiten en los distritos industriales (Baptista y Swann, 1998; Muscio, 2006). Esta tendencia a la innovación en el ámbito de los distritos se ha justificado por la fuerte rivalidad por los

[83] Nahapiet y Ghoshal, 1998) diferencian tres dimensiones del capital social: estructural, relacional y cognitivo.

recursos y los mercados en el ámbito local (Mistri y Solari, 2001), así como por la posibilidad de cooperar y compartir información con las instituciones y el resto de agentes del distrito (Baptista y Swann, 1998; Molina y Martínez, 2003). Sin embargo, recientemente se ha señalado que los problemas de inercia y bloque espacial en los distritos pueden limitar la capacidad de innovación de las empresas (Boschma, 2005). Efectivamente, las empresas pueden no ser capaces de aprovechar las ventajas potenciales para innovar de su pertenencia al distrito (Molina-Morales y Martínez-Fernández, 2010). Diversos autores han señalado la adquisición de conocimiento externo como un elemento clave para el desarrollo de innovaciones efectivas (Yli-Renko, Autio y Sapienza, 2001; Chen y Huang, 2008). Entendemos que necesitamos comprender mejor cómo la adquisición de conocimiento justifica la heterogeneidad en el resultado de la innovación de las empresas de los distritos.

En los últimos años se ha destacado el papel la capacidad de absorción en el proceso de gestión del conocimiento (Dyer y Singh, 1998; Lim, 2009). Desde la introducción de este concepto por Cohen y Levintal (1989), se han incorporado numerosos enfoques conceptuales y estructuras dimensionales (Cohen y Levintal, 1990; 1994; Mowery y Oxley, 1995; Zahra y George, 2002; Todorova y Durisin, 2007, entre otros), sin que exista todavía consenso (Lane, Koka y Pathak, 2006). Cohen y Levintal (1990) entienden la capacidad de absorción como la habilidad de una empresa para identificar el valor de información nueva, asimilarla y aplicarla. Entendemos que esta capacidad dinámica (Zahra y George, 2002) es una condición necesaria para capturar conocimiento y beneficiarse del mismo (Greunz, 2005).

Uno de los aspectos sin resolver en el estudio de la capacidad de absorción es su conexión con el conocimiento externo adquirido. Diversas investigaciones miden la capacidad de absorción a través del conocimiento adquirido, identificando ambos conceptos (p.e. Murovec y Prodan, 2009). Otros trabajos inciden en el uso del conocimiento externo, asumiendo que las empresas tienen acceso libre al mismo. Este enfoque se ha recogido en la literatura tradicional de distritos industriales, interpretando que existe un amplio conocimiento público "en el aire" que se transfiere espontáneamente entre los agentes (Becattini, 1990; Paniccia, 1998). Nosotros entendemos que el conocimiento externo adquirido es un factor intermedio del proceso que puede conducir a una empresa inmersa en una red de contactos a obtener innovaciones efectivas. Sin embargo, este proceso no es automático y los componentes de la capacidad de absorción inciden de manera diferenciada en las etapas del mismo. Para abordar el efecto de la capacidad de absorción en este proceso, seguimos el planteamiento secuencial de Lane et al. (2006) y agrupamos las dimensiones de la capacidad de absorción en dos componentes: la capacidad de identificación, que nos permite escanear el conocimiento externo nuevo, potencialmente valioso para la empresa; y la capacidad de combinación, que incluye la asimilación del conocimiento externo valioso y la aplicación del conocimiento para generar nuevo conocimiento o aplicaciones comerciales. Desde este enfoque, por un lado, nos proponemos estudiar si la capacidad de identificación impulsa la adquisición de conocimiento relevante a partir de la interacción de la empresa con agentes del distrito con los que comparte metas y cultura. Por otro lado, nos preguntamos hasta qué punto la capacidad de combinación puede favorecer el camino del conocimiento novedoso adquirido para desarrollar y explotar innovaciones de éxito.

El objetivo del trabajo es *estudiar el papel moderador de la capacidad de absorción en el proceso que lleva a las empresas de los distritos industriales con capital social cognitivo a obtener innovaciones efectivas a través de la adquisición de conocimiento*. Más concretamente, analizamos hasta qué punto la capacidad de identificación mejora la relación entre capital social cognitivo y la adquisición de conocimiento. También estudiamos cómo la capacidad de combinación puede fortalecer la relación entre la adquisición de conocimiento y el resultado de la innovación.

Con este trabajo contribuimos a justificar la heterogeneidad en el comportamiento y los resultados de las empresas en los distritos industriales. También contribuimos a explicar el papel contingente de la capacidad de absorción para impulsar el camino de las empresas desde el desarrollo de su red de contactos a una innovación efectiva. Además, destacamos rol central de la adquisición de conocimiento externo en el proceso de innovación de las empresas pertenecientes a los distritos. Finalmente, tratamos de comprender mejor las funciones diferenciadas de los componentes de la capacidad de absorción.

Para el desarrollo de esta investigación estudiamos una muestra de 166 empresas localizadas en los distritos del sector del calzado en España. Entendemos que este es un ámbito adecuado para abordar los objetivos de la investigación. El sector del calzado es un sector maduro y tradicional, en el que la mayor parte de las empresas se encuentran ubicadas y arraigadas en distritos industriales (Boix y Galleto, 2006). Por otra parte, dada la orientación exportadora de las empresas del sector analizado, la innovación tiene papel relevante para afrontar las dificultades a las que se enfrentan para competir en el contexto global actual.

El trabajo se estructura en los siguientes apartados. Después de esta introducción, en el segundo y tercer apartados se explican la teoría y las hipótesis a contrastar. El cuarto apartado aborda la metodología de la investigación empírica. El siguiente apartado recoge los resultados empíricos. Por último, discutimos los resultados y exponemos las principales conclusiones, las limitaciones del estudio y proponemos nuevas líneas de investigación.

2. TEORÍA

Distritos industriales

El concepto de distrito industrial surgió con la obra de A. Marshall "*Principles of Economics*" en 1890, quien trató de explicar las ventajas obtenidas por la localización de las empresas en ámbitos geográficos reducidos. Este autor utilizó el concepto de economías externas y aglomeración como los dos pilares básicos de las ventajas económicas que obtienen dichas empresas. Sin embargo, es Becattini (1979) quien recupera y revitaliza este concepto de distrito industrial. Este mismo autor establece que el distrito industrial se define como "una entidad socioeconómica que se caracteriza por la presencia activa de una comunidad de personas y una población de empresas en una zona natural e históricamente delimitada (Becattini 1990: 39). Así, el distrito está comprendido por numerosas pequeñas empresas, entre las cuales se observa la existencia de redes de cooperación y una comunidad de personas que poseen un fuerte sentimiento de pertenencia y unas características culturales comunes, siendo cada distrito el resultado de un proceso histórico y social único e irrepetible.

You and Wilkinson (1994) señalan que el principal rasgo distintivo de un distrito industrial es la particular combinación de competencia y cooperación entre sus empresas. Por un lado, en el interior de los distritos se genera una intensa competencia derivada de la aglomeración de empresas pertenecientes a una misma industria. Por otro lado, las empresas que componen un distrito industrial pertenecen a una misma industria o relacionada y están especializadas en una o más fases del proceso de producción. Esto provoca que las empresas del sistema sean mutuamente dependientes y, por tanto, necesariamente cooperativas (You y Wilkinson, 1994).

Uno de los elementos principales del distrito industrial es la atmósfera industrial (Becattini, 1990). Este término marshalliano puede entenderse como los flujos de experiencias, información y conocimiento que circulan por el distrito con pocas o ninguna restricción, convirtiéndose, así, en elementos comunes para las empresas internas al distrito. De manera que en el distrito, como el propio Marshall describe, las habilidades requeridas y los conocimientos relevantes se convierten en un bien público local, es como si "estuvieran en el aire" (Marshall, 1890). En este punto también debemos considerar las actividades formativas desarrolladas por las instituciones públicas y/o privadas del distrito destinadas a la mano de obra que integra el mercado de trabajo local.

Por otra parte, las economías de aglomeración, también denominadas marshallianas fueron la primera justificación de los beneficios que los distritos industriales ofrecen a las empresas. En este sentido, Marshall (1980) identifica tres economías externas: la disponibilidad de una oferta de mano de obra local cualificada, proveedores especializados y los desbordamientos tecnológicos. Así, siguiendo a Paniccia (1998), podemos decir que las empresas de los distritos se benefician de las relaciones a largo plazo y repetidas, el conocimiento mutuo, o la experiencia común que desarrollan una actitud cooperativa y confianza.

Diversos estudios han señalado que los principios organizativos subyacentes de los distritos en el noroeste de Italia, aunque pueden variar considerablemente en detalles individuales, se pueden aplicar a un amplio espectro de casos. Así, se han encontrado relaciones similares de cooperación entre empresas al sur-oeste de Alemania, Escandinavia, España o en Silicon Valley (Molina-Morales y Martínez-Fernández, 2009: Parra-Requena, Molina-Morales and Garcia-Villaverde, 2010).

Finalmente, debemos señalar que tradicionalmente se ha asumido la existencia de homogeneidad interna entre las empresas del distrito. Esta idea sugiere que los recursos de conocimiento y los canales a través de los cuales fluyen son de naturaleza pública para los miembros del distrito. Sin embargo, esto no ha sido confirmado. Por el contrario se observa que los flujos de conocimiento están restringidos a subgrupos de empresarios (Molina-Morales and Martinez-Fernandez, 2009). Así, no todas las empresas del distrito usan en la misma medida las economías externas y, en función de sus recursos y capacidades internas, podrán aprovecharlas en menor o mayor medida. Por tanto, aparecerá heterogeneidad en el comportamiento y los resultados de las empresas de los distritos (Boschma and Ter Wall, 2007).

Capital social

Después de que Bourdieu (1986) y Coleman (1988) reavivaran el interés académico por el capital social, este concepto ha generado un elevado interés (Koka y Prescott, 2002). De hecho, se ha convertido en un pilar importante de investigación en redes sociales (Gulati, 1998; Nahapiet y Ghoshal, 1998; Koka y Prescott, 2002). Este concepto se basa en la asunción de los beneficios potenciales que pueden derivarse por estar arraigado en una estructura de red social favorable (Bourdieu, 1986; Coleman, 1988, 1990). Aunque inicialmente el concepto de capital social apareció en los estudios de sociedades, posteriormente se aplicó a los individuos, así como a las relaciones dentro y fuera de las empresas (Burt, 1992). Así, encontramos estudios que analizan el papel que ejerce el capital social en el desarrollo del capital humano (Coleman, 1988), en el resultado económico de las empresas (Baker, 1990), regiones geográficas (Putnam, 1993, 1995), etc.

El concepto de capital social hace referencia a la estructura y al contenido de las relaciones, Su papel se ha valorado porque permite resolver problemas de coordinación, reduce costes de transacción y facilita los flujos de información entre los agentes (Lin, 2001). De este modo, la perspectiva del capital social postula que las redes de relaciones proporcionan valor a los agentes, ya sean individuos, organizaciones o comunidades, permitiéndoles explotar para su beneficio los recursos insertados en tales relaciones (Bourdieu, 1986; Lin, 2001; Bowey and Easton 2007; Rampersad, Quester and Troshani 2010). De modo que el capital social se ha propuesto como un elemento que contribuye significativamente a la ventaja de las organizaciones (p.e. Dyer y Singh, 1998; Nahapiet y Ghoshal, 1998; Tsai y Ghoshal, 1998; Leana y Van Buren, 1999; Gulati *et al.,* 2000; Lee, Lee y Pennigns, 2001; Adler y Kwon, 2002, entre otros).

En relación a la noción de red, ésta hace referencia a un conjunto de actores y a la relación o relaciones definidas que los conectan. Dichos actores pueden ser individuos o grupos, y los vínculos pueden ser formales o informales. Por tanto, un grupo de organizaciones relacionadas se considera una red y, al mismo tiempo, cada organización en sí misma es considerada una red (Semitiel, 2006). Por ello, los grupos de empresas relacionadas, entre ellos los distritos industriales, pueden ser identificados y analizados aplicándoles una perspectiva de red (Semitiel, 2006).

Siguiendo la definición ampliamente aceptada de Nahapiet and Ghoshal (1998:243), podemos considerar social capital como la suma de recursos actuales y potenciales insertados en, disponibles a través de y derivados desde la red de relaciones poseídas por una unidad social. En este punto, debemos señalar que esta definición es apropiada para examinar las redes sociales en las organizaciones (Bolino, Turnley and Bloodgood, 2002). El capital social es un concepto multidimensional cuyo valor no puede ser medido de manera directa, sino que tenemos que aproximarnos al mismo mediante la identificación y medida de una serie de dimensiones (Koka y Prescott, 2002). Nahapiet y Ghoshal (1998) plantean tres dimensiones para analizar las características del capital social -estructural, relacional y cognitiva-, que son las dimensiones adoptadas en nuestro trabajo. La dimensión estructural cubre toda la interacción de la red social, centrándose en las propiedades del sistema social y de la red de relaciones como un todo (Nahapiet and Ghoshal 1998). Esta dimensión puede ser analizada desde los vínculos de la red y la configuración de la red. Los vínculos de la red implican el modo en el cual los actores se relacionan en términos de frecuencia, fuerza y estrechez de las relaciones. La configuración de la red analiza en mediante la conectividad, la densidad y la jerarquía, el modelo de conexiones entre los miembros de la red. Por otra parte, las características y atributos de las relaciones que se derivan de la historia y de la reputación de la empresa son analizadas en la dimensión relacional. La confianza y el contenido relacional son los principales aspectos de esta dimensión. Una de las variables que conforman el contenido relacional es la identidad, la cual se refiere al grado en el que los actores se ven a ellos mismos conectados con otros actores. La confianza se refiere al conjunto de expectativas positivas sobre los demás o sobre sus acciones que permiten reducir la incertidumbre respecto a la conducta de otros agentes (Tsai and Ghoshal, 1998). La dimensión cognitiva, por su parte, representa los recursos proporcionados por el entendimiento y el significado compartido entre los miembros de la red (Nahapiet and Ghoshal, 1998). La cultura común y las metas compartidas entre los miembros de la red son las facetas clave de esta dimensión. La cultura compartida se refiere al grado en el cual las normas de comportamiento controlan o dirigen las relaciones, es decir es el conjunto de reglas y normas institucionalizadas que dirigen un comportamiento apropiado en la red (Ikpen y Tsang, 2005). Así, compartir la cultura significa compartir aspectos como procesos, objetivos, rutinas, códigos, lenguaje, etc. (Rowley, 1997). Mientras que las metas compartidas representan el grado por el cual los miembros de la red comparten un entendimiento y un enfoque hacia el logro de las tareas y el resultado de la red.

Aunque las tres dimensiones muestras diferentes facetas del capital social, éstas mantienen relaciones significativas entre sí (Tsai and Ghoshal, 1998). Sin embargo, debido a que cada dimensión puede tener distintos efectos e incluso contrapuestos (Yli-Renko et al., 2001) se plantea el interés por analizar de manera independiente el efecto de cada una de las dimensiones. La dimensión cognitiva ha sido la menos analizada en la literatura (Bolino et al., 2002). Sin embargo, nosotros consideramos que esta dimensión puede ser muy relevante a la hora de explicar determinadas variables clave para las empresas, como es la adquisición de conocimiento externo. Así, cuando las empresas comparten valores, visiones, objetivos, lenguaje, rutinas etc., se produce un mejor entendimiento entre los agentes, y se producen más oportunidades para intercambiar ideas y recursos (Inkpen and Tsang, 2005). Por tanto, el capital social cognitivo puede ser un elemento esencial que fomente la adquisición de conocimiento.

Adquisición de conocimiento

En los últimos años ha sido creciente el interés entre los académicos por el conocimiento como un elemento clave para el éxito de las organizaciones (p.e. Carlucci y Schiuma, 2006; Kohlbacher y Krähe, 2007; Lee y Lee, 2007; Weber y Weber, 2007; McLaughlin y Paton, 2008). En concreto, el hecho de compartir conocimientos se ha convertido en un foco de atención importante en el campo de la dirección estratégica, como un determinante clave de la ventaja competitiva de las empresas.

La adquisición de conocimiento es el proceso por el cual las empresas obtienen conocimiento a través de diversas actividades tanto formales como informales. El conocimiento es un elemento difícil y costoso de absorber debido a su naturaleza y a su relación contextual, ya que es un resultado social de un proceso histórico de acumulación de capacidades tecnológicas y habilidades. Además, como es bien conocido, la mayoría de las organizaciones no disponen de todo el conocimiento que requieren, por lo que deben contar con vínculos fuera de la organización para adquirir conocimiento (Anand, Glick y Manz, 2002). Así, aunque el conocimiento proviene de fuentes tanto internas como externas a la organización, la recepción de conocimientos valiosos del exterior de la empresa –su entorno- es aún más importante (Martín, López y Navas, 2004). Es por esto, por lo que la adquisición de conocimiento del exterior a través de la transmisión de conocimiento entre empresas ha despertado el interés de los investigadores (Darr, *et al.,* 1995; Mowery, *et al.,* 1996; Simonin, 1999; y Soekijad y Andrienssen, 2003; Dushnitsky and Shaver, 2009; Li, Poppo and Zhou, 2010; Presutti, Boari and Majocchi, 2011).

Esta adquisición de conocimiento externo forma parte de las tres actividades que, siguiendo a Grant (2000), comprenden la generación de conocimiento: la creación interna de conocimiento, que se obtiene de la investigación y desarrollo interno a la empresa; el aprendizaje por acción, a través del entrenamiento en el trabajo, experimentos y simulaciones; y, finalmente, la adquisición de conocimiento externo a través de la asistencia a conferencias, cursos y/o seminarios, la incorporación de nuevo personal, la interacción con otros agentes u organizaciones como instituciones, proveedores, clientes y/o competidores, el establecimiento de alianzas, etc.

Finalmente, debemos destacar que la adquisición de conocimiento externo se convierte en un elemento crucial para las empresas ya que los flujos de conocimiento son necesarios para mejorar la capacidad de innovación de las empresas (Dyer and Singh 1998; Lane and Lubatkin 1998). En esta línea, diversos estudios muestran evidencias del efecto positivo de la adquisición de conocimiento en la innovación (p.e. Ahuja and Katila 2001; Chen and Huang 2008). Del mismo modo, algunos trabajos han mostrado la relevancia de la adquisición de conocimiento al contribuir positivamente sobre los resultados de la empresa (DeCarolis and Deeds, 1999; Yli-Renko et al., 2001; Weber and Weber, 2007, entre otros).

Capacidad de absorción

La capacidad de absorción es un concepto introducido por Cohen y Levinthal (1989), que ha sido estudiado ampliamente en la última década por su relevancia en la gestión del conocimiento (Dyer y Singh, 1998; Zahra y George; 2002; Lane, Koka y Pathak, 2006: Todorova y Durisin, 2007; Lichtenhaler, 2009; Lim, 2009; Murovec y Prodan, 2009; entre otros). La capacidad de absorción permite capturar conocimiento y beneficiarse del mismo (Greunz, 2005), ya que es la habilidad de una empresa para reconocer el valor de información nueva, asimilarla y aplicarla con fines comerciales (Cohen y Levinthal, 1990).

Cohen y Levinthal (1990) diferencian tres dimensiones básicas de la capacidad de absorción: la identificación, que se refiere a la habilidad para localizar y adquirir conocimiento externo; la asimilación de conocimiento, relativa a la habilidad de la empresa para analizar, procesar, interpretar y entender dicho conocimiento externo; y la explotación del conocimiento, que hace referencia a la habilidad de la empresa para aprovechar el nuevo conocimiento adquirido y traducirlo en nuevos productos, procesos, conocimientos, competencias, etc. Estos autores complementan posteriormente su enfoque inicial, incluyendo la habilidad para anticipar información relevante sobre el desarrollo futuro de la tecnología y las oportunidades de mercado (Cohen y Levintal, 1994). Esta posibilidad de predecir la evolución del contexto competitivo al que se enfrentan las empresas les permite conseguir ventajas competitivas. Mowery y Oxley (1995) también aportan una nueva definición de capacidad de absorción, considerándola como un amplio conjunto de habilidades necesarias para tratar el componente tácito del conocimiento transferido y para modificar este conocimiento importado.

Una de las principales contribuciones en este campo es la de Zahra y George (2002), que plantean identifican la capacidad de absorción como una capacidad dinámica. Desde este enfoque la capacidad de absorción se entiende como un conjunto de rutinas y procesos organizativos a través de los cuales las empresas adquieren, asimilan, transforman y explotan conocimiento para producir una capacidad organizativa dinámica. Esta capacidad es dinámica porque puede modificarse a través de la gestión de los activos basados en el conocimiento. Estos autores formulan un constructo de capacidad de absorción, más amplio que el planteado por Cohen y Levintal (1990), agrupando cuatro dimensiones en dos componentes: capacidad de absorción potencial –adquisición y asimilación- y capacidad de absorción realizada –transformación y explotación- (Zahra y George, 2002).

Posteriormente, Lane, Koka y Pathak (2006: 856), después de revisar la literatura sobre la capacidad de absorción, la definen como la habilidad de las organizaciones para usar conocimiento externo nuevo, a través de tres procesos secuenciales: identificación y comprensión de conocimiento externo nuevo, potencialmente valioso para la organización, haciendo uso del conocimiento exploratorio; asimilación del conocimiento externo valioso, haciendo uso del conocimiento transformador; y aplicación del conocimiento asimilado para generar nuevo conocimiento o aplicaciones comerciales, haciendo uso del conocimiento explotador.

En nuestro caso, el enfoque del trabajo nos lleva a centramos en dos componentes. En primer lugar la capacidad de identificación, que se refiere a la habilidad de la empresa para localizar y adquirir conocimiento externo crítico para su actividad. Esta dimensión de la capacidad de absorción la podemos asimilar a la capacidad de escaneo, orientada a controlar y analizar la información del entorno para detectar oportunidades y amenazas (McEvely y Zaheer, 1999). La capacidad de identificación se ha vinculado en la literatura con el acceso al conocimiento externo a la empresa (Zahra y George, 2002) y con la actividad innovadora en contextos de distritos industriales (Expósito et al., 2011).

Por otro lado, recogemos la capacidad de combinación, concebida como un componente la capacidad de absorción (Kogut y Zander, 1992; Van den Bosch, Volberda y Boer, 1999), que consiste en la habilidad para sintetizar y aplicar el conocimiento adquirido del exterior y el existente en la empresa. Desde este enfoque entendemos que la capacidad de combinación integra las habilidades para asimilar y aplicar el conocimiento externo, lo que implica la difusión del conocimiento en la organización, su integración con las actividades de dicha organización y la generación de nuevo conocimiento (Lane et al., 2001). En la literatura sobre distritos industriales, se destaca el papel que juegan la asimilación y la aplicación de conocimiento externo en el proceso innovador de las empresas (Giuliani y Bell, 2005).

3. HIPÓTESIS

Capital social cognitivo y adquisición de conocimiento

Efecto directo

El conocimiento no es algo que fluya rápidamente de una organización a otra. Especialmente el conocimiento tácito requiere que las organizaciones compartan determinados elementos que faciliten la transferencia. En esta línea, DeCarolis y Deeds (1999) señalan que cuando las empresas tienen intereses similares se promueve el intercambio natural de ideas a través de las redes de relaciones establecidas. De modo que la dimensión cognitiva del capital social posee relevancia como un elemento que favorece la adquisición de conocimiento entre las empresas.

Disponer de capital social cognitivo significa que las empresas relacionadas presentan una cultura, unas expectativas y una visión compartida, así como un lenguaje, unas normas y unos valores comunes. Respecto a la cultura compartida, Storper (1997) y Parkhe (1991) ya señalaban que la adquisición de conocimiento tácito es más fácil cuando los agentes comparten un contexto cultural similar. De manera que la transferencia y adquisición de conocimiento será más efectiva y eficiente cuando las empresas disponen de similares estructuras de referencia

(Knoben and Oerlemans, 2006). De hecho, Simonin (1999) destaca que, cuando las culturas de los agentes implicados en la transferencia son diferentes, se pueden producir conflictos culturales y malentendidos que dificultan la adquisición de información y de conocimiento, así como el aprendizaje entre empresas. Por tanto, se necesita que las culturas de las organizaciones sean compatibles y faciliten la comprensión de las normas y los valores de las partes implicadas para que se produzca dicha adquisición de conocimiento (Lane et al., 2001). Las metas compartidas son otro elemento cognitivo que puede facilitar la adquisición de conocimiento entre las empresas. Así, como indican Tsai y Ghoshal (1998), disponer de una visión compartida entre las partes aumenta la probabilidad de intercambio de ideas y recursos, a la vez que evita los malentendidos y genera percepciones similares sobre cómo deben actuar entre ellos en el proceso de comunicación.

Por tanto, nosotros entendemos que el capital social cognitivo es crítico para que se produzca la adquisición de conocimiento entre las empresas (Parra et al., 2010). Aunque tradicionalmente la literatura sobre distritos industriales ha sugerido la existencia de un sistema relativamente homogéneo de valores e ideas (Becattini, 1990) y que las empresas del distrito se encuentran arraigadas a una fuerte cultura local (Harrison, 1992; Dei Ottati, 1994), consideramos que las empresas presentan un grado diferente de capital social cognitivo que determina la adquisición de conocimiento externo. Así, las empresas que mejor consigan alinear sus metas y cultura con las de sus contactos, serán capaces de adquirir más conocimiento externo. A partir de los argumentos expuestos podemos plantear la siguiente hipótesis:

H_1: El capital social cognitivo esta asociado positivamente con la adquisición de conocimiento de las empresas pertenecientes a los distritos industriales.

El papel moderador de la capacidad de identificación

Como hemos señalado, se espera que las empresas que comparten valores, metas y lenguaje con sus contactos puedan adquirir mayor conocimiento novedoso y valioso de los mismos (Lane et al., 2001). Sin embargo, la fortaleza del flujo de información e ideas novedosas entre las empresas con intereses y cultura comunes pertenecientes a una red dependerá de su capacidad de absorción. Más concretamente, va a ser la capacidad de identificación, propuesta por Cohen y Levintal (1990), la que puede facilitar a una empresa la localización y adquisición de conocimiento externo.

En el ámbito de los distritos industriales se señala que cuando las empresas comparten un contexto cognitivo común tienden a intercambiar mayor conocimiento (Parra et al, 2010). No obstante, las capacidades de las empresas que configuran la red afectan a la intensidad de transmisión y adquisición de conocimiento. Así, son las habilidades de determinadas empresas para reconocer y valorar información externa novedosa las que impulsan la adquisición de conocimiento tácito y valioso (Lane y Lubatkin, 1998). Por tanto, las capacidades para escanear el contexto competitivo y de mercado permiten a las empresas extraer de sus contactos información relevante sobre las tendencias estratégicas de sus competidores y sobre las nuevas demandas de sus clientes (McEvely y Zaheer, 1999).

Desde este enfoque señalamos la capacidad de identificación de la empresa como un factor contingente que favorece la obtención de conocimiento crítico de los contactos con los que comparte valores e ideas. Podemos argumentar que la adquisición de conocimiento valioso procedente de redes externas de información mejora cuando la empresa dispone de mayor capacidad de identificación para explorar su potencialidad (Expósito et al., 2011). Se justifica, así, el papel moderador que ejercen la capacidad de identificación en la relación entre el capital social cognitivo y la adquisición de conocimiento entre las empresas de los distritos industriales. Así, formulamos la siguiente hipótesis:

H2. La disponibilidad de mayor capacidad de identificación mejora la relación entre el capital social cognitivo y la adquisición de conocimiento de las empresas pertenecientes a los distritos industriales.

Adquisición de conocimiento y resultado de la innovación

Efecto directo

El proceso de la innovación requiere flujos externos de conocimiento que favorezcan su desarrollo (Dyer y Asingh, 1998; Lane and Lubatkin, 1998). De hecho, Nonaka y Takeuchi (1995) consideran que el conocimiento es el requisito principal para la innovación y la competitividad de la empresa. En este punto, DeCarolis and Deeds (1999) consideran que las fuentes externas de conocimiento son críticas para la innovación. Así, en función del grado en el que una empresa tenga acceso a fuentes externas de conocimiento, podrá aprovechar en mayor medida sus recursos para generar innovaciones (Kogut y Zander, 1992). La adquisición de conocimiento externo permite el desarrollo de ideas, recursos y capacidades (Yli-Renko et al., 2001), que aumentan el potencial de generar innovaciones efectivas (Galunic y Rodan, 1998). En esta línea, trabajos como el de Yli-Renko et al. (2001) y Chen y Huang (2008) han aportado evidencias empíricas sobre el efecto positivo de la adquisición de conocimiento externo sobre el resultado de la innovación. También el trabajo reciente de Li et al. (2010) muestra que, gracias a la metas compartidas, las empresas adoptan un compromiso para cooperar y, como resultado, las partes comparten información valiosa y necesaria, en la forma de conocimiento tanto tácito como explicito.

La adquisición de conocimiento externo adquiere una especial importancia para la competitividad de las empresas pertenecientes a los distritos industriales (Albino et al., 1999). Así, los mecanismos de cooperación y de difusión de conocimiento que caracterizan a los *cluster* geográficos han sido considerados como herramientas clave para el desarrollo de las innovaciones de las empresas pertenecientes al mismo (Albors y Molina, 2001, Tallman *et al.,* 2004). En este punto, Inkpen and Tsang (2005) señalan que las metas compartidas mitigan la tensión entre la cooperación y la competencia. Esto es porque las metas compartidas ayudan a los socios a reconocer que la cooperación puede mejorar tanto la posición individual como la conjunta y de esta forma los participantes están más dispuestos a compartir ideas y conocimiento (Li et al., 2010).

Aunque conceptualmente (Beaudry and Breschi, 2003) y empíricamente (p.e. Baptista y Swann, 1998; Brouwer et al. 1999; Molina and Martinez, 2003) hay evidencias que sugieren que las empresas en un cluster son mas innovadoras que las empresas externas al mismo, consideramos que no todas las empresas del distrito presentan el mismo grado de innovación, puesto que no todas las empresas disponen de los mismos recursos y capacidades para aprovecharse de las ventajas potenciales que ofrece su localización en un distrito industrial. Así, nosotros consideramos que aquellas empresas que sean capaces de adquirir mayor cantidad y calidad de conocimiento externo serán las que presenten innovaciones más exitosas. A partir de los argumentos expuestos planteamos la siguiente hipótesis:

> *H3: La adquisición de conocimiento esta asociada positivamente con el resultado de la innovación de las empresas pertenecientes a los distritos industriales.*

El papel moderador de la capacidad de combinación

La capacidad de absorción posee un papel relevante en el proceso de desarrollo y resultado de la innovación derivado del conocimiento externo (Chen and Huang, 2008). En este caso es la capacidad de combinación, vinculada a la asimilación y aplicación de conocimiento, la que va a ejercer un rol potenciador de la innovación efectiva a partir de la adquisición de conocimiento novedoso (Nahapiet y Ghoshal, 1998; Lane et al., 2006). Por tanto, la fuerza con la que el conocimiento adquirido se transforma en innovaciones valiosas depende, en gran medida, de la capacidad de combinación de la empresa.

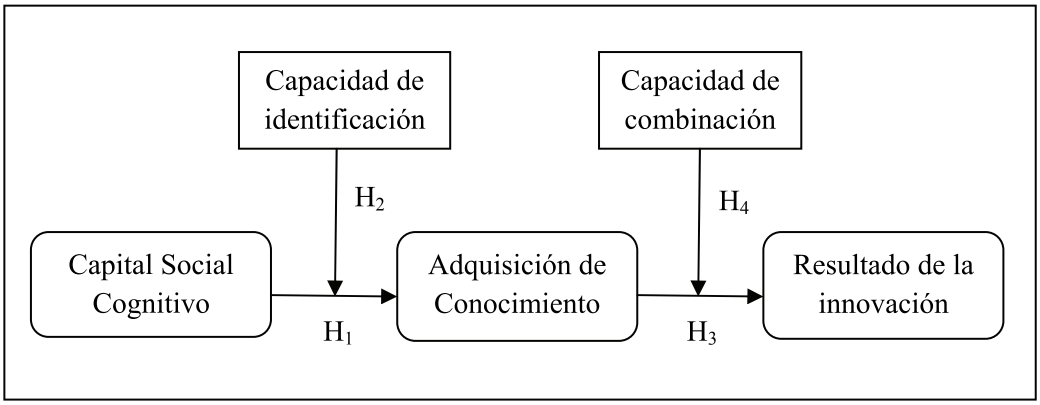
Entendemos que el proceso de aprendizaje no finaliza con la adquisición de conocimiento externo, sino que este debe ser asimilado, transformado y explotado (Zahra y George*,* 2002) para impulsar su camino hacia la innovación. En este contexto adquiere relevancia el proceso de recombinación e integración del conocimiento adquirido con el existente en la empresa.

Desde este enfoque, en el ámbito de los distritos industriales, deducimos que los flujos de conocimiento novedoso y exclusivo procedentes del exterior de la empresa van a generar un mayor valor cuando se integran adecuadamente con el conocimiento existente en la empresa, ya que se generarán nuevos conocimientos y capacidades, que se reflejarán en unos mayores resultados de la innovación. Por tanto, las empresas de los distritos podrán aprovechar todo el potencial del conocimiento adquirido en la medida en la que sean capaces de combinarlo con el conocimiento existente en la empresa, lo que les permitirá la creación de conocimiento exclusivo para innovar de manera más efectiva que sus competidores (Expósito et al., 2011). Estos argumentos sugieren que existe un efecto moderador de la capacidad de combinación sobre la relación entre la adquisición de conocimiento y los resultados de la innovación. De manera que la mayor capacidad de combinación de la empresa mejora el impacto de la adquisición de conocimiento sobre la efectividad de la innovación en las empresas pertenecientes a un distrito industrial. A partir de los argumentos señalados establecemos la siguiente hipótesis:

> *H_4. La disponibilidad de mayor capacidad de combinación mejora la relación entre la adquisición de conocimiento y el resultado de la innovación de las empresas pertenecientes a los distritos industriales.*

Las hipótesis justificadas y formuladas anteriormente configuran un modelo contingente (ver figura 1). En primer lugar proponemos un papel moderador de la capacidad de identificación para fortalecer la relación entre el capital social cognitivo y la adquisición de conocimiento. También planteamos un efecto moderador positivo de la capacidad de combinación en la relación entre la adquisición de conocimiento y el resultado de la innovación. Incorporamos en el modelo el tamaño y la edad de la empresa como variables de control para las dos variables dependientes. El modelo contingente propuesto nos permite entender mejor cómo el capital social cognitivo conduce a las empresas pertenecientes a los distritos industriales a innovaciones exitosas.

Figura 1. Modelo contingente e hipótesis.



4. METODOLOGÍA

Muestra

El estudio empírico ha sido desarrollado en la industria del calzado en España[84]. Esta industria está estructurada principalmente en distritos industriales, así, podemos encontrar 30 distritos industriales (Boix y Galleto, 2006). La mayoría de ellos están localizados en la Comunidad Valenciana (65.9%), especialmente en la provincia de Alicante–Elche, Elda, Villena, Crevillente, etc-; sin embargo, otros distritos industriales importantes se encuentran en Castilla-La Mancha (9.94%) -Almansa y Fuensalida-, y en La Rioja (7.1%) –Arnedo y Calahorra- entre otros. Todos estos distritos industriales suponen el 76.7% del empleo total de la industria española del calzado. En 2007, de acuerdo al directorio central de empresas (DIRCE), la industria estaba compuesta por 4,366 empresas, incluyendo a los empresarios individuales. En el mismo año, estas empresas fabricaron 108.4 millones de pares de calzado, con un valor de 1,905 millones de euros, dirigidos principalmente a la exportación (93.7% del total en 2007).

En este estudio vamos a centrarnos en aquellas empresas que se encuentran localizadas en distritos industriales. Además, como uno de los aspectos principales de nuestro modelo, el capital social cognitivo requiere un cierto periodo de tiempo para ser totalmente desarrollado, por lo que una industria madura como la del calzado resulta adecuada para nuestro análisis. Además, la elevada competitividad del entorno industrial permite analizar aspectos relacionados con la adquisición de conocimiento y el resultado de los nuevos productos de las empresas. Las

[84] Esta industria se caracteriza por el predominio de pequeñas y medianas empresas (más del 99.5%) suponen el 2.3 % del empleo en España y el 1.2 % del PIB español (Datos de la Sección General de Análisis, Estrategia y Evaluación, 2009).

fuentes de datos utilizadas fueron SABI[85] y Camerdata[86]. Decidimos no incluir aquellas empresas con menos de cinco trabajadores. Esto se realizó debido a que se necesita una estructura operativa mínima para definir el resultado y el comportamiento de las empresas. A partir de estas bases obtuvimos una población de 1,403 empresas (1093 localizadas en distritos industriales y 310 empresas localizadas fuera de los distritos), una vez que se eliminaron las duplicidades de las distintas bases de datos. Después de enviar un cuestionario a la totalidad de las empresas, procedimos a enviar de nuevo un cuestionario tres semanas después a todas aquellas empresas de las cuales no habíamos obtenido respuesta. Finalmente, obtuvimos una muestra de 224 empresas. De estos 224 cuestionarios, 166 correspondían a empresas internas a un distrito industrial, lo que supone una tasa de respuesta en relación a la población de empresas pertenecientes a un distrito industrial del 15,19 %. Para un nivel de confianza del 95 % y la situación menos favorable de p=q=0.5, el error muestral es de 6.99 %. Además, procedimos a contrastar el sesgo de no respuesta. En este sentido, comparamos la media de las variables tamaño y edad entre las empresas de la muestra y las del conjunto de la población y obtuvimos valores similares para ambos grupos. Por tanto, siguiendo a Amstrong y Overton (1977), podemos excluir la existencia de un sesgo de no respuesta. Además, desarrollamos un test ANOVA y un test Chi-cuadrado[87] entre las empresas que respondieron al primer y segundo envío y no encontramos diferencias en ninguna de las variables analizadas.

Medición

Pertenencia al distrito:

Para identificar la pertenencia de las empresas a los distritos industriales se preguntó acerca de la localización de las empresas. En este sentido, utilizamos una variable dummy para distinguir entre las empresas localizadas o no localizadas en un distrito (Hundley y Jacobson, 1998; Molina-Morales, 2002; entre otros). Nosotros establecimos la pertenencia al distrito cuando la empresa estaba localizada en uno de los distritos industriales identificados en investigaciones previas (Boix y Galletto, 2006; Belso, Molina y Mas, 2011). A partir de las respuestas del cuestionario, la variable tomaba valor uno si la empresa estaba localizada en uno de los distritos industriales identificados y valor cero si la empresa no estaba localizada en ningún distrito industrial. Además, para reforzar la consistencia interna de esta medida objetiva de pertenencia al distrito, incluimos también una variable perceptual en el cuestionario para medir el sentimiento de pertenencia. Siguiendo el criterio de Becattini (1979), utilizamos una escala

[85] SABI es un directorio de empresas de España y Portugal que proporciona datos financieros y generales de las empresas.
[86] La base de datos Camerdata es un directorio de todas las empresas españolas de la red de Cámaras de Comercio locales.
[87] Para las variables incluidas en el estudio.

Likert de siete puntos con un solo ítem para medir esta percepción -*en general, me siento identificado con las empresas de mi localidad/comarca-*. Finalmente, para asegurar que los distritos industriales son suficientemente homogéneos como para ser integrados en la misma muestra. Nosotros hemos analizado la diferencia de medias entre las variables incluidas en el estudio para las empresas pertenecientes a cada uno de los distritos industriales. Para comprobar la existencia de posibles sesgos, hemos desarrollado un test ANOVA y un test Scheffe's entre pares de distritos y no hemos encontrado diferencias significativas[88].

Capital social cognitivo:

Para medir el capital social cognitivo nos hemos centrado en el nivel organizacional (Knoben y Oerlemans 2006). La cultura compartida y los objetivos compartidos son dos aspectos principales de esta dimensión del capital social. La cultura compartida se puede definir como el conjunto de normas y reglas institucionalizadas que guían un comportamiento apropiado en la red (Gulati et al (2000:205). Así, la *cultura compartida* implica compartir patrones de acción, rutinas, etc. (Rowley, 1997). Para medir esta variable utilizamos una escala Likert de 7 puntos adaptada de Simonin (1999), con dos items -*nuestras practicas empresariales y técnicas de trabajo son similares a las de nuestros contactos* y *nuestra cultura empresarial es muy similar a la de nuestros contactos*- (Alpha: 0.886), mientras que para los objetivos compartidos, la escala de seis ítems utilizada es el resultado de adaptar varias escalas previas (Tsai y Ghoshal 1998; Young-Ybarra y Wiersema 1999 y Yli-Renko et al. 2001), a nuestro contexto particular -*nuestra empresa comparte las mismas ambiciones y visiones que las empresas con las que nos relacionamos; las personas en nuestra empresa están entusiasmadas con la búsqueda de objetivos y misiones comunes de nuestras relaciones, Compartimos metas y objetivos con nuestros contactos; entendemos las estrategias y necesidades de nuestros contactos; los empleados de nuestra empresa y los de mis contactos, tienen actitudes positivas hacia las relaciones cooperativas* y *nuestra empresa y mis contactos están de acuerdo en como llevar a cabo las relaciones de trabajo*- (Alpha: 0.890). Además, utilizamos un constructo de segundo orden para medir el capital social cognitivo, formado por los dos constructos de primer orden –cultura compartida y objetivos compartidos- (Alpha: 0.903)

Adquisición de conocimiento:

Medimos esta variable a partir de una adaptación de las escalas de Kale, Singh y Pelmutter (2000) y Maula, Autio y Murray (2003). La escala resultante de tres ítems incluye la adquisición

[88] Para reforzar la validez del instrumento de medida, verificamos la información recibida de las empresas (nombre del negocio, número de teléfono y dirección) a partir de búsquedas en la web o en bases de datos conocidas (por ejemplo, Dun&Bradstreet o SABI).

de conocimiento sobre necesidades y preferencias de los consumidores, la competencia y aspectos técnicos -*nuestros contactos han sido una fuente importante de información y/o conocimiento sobre las necesidades de clientes y tendencias; nuestros contactos han sido una fuente importante de información y/o conocimiento sobre la competencia; nuestros contactos han sido una fuente importante de información y/o conocimiento sobre cuestiones técnicas*- (Alpha: 0.869). En este sentido, la variable incluye la adquisición de información relevante sobre áreas críticas de la empresa. De manera que se trata de un conocimiento de gran valor para la empresa porque este conocimiento es fundamental para su competitividad (ver por ejemplo Spanos y Lioukas 2001; Teece, Pisano y Shuen 1997).

Resultado de la innovación:

Medimos el resultado de la innovación a través del resultado de los nuevos productos, ya que es un buen indicador del mismo en empresas manufactureras, como ocurre en este estudio (Laursen y Salter, 2006). Para reflejar de manera adecuada el resultado de los nuevos productos de la empresa hemos calculado el producto de la importancia atribuida por la satisfacción obtenida por el gerente (Gupta y Govindarajan, 1984; Zahra, 1996) en dos ítemes *–rentabilidad de los nuevos productos* y *ventas de los nuevos* - (alfa de Chronbach de 0.944). Establecimos el horizonte temporal de medida en tres años como una aproximación a la sostenibilidad del resultado. En este sentido, se pidió a los encuestados que valoraran los dos ítemes para los tres últimos años (Spanos y Lioukas, 2001). Además, para verificar la fiabilidad de las escalas de resultado incluidas en el estudio procedimos a calcular las correlaciones entre estas medidas y diversas medidas objetivas de resultado que fueron obtenidas de la base de datos SABI. Encontramos, para una submuestra de 66 empresas, que las correlaciones eran positivas y significativas. Por tanto, la hipótesis de independencia entre las variables fue rechazada con un nivel de significatividad del 95 %.

Capacidad de identificación:

Tal y como se ha expuesto previamente, la capacidad de identificación es considerada como una de las dimensiones básicas de la capacidad de absorción (Cohen y Lenvintal, 1990; Lane et al., 2006) y adquiere un papel relevante para la detección de información clave para la empresa, especialmente en los distritos industriales. Esta capacidad permite a la empresa escanear el entorno para identificar oportunidades y amenazas. En este estudio la variable fue operacionalizada con tres ítems basados en la escala de McEvily y Zaheer (1999) -*supervisamos* *y controlamos las estrategias y tácticas de nuestros contactos; buscamos información sobre quienes son los clientes de nuestros sector;* y *recopilamos información sobre el mercado en el que actuamos*- (Alpha: 0.880).

Capacidad de combinación:

Consideramos la capacidad de combinación como un componente de la capacidad de absorción (Kogut y Zander, 1992; Van den Bosch *et al.,* 1999). Esta capacidad mide la habilidad de la empresa para sintetizar y aplicar el conocimiento adquirido. Así, la fuerza con la que el conocimiento adquirido se transforma en valor va a depender en gran medida de la capacidad de combinación que posea la empresa. Para medir esta variable, optamos por utilizar la escala creada por Ye (2005), adaptada de las medidas propuestas por Van den Bosch *et al.* (1999). A continuación se muestran los 6 ítems que componen la escala de medición de la capacidad de combinación -*nuestros empleados son hábiles en la combinación e intercambio de ideas para resolver problemas o crear oportunidades; nuestros empleados han aprendido a agrupar sus ideas y conocimientos eficazmente; tenemos la habilidad de reflejar las reglas, procedimientos, e instrucciones en documentos formales para incorporar el conocimiento; tenemos la habilidad de usar procesos de interacción (como rotaciones, mecanismos de coordinación y participación) para incorporar el conocimiento; en general, tenemos la capacidad de asimilar conocimiento;* y *en general, tenemos la capacidad de aplicación del conocimiento en varias áreas del negocio*). (Alpha: 0.920)

Variables de control:

En este estudio hemos incorporado el tamaño y la edad como variables de control. Incluimos la variable *tamaño* para controlar el efecto que puede tener en la adquisición de conocimiento y el resultado de los nuevos productos (McEvily y Zaheer, 1999). El tamaño puede influir en la adquisición de conocimiento porque, a medida que aumenta el tamaño de las empresas que operan en un mercado, mayor es su capacidad de aprendizaje (Li et al., 2010). Por otra parte, el tamaño se incluye frecuentemente en los estudios para controlar su influencia en el resultado de las empresas. Las empresas grandes y maduras pueden poseer más recursos para obtener una mejor posición en el mercado y desarrollar economías de escala que les ayudarán a conseguir un mejor (McEvily y Zaheer, 1999). Esta variable ha sido incluida a través del logaritmo natural del número de trabajadores (Spanos y Lioukas, 2001; Tsai, 2001). Además, la variable *edad* se incluye también para controlar su influencia en la adquisición de conocimiento y el resultado de los nuevos productos de la empresa (Chandler y Hanks, 1994; Zahra, Ireland y Hitt, 2000).

Técnicas de análisis

Para contrastar las hipótesis propuestas en nuestra investigación utilizamos diferentes técnicas estadísticas. En primer lugar, desarrollamos un análisis de correlación para verificar que no existían problemas de multicolinealidad entre las variables incluidas en los modelos. A continuación, desarrollamos dos análisis de regresión jerárquicos, uno para la primera parte del modelo y otro para la segunda parte. La aproximación jerárquica es necesaria ya que un efecto interactivo existe si, y solo si, el término interactivo supone una contribución significativa sobre el modelo de los efectos directos (Cohen 1978; Cohen y Cohen 1983). La magnitud de los coeficientes de regresión altamente significativos no puede ser evaluada de manera separada de aquellos coeficientes con significatividad baja, sino que tienen que valorarse conjuntamente. De manera tradicional, la valoración de cómo los efectos interactivos significativos afectan a la variable dependiente se realiza incluyendo en primer lugar los valores de los efectos interactivos en la ecuación de regresión y representando estos valores frente a los obtenidos para la variable dependiente, tal como recogemos en este estudio. Estas representaciones muestran el efecto de una variable, dada la combinación de valores para las otras variables (Wiklund y Shepherd, 2005).

5. RESULTADOS

Las tablas 1 y 2 muestran las medias y desviaciones típicas para las variables de cada regresión y la matriz de correlaciones. También hemos calculado los factores de inflación de la varianza (VIF), que se recogen en la tabla 3. Todos presentan valores inferiores a dos, lo cual se encuentra dentro de los límites de aceptación (Hair, Anderson, Tatham, y Black, 2001). Esto indica que la multicolinealidad no es un problema en este estudio.

Tabla 1.Correlaciones capital social cognitivo y adquisición de conocimiento

	Edad	Tamaño	CSCognitivo	Cap.Ident.	CSCxCapIden	Adq.Con.
Media	13.21	25.91	4.63	4.39	20.42	4.64
Desv. típica	30.61	61,77	1.54	1.48	9.90	1.24
Edad	1					
Tamaño	.010	1				
CSCognitivo	-.057	.002	1			
Cap.Identific	-.024	.017	.211*	1		
CSCxCapIden	.005	-.075	-.220*	.164	1	
Adq.Conoc.	.018	.025	.381***	.464***	.178	1

Tabla 2. Correlaciones adquisición conocimiento y resultado de la innovación

	Edad	Tamaño	Adq.Co	Cap.Comb.	Ad.C.xCapCom.	Rdo.Inn.
Media	13.21	25.91	4.64	4.24	20.47	24.28
Desv. típica	30.61	61,77	1.24	1.35	9.93	10.82
Edad	1					
Tamaño	.010	1				
Adq.Con.	.018	.025	1			
Cap.Combinac.	-.016	.121	.259*	1		
Ad.C.xCapCom	.042	.058	.230*	.170	1	
Rdo. Innov	-.029	-.041	.455***	.410***	.313***	1

Tabla 3. Tolerancia y VIF

	Tolerancia	VIF
Edad	.0994	1.006
Tamaño	.981	1.019
CSCognitivo	.888	1.126
Cap. Identificación	.914	1.094
CSCxCap.Identific.	.903	1.108
Adq. Conoc.	.663	1.507
Cap.Combinación	.780	1.282
Adq.C.xCap.Comb	.808	1.238

El contraste de las hipótesis se realiza mediante dos análisis de regresión jerárquicos. Para contrastar las hipótesis 1 y 2, se incluyeron en un modelo base las variables de control, tamaño y edad, y las variables independientes de capital social cognitivo y capacidad de identificación[89] (ver tabla 4). Este modelo explica un porcentaje significativo de la varianza de la adquisición de conocimiento de la empresa (R^2_{adj}= 0.282). Los resultados obtenidos en este modelo muestran que el capital social cognitivo (β=0.306; p<0.001) y la capacidad de identificación (β=0.394; p<0.001) tienen un efecto positivo y significativo en la adquisición de conocimiento externo de las empresas. Es necesario destacar que nuestro modelo base tiene un elevado poder predictivo. Además, el capital social cognitivo tiene una influencia positiva y significativa en la adquisición de conocimiento, lo que nos permita aceptar la hipótesis 1.

[89] Todas las variables incluidas en el análisis de regresión han sido previamente tipificadas.

3.2.3 Tabla 4. Análisis de regresión

3.2.4 *(Variable dependiente: adquisición de conocimiento)*

Variables	Modelo base		Modelo completo	
	B	t	*β*	t
Edad	.006	.092	.003	.052
Tamaño	.017	.261	.033	.512
Capital social cognitivo	.306	4.504***	.360	5.245***
Capacidades de identificación	.394	5.805***	.352	5.194***
CSC x Cap.identificación			.204	2.993**
Modelo				
R^2		.300***		.337***
R^2 ajustada		.282***		.316***
Cambio en R^2		.300***		.037***

A continuación, en el modelo contingente o modelo completo, incluimos el doble efecto interactivo (capital social cognitivo x capacidad de identificación). Este modelo supone una contribución significativa sobre el modelo base ($\Delta R^2_{corr} = 0.037$). En este modelo, encontramos de nuevo la influencia positiva y significativa del capital social cognitivo (β=0.360; p<0.001) y de la capacidad de identificación (β=0.352; p<0.001) en la adquisición de conocimiento externo de las empresas. En relación al efecto interactivo, los resultados muestran que la capacidad de identificación (β=0.204; p<0.05) modera positivamente la relación entre el capital social cognitivo y la adquisición de conocimiento. Por tanto, el análisis desarrollado nos ha permitido comprobar el efecto moderador de la capacidad de identificación en la relación entre el capital social cognitivo y la adquisición de conocimiento para las empresas localizadas en un distrito industrial. Aceptamos, por tanto, la hipótesis 2.

Para contrastar las hipótesis 3 y 4 hemos desarrollado el segundo análisis de regresión (ver tabla 5). En este sentido, las variables de control tamaño y edad y las variables independientes de adquisición de conocimiento y capacidad de combinación fueron inicialmente incluidas en un modelo base. Este modelo explica un porcentaje significativo de la varianza del resultado de producíosla innovación de las empresas (R^2_{adj}= 0.243). Los resultados obtenidos en este modelo muestran que la adquisición de conocimiento (β=0.320; p<0.001) y la capacidad de combinación (β=0.277; p<0.001) tienen una influencia positiva y significativa en el resultado de la innovación de las empresas analizadas, lo que nos permite aceptar la hipótesis 3. También en este caso el modelo base presenta un elevado poder predictivo.

3.2.5 Tabla 5. Análisis de regresión *3.2.6 (Variable dependiente: resultado de la inovación)*				
Variables	Modelo base		Modelo completo	
	B	t	*β*	t
Edad	-.035	-.520	-.043	-.644
Tamaño	-.082	-1.192	-.091	-1.334
Adquisición de conocimiento	.320	4.192***	.244	2.950**
Capacidad de combinación	.277	3.591***	.284	3.725***
Adq.conoc. x Cap. combinación			.171	2.290**
Modelo				
R^2		.262***		.286***
R^2 ajustada		.243***		.263***
Cambio en R^2		.262***		.024***

Como paso siguiente, en el modelo completo incluimos el doble efecto interactivo (adquisición de conocimiento por capacidad de combinación). Este modelo realiza una contribución significativa sobre el modelo base (ΔR^2_{corr} = 0.024). De nuevo en este modelo encontramos la influencia positiva y significativa de la adquisición de conocimiento (β=0.244; p<0.05) y la capacidad de combinación (β=0.284; p<0.001) en el resultado de la innovación de la empresa. En relación a los efectos interactivos, los resultados muestran que la capacidad de combinación (β=0.171; p<0.05) modera de manera positiva la relación entre la adquisición de conocimiento y el resultado de la innovación de las empresas analizadas, lo que nos permite aceptar la hipótesis 4.

Tal como hemos explicado previamente, para determinar la naturaleza de los efectos interactivos (tanto de la capacidad de identificación como de la capacidad de combinación) el estudio incluye una representación gráfica de cada relación. Para el primer caso en el eje Y se representa la variable dependiente (adquisición de conocimiento) y en el eje X el capital social cognitivo para niveles altos y bajos de capacidad de identificación[90]. La figura 2 indica que la adquisición de conocimiento aumenta con el capital social cognitivo pero a mayor nivel para aquellas empresas que poseen una capacidad de identificación superior. Para la segunda representación en el eje Y se recoge el resultado de la innovación como variable dependiente y en el eje X la adquisición de conocimiento para niveles altos y bajos de capacidad de combinación. Observamos en la figura 3 que el resultado de la innovación se incrementa con la adquisición de conocimiento externo, aunque a un mayor nivel para las empresas con

[90] Más y menos de una desviación estandar de su media (Cohen and Cohen, 1983).

una elevada capacidad de combinación. En ambos casos, las representaciones refuerzan la aceptación de las hipótesis 2 y 4, respectivamente.

Figura 2. Adquisición de conocimiento
Capital social cognitivo-capacidad de identificación

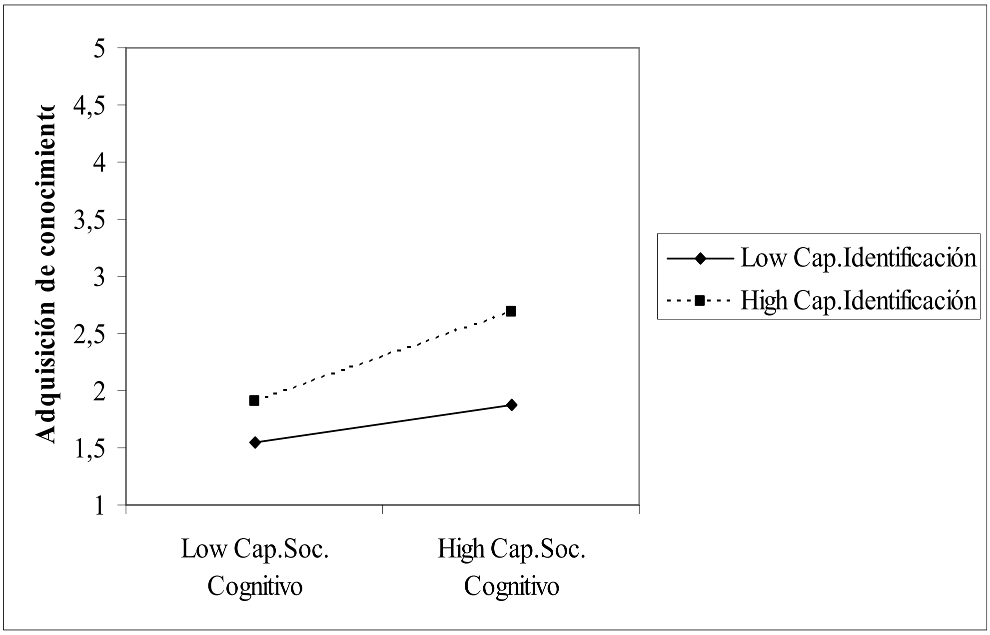
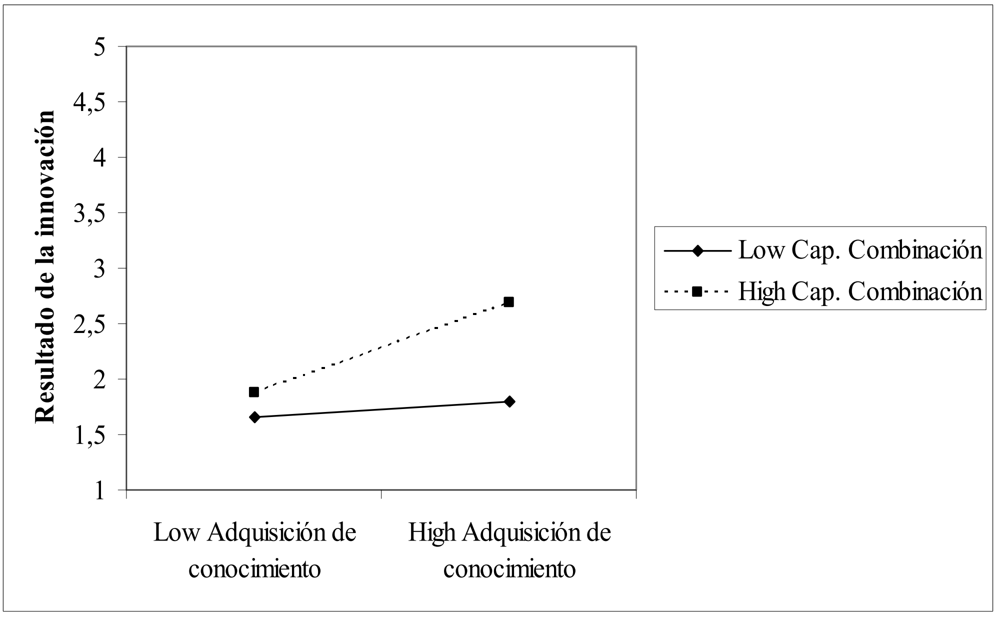


Figura 3. Resultado de la innovación
Adquisición de conocimiento-capacidad de combinación



6. DISCUSION Y CONCLUSIONES

Los resultados obtenidos nos han permitido comprobar que el capital social cognitivo, es decir los valores y metas compartidas, tienen un efecto directo en la adquisición de conocimiento. Se refuerza, así, la idea de que la transferencia y adquisición de conocimiento será más efectiva y eficiente cuando las empresas de los distritos compartan propósitos similares (Knoben y Oerlemans, 2006). El enfoque contingente muestra que la relación entre el capital social cognitivo y la adquisición de conocimiento está moderada positivamente por la capacidad de identificación de la empresa. Por tanto, las empresas de los distritos podrán mejorar la adquisición de conocimiento novedoso y valioso procedente de redes externas de información cuando dispongan de capacidad de identificación para explorar su potencialidad (Expósito et al., 2011).

Los resultados también nos indican que la adquisición de conocimiento influye positivamente en el resultado de la innovación. En este sentido, los flujos de conocimiento externos favorecen las innovaciones efectivas de las empresas de los distritos (Lane y Lubatkin, 1998). Por tanto, tal como hemos argumentado previamente, no todas las empresas localizadas en el distrito industrial presentarán el mismo nivel de éxito en sus nuevos productos. Serán las empresas capaces de adquirir mayor cantidad de conocimiento externo las que presenten mejores resultados de sus innovaciones. También detectamos que la capacidad de combinación mejora la relación entre la adquisición de conocimiento externo y el resultado de la innovación. Planteamos, así, que las empresas situadas en un distrito industrial que posean mayor capacidad de combinación podrán aprovechar mejor el conocimiento adquirido que se traducirá en el desarrollo de nuevos productos exitosos (Lane et al., 2006).

En este estudio, proponemos y verificamos un modelo que proporciona un mejor entendimiento sobre la heterogeneidad del comportamiento y los resultados entre los miembros de un distrito industrial. Para ello, hemos profundizado en los factores que influyen en el proceso de adquisición de conocimiento y el resultado de la innovación entre las empresas aglomeradas territorialmente. Consideramos que la conjunción de la perspectiva del capital social (Putnam, 1995; Nahapiet and Ghoshal, 1998), el enfoque basado en el conocimiento (Nonaka, 1994; Spender and Grant, 1996) y la perspectiva la capacidad de absorción como capacidad dinámica (Zahra y George, 2002, Lane et al., 2006) proporcionan una base sólida para explicar la innovación en el ámbito de los distritos industriales.

Los resultados obtenidos nos permiten concluir que, en el contexto de los distritos, cuando las empresas fortalecen sus relaciones con los agentes del entorno, compartiendo con ellos valores, visión y la cultura, podrán acceder a conocimiento externo relevante. Así mismo, destacamos el papel clave de la adquisición de conocimiento en la consecución de innovaciones exitosas entre las empresas de los distritos. Finalmente, destacamos el papel moderador de la capacidad de absorción, que permite potenciar los dos efectos señalados. Por tanto, concluimos que la capacidad de identificación ejerce un papel contingente, favoreciendo la extracción de conocimiento valioso de aquellos contactos con los que comparte cultura, metas, objetivos. Del mismo modo, también la capacidad de combinación adopta un rol impulsor de la obtención de innovaciones exitosas a través del conocimiento adquirido del exterior.

Con este trabajo contribuimos resolver un debate de la literatura actual de los distritos industriales, profundizando en el origen de la heterogeneidad de las empresas que los integran. Así, en contraste con parte de la literatura tradicional sobre distritos industriales que se centran en las ventajas sistémicas del mismo (Signorini, 1994), en este estudio comprobamos que no todas las empresas del distrito pueden acceder en el mismo grado al conocimiento externo ni muestran el mismo nivel de innovación. En este sentido, destacamos el papel que tienen las relaciones sociales y las capacidades individuales de las empresas para el desarrollo de los factores señalados. Más concretamente, los componentes de identificación y combinación de la capacidad de absorción son claves para explicar la heterogeneidad existente entre las empresas de las aglomeraciones territoriales. Por tanto, comprobamos que la pertenencia a un distrito no garantiza el acceso a conocimiento valioso, ni asegura su potencial de innovación.

También contribuimos al desarrollo de la perspectiva del capital social, ya que nos centramos en la dimensión cognitiva, que es la menos estudiada y, sin embargo, posee una importancia clave para que las empresas de un distrito puedan adquirir conocimiento relevante del exterior (Parra et al. 2010). Acentuamos, así, el protagonismo del capital social cognitivo, vinculado a las metas, los valores y la cultura compartidas, en el proceso de adquisición de conocimiento en el contexto de los distritos industriales.

Por otra parte, una de nuestras principales aportaciones es explicar el papel contingente de la capacidad de absorción para impulsar el proceso que lleva a las empresas a una innovación efectiva a partir de sus redes sociales. Para ello, hemos profundizado en las funciones diferenciadas que ejercen los componentes de la capacidad de absorción. Concretamente subrayamos el carácter impulsor de la capacidad de identificación para adquirir conocimiento, mientras que la capacidad de combinación potencia el desarrollo de innovaciones exitosas derivadas de dicha adquisición de conocimiento externo. Con el modelo planteado y contrastado también destacamos el papel central de la adquisición de conocimiento en el proceso de innovación de las empresas pertenecientes a un distrito industrial.

Finalmente, con el trabajo contribuimos a reforzar la conceptualización y delimitación del distrito industrial. Así, siguiendo a Becattini (1990), hemos usado tanto elementos objetivos para identificar el distrito como elementos subjetivos, vinculados con la percepción del sentimiento de pertenencia. También consideramos que el sector y el ámbito elegidos son adecuados para la investigación planteada por la madurez y tradición de la industria del calzado, y por la extensión del estudio a todos los distritos industriales del calzado en España, en vez de analizar un distrito en particular.

Como recomendación para las empresas consideramos que deberían desarrollar una actitud proactiva para aprovechar las ventajas que les ofrece el distrito industrial. En este sentido, las empresas deberían invertir esfuerzos en el desarrollo de normas, valores y elementos culturales comunes con sus contactos para adquirir conocimiento eficientemente y, a través del mismo, desarrollar innovaciones en la empresa. También indicamos a las empresas que fortalezcan sus relaciones con las instituciones locales, ya que les pueden facilitar el desarrollo de capital social cognitivo.

Además recomendamos que las empresas dirijan sus esfuerzos hacia el desarrollo de capacidad de absorción, ya que tendrá una doble utilidad. Por un lado, la capacidad de identificación permitirá a las empresas del distrito aprovechar en mayor medida sus relaciones sociales para la adquisición de conocimiento valioso. Y, por otra parte, la capacidad de combinación favorecerá que el conocimiento sea mejor aprovechado para la consecución de innovaciones. De este modo que para acceder a fuentes externas de conocimiento valioso y poder innovar, las empresas en los distritos industriales deben utilizar sus redes sociales así como sus capacidades individuales de análisis y combinación.

En cuanto a las recomendaciones orientadas a las instituciones locales de los distritos (que incluyen institutos tecnológicos, asociaciones empresariales, universidades locales, entre otras) sugerimos que dirijan sus actividades (como la formación, el desarrollo de proyectos conjuntos tecnológicos y de marketing) de manera coordinada para que faciliten el desarrollo de una representación colectiva, y una visión y una cultura compartida entre los miembros del distrito. Además, las instituciones deben establecer relaciones con agentes externos al distrito que faciliten el acceso de información novedosa y relevante para las empresas y, por tanto, promuevan la innovación.

Como limitaciones de este estudio debemos señalar que se centra en el sector del calzado español, lo que puede limitar la generalización de los resultados. Sin embargo, las similitudes con otras industrias maduras podrían permitir generalizar, con cierta cautela, las conclusiones obtenidas. Por otra parte, nuestro estudio es transversal y no longitudinal. En este punto, consideramos que la aproximación transversal del trabajo cubre los objetivos propuestos. Además, las percepciones de los gerentes sobre los principales aspectos del estudio pueden no coincidir exactamente con la realidad objetiva. Sin embargo, consideramos que las percepciones de los gerentes reflejan la realidad empresarial de una manera significativa y en ocasiones más precisa que algunos indicadores objetivos.

Finalmente, el estudio se centra en una de las dimensiones del capital social, por lo que una línea complementaria de investigación consistiría en analizar el papel de las otras dos dimensiones –relacional y estructural- en la adquisición de conocimiento de las empresas aglomeradas. Siguiendo con el análisis de la heterogeneidad en el ámbito de los distritos, consideramos que deberían analizarse otras variables internas como la estrategia competitiva, u otro tipo de capacidades como las tecnológicas, directivas o de marketing que proporcionen una explicación más precisa sobre porque las empresas en un distrito industrial varían a la hora de explotar sus externalidades. Asimismo, sería interesante realizar el estudio en otros sectores para comprobar si existen diferencias en los resultados obtenidos en función del sector analizado.

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THE USE OF INFORMATION TECHNOLOGY IN INTERDEPENDENT TASKS: IMPACT ON ABSORPTIVE CAPACITY AND ORGANIZATIONAL PERFORMANCE

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ABSTRACT

Information Technology (IT) facilitates new applications for the interaction of employees who have to carry out interdependent tasks. The aim of this paper is to present a theoretical model to show how the use of IT in interdependent tasks influences the development of organizational potential absorptive capacity and realized absorptive capacity, which in turn may affect organizational performance. This study addresses a topic of increasing interest for organizational researchers, considering that knowledge is one of the main resources for organizations to sustain and improve their competitive advantages and given that, in recent times, the use of groups that interact through IT is increasing within organizations.

Keywords

Interdependent tasks, Information Technology, absorptive capacity, organizational performance.

1. INTRODUCTION

Nowadays, we are witnessing the evolution from what we called the post-industrial era to today's knowledge-based society (Rico & Cohen, 2005). In this context, the management of external knowledge is becoming a key factor for firms to create value and gain and sustain competitive advantage (Camisón & Forés, 2010). However, many organizations face strong difficulties when trying to benefit from external knowledge flows, which highlights the need to develop and strength their absorptive capacity.

Cohen and Levinthal (1990: 128) defined absorptive capacity as 'the ability to recognize the value of new information, to assimilate it, and apply it to commercial ends'. Zahra and George (2002) point out that absorptive capacity is viewed as a dynamic capability that exists as two subsets of potential and realized absorptive capacity. Potential absorptive capacity refers to knowledge acquisition and assimilation, captures efforts for identifying and acquiring new external knowledge and in assimilating that knowledge obtained from external sources (Zahra & George, 2002). Realized absorptive capacity consists on a firm's ability to transform and exploit the assimilated knowledge by incorporating it into the firm's operations (Jansen et al., 2005; Jiménez-Barrionuevo et al., 2011; Kotabe et al., 2011; Zahra & George, 2002). Thus, absorptive capacity is determined by four dimensions: acquisition, assimilation, transformation and exploitation of knowledge, which becomes essential for organizations to obtain competitive advantages (Zahra & George, 2002).

The principle objective of this study, considering the importance of the ideas presented above, is to develop a theoretical framework to analyze how through the utilization of IT to carry out interdependent tasks, organizations may be able to enhance their potential and realized absorptive capacity, which in turn may also affect their organizational performance. Although previous studies have highlighted the existence of a relationship between IT and absorptive capacity (Gray, 2006; Malhotra et al., 2005) or IT and organizational performance (Jean et al., 2008; Kohli & Devaraj, 2003), there are several gaps in the literature that still remain and that need to be understood. Specifically, little research has analyzed how the use of IT in interdependent tasks, which is taking place any time more and more, may affect the improvement of potential and realized absorptive capacity. For this reason, we will develop a theoretical model and, eventually, will analyze the repercussions that may derive for organizational performance.

This study provides an explanation of how the use of IT in interdependent tasks can favor the development of potential absorptive capacity and realized absorptive capacity. Interdependence has been conceptualized as the extent to which an organization's tasks require its members to work with one another (Bailey et al, 2010). In this sense, interdependent tasks refer to the extent to which "group members must interact and depend on each other in order for the group to accomplish its work" (Guzzo & Shea, 1992, p.296).

The growth in the use of groups is happening in order to search for greater flexibility, responsiveness and learning from organizational members, since they constitute a good mechanism to improve communication, helping, information sharing, and other forms of cooperation that are more common under interdependent tasks than under individualistic ones (Wageman & Baker, 1997). In this point, we highlight the importance of teams that interact via electronic communication systems (Rico & Cohen, 2005). Information and communication technologies facilitate new applications for interaction of employees, such as groupware, intranet, or virtual communities, among others, which have a positive influence in the relationship between knowledge sharing and absorptive capacity (Andrawina, 2008). Thus, it is possible to expect that the use of IT in interdependent tasks will positively affect both potential and realized absorptive capacity (Andrawina, 2008).

There is no integrated model of all of these systems in the literature, even though IT plays a key role within organizations. IT can be defined as any form of computer-based information system (Powell & Dent-Micallef, 1997) and has been widely considered as a major driver of economic growth (Aasheim et al., 2009, Byrd & Turner, 2001). Its importance is reflected in the fact that firms spend more than 50% of their capital investment and 4.2% of their annual revenue in IT investment (Lee & Mirchandani, 2010). Thanks to the use of IT in interdependence tasks, firms may find themselves in a better position to improve their potential and realized absorptive capacity, which in turn may allow them to achieve competitive advantages and greater organizational performance (Melville, 2004) (See Figure 1). In this study, organizational performance will refer to both strategic market performance -including market share and sales growth rate- and financial market performance -including return on sales, return on investment and return on equity (Murray & Kotabe, 1999).

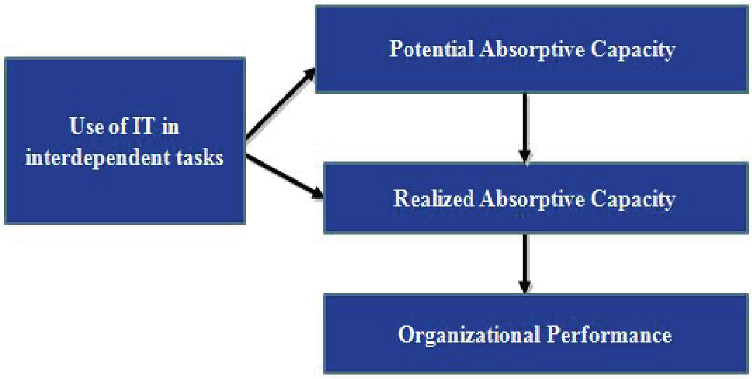

Figure 1: Proposed model

To achieve the objectives presented before, this paper is structured as follows. Section 2, based on prior literature, develops a set of propositions. Finally, Section 3 presents the conclusions of this study, some limitations and different lines for future research.

2. THEORY DEVELOPMENT

2.1. The influence of the use of IT in interdependent tasks on potential absorptive capacity

In the current technology environment, pure face-to-face teams are becoming less common in organizations, considering that nowadays IT make virtual teams a viable alternative to face-to-face work (Griffith et al., 2003). This issue is increasing the importance of the use of IT in interdependent tasks. In virtual teams, the utilization of information and communication technologies allows team members to share knowledge despite the disparities in location (Rico & Cohen, 2005). The interaction with other organizational members through the use of tools such as email, web-based repositories of shared knowledge, instant messaging, chat or videoconferencing, among others, encourage the processes of knowledge collection (Griffith et al., 2003; Rico & Cohen, 2005). These technologies facilitate the acquisition and dissemination of knowledge across the organization and, as a consequence, teams that use IT in interdependent tasks have the opportunity to capture more knowledge for the organization, given that they access larger networks for sources of knowledge (Griffith et al., 2003). Thus, team members can benefit from using information and communication technology applications that provide quick and easy access to external sources of knowledge and new and more intense communication channels (Corso et al., 2003) that, in turn, foster potential absorptive capacity (Jansen et al., 2005; Jiménez-Barrionuevo et al., 2011).

Potential absorptive capacity, which consists of building the organization’s ability to access and share external knowledge, requires a knowledge sharing culture (Daghfous, 2004). Given that IT can lead to a greater breadth and depth of knowledge creation and storage and that can improve group members' ability to share knowledge (Alavi & Leidner, 2001; Young-Choi et al., 2010), it is possible to expect that carrying out interdependent tasks in which the use of IT takes place will lead to an increase in potential absorptive capacity. Based on the foregoing, we arrive at the following proposition:

Proposition 1: The use of IT in interdependent tasks will be positively related to potential absorptive capacity.

2.2 The influence of the use of IT in interdependent tasks on realized absorptive capacity

Organizations have made significant investments in implementing IT that is specifically designed to support the sharing of knowledge among team members in the organization (Young-Choi, 2010). As a result, teams that interact through IT are becoming an important building block in today's knowledge-based organizations (Rico et al., 2008). These team's ability to integrate their existing stock of knowledge and apply it within a new context is an important factor that contributes to team performance (Young-Choi, 2010), but also affects the development of organizational realized absorptive capacity, which involves the transformation and exploitation of new external knowledge (Zahra & George, 2002).

Knowledge application is important as knowledge creation do not necessarily lead to performance improvements unless they are correctly applied (Alavi & Leidner, 2001). Therefore, teams that use IT to complete a given task must not only share knowledge, but also apply it effectively in order to address the given challenge (Young-Choi, 2010), which is related to organizational realized capacity, because it encompasses the application of new external knowledge to commercial ends (Cohen & Levinthal, 1990). Thanks to using IT to carry out interdependent tasks team members solve complex problems and invent new solutions by taking diverse perspectives into consideration (Boland & Tenkasi 1995), which enables the exploitation of knowledge. This interaction through the utilization of IT also allows tacit knowledge to be captured in a more standardized format so that it can be readily applied in different contexts (Hansen et al., 1999).

For effective knowledge integration it is necessary to consider who has the required knowledge and expertise within the organization, where the knowledge and expertise are located, and where they are needed (Alavi & Tiwana, 2002). All the information and communication technologies implemented within the firm - such as web-based repositories, instant messaging, chat, videoconferencing, etc (Rico & Cohen, 2005)- and used to perform interdependent tasks, promote emergent process of rich exchanges to integrate and apply knowledge and expertise (Alavi & Tiwana, 2002), therefore fostering organizational realized absorptive capacity. Thus, and based on the foregoing, we arrive at the following proposition:

Proposition 2: The use of IT in interdependent tasks will be positively related to realized absorptive capacity.

2.3. The influence of potential absorptive capacity on realized absorptive capacity

Previously, it has been pointed out that potential absorptive capacity refers to the acquisition and assimilation of external knowledge, while realized absorptive capacity involves transforming and exploiting the assimilated knowledge by incorporating it into the firm's operations (Zahra & George, 2002).

Despite differentiating these two components of absorptive capacity, it is necessary to highlight that both perform separate but complementary roles (Camisón & Forés, 2010). Previous studies have already shown how potential absorptive capacity affects realized absorptive capacity (Lev et al., 2009). Firms cannot possibly exploit knowledge without first acquiring it (Zahra & George, 2002). Similarly, those organizations focusing on acquisition and assimilation of new knowledge are able to continually renew their knowledge stock, but they may suffer from the costs of acquisition without gaining benefits from exploitation (Jansen et al., 2005). The mere fact that a firm evaluates and acquires knowledge from the exterior does not guarantee that it will exploit this knowledge (Jiménez-Barrionuevo et al., 2011). Consequently, to produce tangible benefits, organizations need to recognize the value of new external knowledge, acquire, assimilate, and exploit it so as to generate commercializable outputs (Kostopoulos et al., 2011; Todorova & Durisin, 2007). More specifically, firms have to be receptive to external knowledge, that is, to acquire, analyze, interpret and understand this knowledge, which involves potential absorptive capacity (Jiménez-Barrionuevo et al., 2011; Lane & Lubatkin, 1998), but they also need, through realized absorptive capacity, to transform and exploit the assimilated knowledge by incorporating it, with existing knowledge, into the firm's operations to achieve its commercial ends (Zahra & George, 2002). Thus, and based on these arguments, we arrive at the following proposition:

Proposition 3: Potential absorptive capacity will be positively related to realized absorptive capacity.

2.4. The influence of realized absorptive capacity on organizational performance

Absorptive capacity promotes the development of new cognitive schemas and the change of existing organizational practices, which enable firms to pursue new product develepment and product line extensions (Kazanjian et al., 2002). In turn, it can promote financial performance and contribute to the achievement of competitive advantage (Kostopoulos et al., 2011; Lane et al., 2006; Zahra & George, 2002). Although potential absorptive capacity and realized absorptive capacity are required to improve such performance, it is necessary to point out the special role that the latter plays. Through realized absorptive capacity firms derive new insights and consequences from the combination of existing and newly acquired knowledge (Jansen, 2005). When the transformation and exploitation of such knowledge takes place, firms obtain as an outcome the creation of new goods, systems, processes, knowledge or new organizational forms (Spender, 1996; Zahra & George, 2002). As a result, organizations will find themselves in a better position to promote innovation activities (Tsai, 2001), which in turn leads to the achievement of greater organizational performance (Kostopoulos et al., 2011). Kotabe et al., (2011) argue that when firms lack realized absorptive capacity to internalize knowledge created by others and modify it to fit into their existing applications, processes, and routines, they cannot benefit from knowledge acquisition to improve their new product market performance. In the same line, Jansen et al. (2005) state that processes underlying realized absorptive capacity generate income through transforming and exploiting knowledge into products and services. Based on the foregoing, we arrive at the following propositon:

Proposition 4: Realized absorptive capacity will be positively related to organizational performance.

5. Discussion and Future Research

This study analyzes the relationships between the use of IT in interdependent tasks, potential and realized absorptive capacity and organizational performance. In previous literature these constructs have been found to be related to the generation of organizational competitive advantages (Griffith et al., 2003; Zahra & George, 2002). However, little or no research has been carried out to understand, in an integrated way, their relationships, how they interact and how they affect the improvement of organizational performance.

The successful use of IT can improve a company’s performance and its competitive position (Dehning & Stratopoulos, 2003; Bharadwaj, 2000). The most recent studies on the business value of IT have highlighted that IT have an indirect, not a direct, impact on firm performance through enabling other organizational capabilities that create performance gains for firms (Benitez-Amado et al., 2010). Following this stream of the literature, this article provides a new theoretical perspective, establishing a model in which we have shown the positive effects that the use of IT in interdependent tasks has on the development of potential and realized absorptive capacity, considering as well its indirect impact on organizational performance through potential and realized absorptive capacity.

IT applications allow the interaction of team members that have to complete interdependent tasks, which facilitates the sharing of knowledge despite the disparities in location or time zone (Rico & Cohen, 2005). In the same way, when these teams use IT to foster rich information exchanges, the processes of knowledge and expertise integration, application and exploitation are promoted (Alavi & Tiwana, 2002). As a consequence, we have provided theoretical evidence that all these processes influence the development of potential absorptive capacity and realized absorptive capacity. This finding is especially relevant, given that absorptive capacity is linked to the improvement of organizational performance (Kostopoulos et al., 2011; Lane et al., 2006).

To survive in turbulent business environments, organizations need to recognize new external knowledge, assimilate it, and apply it to commercial ends (Jansen et al., 2005). However, although potential absorptive capacity is necessary to make the firm receptive to acquire and assimilating external knowledge (Zahra & George, 2002), the mere fact that a firm evaluates and access new external knowledge does not guarantee that it will exploit this knowledge. These arguments highlight the key role that realized absorptive capacity plays to improve organizational performance (Jiménez-Barrionuevo et al., 2011; Zahra & George, 2002).

In sum, the utilization of IT to carry out interdependent tasks must be taken into account as a means to achieve organizational competitive advantages. Organizations can take advantage of forming teams regardless of the physical location of their members, providing further opportunity and flexibility in building the best teams, which in turn will affect the ability to acquire, use and transform knowledge (Griffith et al., 2003). Thus, the interaction of team members to complete interdependent tasks through the use of IT must be seen as an important tool to improve absorptive capacity, a critical ability in today’s knowledge-intensive business environments (Kostopoulos et al., 2011).

5.2. Limitations and Future Research

The investigation presented here exhibits several limitations that should be considered. The model only analyzes how the use of IT in interdependent tasks relates to organizational performance through absorptive capacity. In this context, other intermediate constructs could be analyzed, such as organizational learning (Senge et al., 1994) or knowledge management (e.g., Nonaka & Takeuchi, 1995).

Also, it is relevant to point out that, considering the increasing importance of the topic presented, empirical research should be carried out in the future. This is the main limitation of this study. Thus, empirical papers supporting or rejecting our propositions in different contexts would be welcomed (especially longitudinal studies).

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MANAGEMENT INNOVATION AS A DETERMINANT OF EXPORTING BEHAVIOUR

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ABSTRACT

Previous literature suggests that innovation and cooperation are related to firms' internationalization. However, few works have taken into account the role of other innovative strategies such as marketing and organization, focusing mainly on technological innovation. Our sample consisted of 206 start-up SMEs from which we obtained information regarding their export activity, their corporate entrepreneurship activities and cooperation with different agents during the period 2000-2004 both inclusive. The findings suggest the importance of management innovation on the exporting behaviour of these firms that is maintained over time. However, different forms of management innovation have dissimilar impacts on the exporting strategy. Besides this, specific cooperation relationships appear to be helpful depending on the phase of the exportation process. Managers should be aware of these various effects in order to choose and efficiently adopt management innovation strategies.

Key words: technological innovation, management innovation, cooperation, internationalization.

1. INTRODUCTION

There is a general consensus that the globalization of the economy and the technological changes are the two phenomena that have impacted SMEs to a greater extent in the last decades, implying new challenges and opportunities and modifying competition. The relationship between both phenomena suggests the need to consider them simultaneously when studying the behaviour of the firms as the linkage between innovation activities and firm's international orientation has been characterized by increasing interdependence in the process of globalization (Harris and Li, 2009).

Innovation has become one of the main priorities of most countries and this has reflected in the academic interest in this topic. The encompassing concept of Corporate Entrepreneurship (CE) is defined as "the sum of a company's innovation, renewal and venturing efforts" (Zahra, 1995, p. 227), being this entrepreneurial orientation a critical aspect to respond to the demands and new challenges derived from globalization (Lefebvre and Lefebvre, 1993). Hitt, Ireland, Camp and Sexton (2001) already argued the strong relationship between internationalization and CE. However, this relationship has not been sufficiently examined in the literature, which has mainly focus on the relationship between technological innovation in products and internationalization almost neglecting the relationship between the international activities of the firm and the strategic renewal aspect of CE –also called organizational or management innovation- (Lam, 2005; Damanpour et al., 2009; Mothe and Thi, 2010). This is despite the Oslo Manual defines other three types of innovation (process, organizational and commercial) (OECD, 2005), that although less attended from the institutional support schemes of innovation, many times have more impact for SMEs. There are many calls in the literature to focus on a multidisciplinary view of innovation (Tatikonda and Montoya-Weiss, 2001) and going further in the comprehension of the effects of distinct types of innovation, and especially of organizational and marketing innovations (Armbruster et al. 2008). Our approach relates most closely to the rational perspective within the literature of management innovation (Birkinshaw et al. 2008), focusing on how management innovations deliver improvements in organizational effectiveness intended to further organizational goals, for example in international orientation. Moreover, most of the recent literature on CE is mainly focused on large mature firms (Simsek and Heavey, 2011 is an exception).

Birkinshaw et al (2008) uses a narrow definition of management innovation, but several other studies (OECD, 2005; Murphy, 2002; Uhlaner et al., 2007; Mothe and Thi, 2010), consider that organizational innovation has three types of practices: 1) management practices (teamwork, knowledge management, flexible work arrangements), 2) second one production approaches (change to the work organization: total quality management, business re-engineering) and 3) external relations with other firms or public institutions, through alliances, partnerships, outsourcing, or sub-contracting. That is, cooperation, together with CE and international orientation, is considered important aspects of a firm's competitive advantage in a knowledge-based global economy and at the present economic situation. That is, SMEs need to innovate, find new markets to sell their products and search for partners to jointly face the difficulties of global competition.

The context of this study is especially important, being it centered in Spain. The expenditure in R&D in Spain has grown more than 10% per year in the last decade according to INE and Spain occupies the number 18 in the world as a percentage of GDP dedicated to innovation, which places it at the tail of the EU, according to Eurostat. Besides this, as a result of the economic crisis, in 2008 the investment in R&D was reduced for the first time since 1994, as highlighted by the COTEC Foundation. This data can be related with the one about exporting; since Spain, although being one of the largest EU economies, has a lower than average percentage of SMEs exporting –in Europe 26% of firms on average are involved in export activities- (European Commission, 2010).

Therefore, the objective of this paper is to analyze how CE activities and cooperation influence the probabilities of young SME's to develop an international strategy and how this influence evolves overtime. Our contribution to the literature is threefold. First, we study simultaneously the effect of technology innovation, management innovation and cooperation on SMEs' exporting behaviour. Although cooperation activities and CE appear closely related as both aims at achieving flexibility for a firm, there is a lack of the literature on how both aspects impact firm's international orientation. Secondly, we focus on start-up firms, since most previous literature is focused on large firms. Moreover, we analyse how relationships evolve overtime with a panel data of 206 start-up firms.

The paper is organized as follows. In the next sections we provide an overview of previous theoretical and empirical work on the relationship between CE, cooperation and export activity and propose several hypotheses to be contrasted. Then we present the methods, the database and results of our empirical analysis. Finally, we end up with the discussion and conclusions.

2. THEORETICAL FRAMEWORK

2.1. Corporate entrepreneurship and export activity

Literature on the relationship between CE and exporting behaviour is mainly focused on large firms and has been centred on the technology innovation element of CE (Lefebvre and Lefebvre, 2001; Roper and Love, 2002; Lachenmaier and Wöbmann, 2006; Roper et al., 2006). However, firms need to organize the innovation process efficiently by combining their technological capabilities with other skills and competencies in marketing, management and organization (Mothe and Thi, 2010).

The role of technological innovation on export behaviour of SMEs has led to inconclusive results in the literature. When treated independently, product innovation is a key determinant of the probability of exporting (Lachenmaier and Wöbmann, 2006; Añón Higón and Driffield, 2011) and previous studies have found that product innovation positively affects the probability of export (Nassimbeni, 2001; Basile, 2001; Roper and Love, 2002). However, studies on the relationship between process innovation and export propensity found conflicting results, since some authors have found no relationship (Nassimbeni, 2001), while others have found a positive effect (Basile, 2001) although only when considered independently from product innovation, that is, it does not enhance the probability of SMEs to export beyond the impact of product innovation (Añón Higón and Driffield, 2011). Therefore, a positive relation is expected between innovation activities and export propensity.

H1 *Technological innovation has a positive impact on the internationalization of young SMEs.*

H1a: *Technological innovation in product has a positive impact on the internationalization of young SMEs.*

H1b: *Technological innovation in process has a positive impact on the internationalization of young SMEs.*

Within management innovation different practices can be identified, related to the implementation of new or significantly changed corporate strategies, marketing strategies, organizational structures and advanced management techniques. With regards to the latter, knowledge management can be included within advanced management techniques; consisting in coding knowledge and management skills, is usually associated with higher flexibility, competitive advantage and performance (Prahalad and Hamel, 1990; Grant, 1996; Becerra-Fernandez and Sabherwal, 2001; Kremp and Mairesse, 2004; Spicer and Sadler-Smith, 2006; Uhlaner et al., 2007). These practices enable the firm to disseminate and exploit organizational knowledge internally, as well as to receive knowledge from external partners and, therefore, we proposed a positive effect on international orientation. However, some studies have found inconclusive results when studying this practice (Chen et al., 2004; Shin, 2004) at least in the short term (Mothe and Thi, 2010).

Another management innovation can consist in introducing significant changes in organizational structures or implementing totally new ones. According to OECD (2005), new work practices are related to lean and just-in-time production, decentralized decision making, team work, flexible job assignments, training and shared rewards. Implementing changes on how the organization works could result in more organizational flexibility, which in turn led to improved firm efficiency and performance. In this line, Ichniowski et al. (1997) found that using a set of innovative work practices leads to higher output levels and product quality. Although these improvements might result only when new work practices are combined with heavy investments in either human capital or ICT (Bresnahan et al., 2002) and leaders may have a significant role in simplifying complex dynamics within organizations (Vaccaro et al., 2011).

Besides these, marketing innovation is defined as “the implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing” and changes in sales or distribution methods, (OECD, 2005, p. 49). Some studies have observed that it contributes to a better ability to increase customer satisfaction compared to competitors (Baker and Sinkula, 1999), to successfully adapt to changing market needs and to access new information and resources for developing new competitive products or processes (Day, 1994; Rust et al., 2004).

In sum, strategic renewal has been proposed to be related to organizational performance, growth and profitability (Zahra, 1993; Lee *et al* 2001). The thrust of the argument for a positive relationship between strategic-renewal and performance is related to first-mover advantages (Liberman and Montgomery, 1988). Renewal activities -as well as technological innovation- keep firms ahead of their competitors, gaining a competitive advantage that leads to superior performance. Firms can obtain first-mover advantages by acting earlier than their competitors. The benefits of renewing resources are likely to be enhanced to the extent that firms exploit these investments by entering new geographic markets. Considering strategic renewal as capabilities and competitive dimensions that could explain and understand export decisions on young SMEs, we propose the following hypothesis:

H2 *Management innovation has a positive impact on the internationalization of young SMEs.*

H2a: Implementation of new or significantly changed corporate strategies has a positive impact on the internationalization of young SMEs.

H2b: Implementation of advanced management techniques has a positive impact on the internationalization of young SMEs.

H2c: New or significantly changed organisational structures have a positive impact on the internationalization of young SMEs.

H2d: Changing significantly the firm's marketing concepts/strategies has a positive impact on the internationalization of young SMEs.

2.2. Cooperation and export activity

Early theories of internationalization suggest that firms pursue international expansion only after acquiring the knowledge and expertise by themselves (Johanson and Vahlne, 1977). However, the traditional model of viewing exporting behaviour based on life cycle models is now redundant; since recent research examines the role of networks in accelerating firm's entry into foreign markets (Yu, Gilbert and Oviatt, 2010) and how young firms may compensate their lack of international experience using other sources of knowledge such as suppliers or investors

(Bruneel, Yli-Renko and Clarysse, 2010). Firms are engaged to cooperate in order to have access to partners' complementary or synergistic skills and "incoming spillovers" (Kogut, 1988; Kogut and Zander, 1993; Cassiman and Veugelers, 2002), to reduce the duplication of R&D efforts as well as risks and costs associated to innovation projects (Jacquemin, 1988; Sakakibara, 1997) and to benefit from economies of scale or scope (Kogut, 1988).

Therefore, recent findings show that firms are becoming exporters much earlier in their development and also at a smaller scale. Regarding this last fact, collaboration with other entities could be key for SMEs to overcome several disadvantages that they face when carrying out export activities, mainly due to their reduced dimension and scarce resources (McDougall et al., 1994). Collaboration could help firms to have access to resources and to develop capabilities that could be relevant for their operations in foreign markets. There are a lot of possibilities of learning that arise from collaboration and of allowing firms to acquire capabilities that enable them to successfully compete in foreign markets. Cooperation with other agents offers partners a better knowledge of the international markets and reduces the risks inherent in the internationalization process (Elango and Pattnaik, 2007). Becoming aware of the characteristics of other markets and countries and the opportunities they may offer positively influence the propensity and speed of internationalization. Therefore, cooperation with other entities will make it easier for new born firms to internationalise (Oviatt and McDougall, 2005). Recently and Nieto (2010) found a positive and significant effect of cooperation and innovation activities on the firms' export intensity for knowledge-intensive business services. Based on these arguments and previous findings we propose the following hypothesis:

H3 *Cooperation with other agents for the development of entrepreneurial activities has a positive impact on the internationalization of young SMEs.*

H3a: Cooperation with clients has a positive impact on the internationalization of young SMEs.

H3b: Cooperation with suppliers has a positive impact on the internationalization of young SMEs.

H3c: Cooperation with competitors has a positive impact on the internationalization of young SMEs.

H3d: Cooperation with consultants and R&D firms has a positive impact on the internationalization of young SMEs.

H3e: Cooperation with R&D centers and universities has a positive impact on the internationalization of young SMEs.

3. METHODOLOGY

3.1. Data and Methods

Our sample consisted of 206 start-up SMEs from which we obtained information regarding their export activity, their corporate entrepreneurship activities and cooperation with different agents during the period 2001-2005 both inclusive. Information was obtained from The Technological Innovation Panel (PITEC). The database is being carried out by the INE (Spanish National Statistics Institute). In order to analyse the relationship between CE, cooperation and export activity we carried out two Logistic Binary Regressions.

3.2. Variables operationalization

Early export activity: A dummy variable that takes the value 1 when the firm exports its goods or services within the first three years of activity, and 0 otherwise.

Later export activity: A dummy variable that takes the value 1 when the firm exports its goods or services five years after the start up and 0 otherwise.

Size: Size is measured as the number of employees at start-up. This variable is introduced as a proxy to overcome the sunk costs associated with entry into foreign markets. Literature has found a positive relationship between size and export propensity (Roper and Love, 2002). Larger firms are expected to have more resources available to initiate an international expansion (Cassiman and Martínez-Ros, 2007). Recent research on SMEs also found that an individual SME exports increases with size of the firm (European Commission, 2010).

Group: A dummy variable that takes the value 1 when the firm belongs to a group and 0 otherwise is included in the model. Being part of a group allows firms to overcome the problem of lacking resources necessary to export, such as finance (Roper and Love, 2002; Roper et al., 2006).

Industry dummies. Domestic market conditions are important aspects explaining exporting behaviour of SMEs (Miesenbock, 1988). The sectorial context in which the firm operates is likely to affect its export propensity. We included industry dummies in our models to capture the effect of sector characteristics related to life cycles and technological regimes on export propensity. The firm's activity classification is of two-digit NACE.

Corporate Entrepreneurship: CE is considered a multidimensional firm-level concept represented in three entrepreneurial elements: innovation, strategic renewal and venturing (Guth and Ginsberg, 1990). For the purpose of this paper we focused on the first two elements. *Innovation* refers to the firm's introduction of new product and production processes and *strategic renewal* involves activities aimed at redefining the firm's relationship with its market. Strategic renewal has strategic and organizational change connotations and includes re-definition of the business concept, reorganization, and the introduction of system-wide changes for innovation (Zahra, 1993). Hence, in order to measure CE activities we included 6 dummy variables that take the value 1 when the firm has introduced a new product, a process innovation, has implemented new or significantly changed corporate strategies, organizational structures, marketing strategies, and management techniques, respectively, during the first three years of activity and 0 otherwise.

Cooperation: In our database, cooperation is defined as "active participation in joint innovation projects (including R&D) with other organisations. It does not necessarily imply that either partner derives immediate commercial benefit from the venture. Pure contracting out of work, where there is no active collaboration, is not defined as co-operation in this survey. We used 5 dummy variables to measure firm's cooperation in entrepreneurial activities with clients, suppliers, competitors, consultants and Research Institutions during the first three years of activity of the firm.

4. RESULTS

In our sample, 29.4 per cent of the firms exported their goods within their first three years of activity. This percentage increased until 32.7 per cent if we consider the first five years of operations of these SMEs. Table 1 shows the transition probabilities from different states of early to later export status. As it can be seen in table 1, almost 74 per cent of the firms in our sample remain in the same state: early exporters continue to export and non-exporters continue as non exporters (55.9 per cent). 14.7 per cent of the firms in our sample decided to start their foreign activities later, once they have had an experience in local markets. On the other hand, 11.4 per cent of the firms started global and decided to quit exporting.

Table 1: Export activity of the firms

		Late export activity		
		No	Yes	
Early export activity	No	118 55.9%	31 14.7%	149 70.6%
	Yes	24 11.4%	38 18.0%	62 29.4%
		142 67.3%	69 32.7%	211 100%

Regarding their CE activity, 94.3 per cent of the firms in our sample introduced a new or significantly changed product or service and 95.3 per cent used a new or significantly improved method for the production or supply of goods and services during their first three years of activity. These percentages remain more or less constant if we consider the exporting status of the firms and its evolution, which might be suggesting that product and process innovation may have a little explanatory power of the above mentioned transitions. With regards to management innovation, on average 37.6 per cent of the firms engage in strategic changes, 39 per cent in management techniques changes, 40 per cent in organizational changes and 32.9 per cent in marketing changes. The percentages are similar across time but differ with regards to firms engaging in exporting or not. Exporting firms outstand in strategic (40.6 vs. 36.2 per cent), organizational (49.3 vs. 35.5 per cent) and marketing changes (34.8 vs. 31.9 per cent) but not in changes with regards to management techniques (36.3 vs. 40.4 per cent).

Finally, 56.4 per cent of these start-up firms had cooperation agreements with other enterprises or institutions for the development of any of their CE activities. The majority of this cooperation is with Research Institutions. 40.8 per cent of the firms in the sample have cooperated with these institutions, while only 9 per cent cooperated with competitors.

Table 2 shows the mean, standard deviation and correlations of the variables included in our binary logistic regression models. Sizes of the firms vary from 1 to 246. The rest of the variables are dichotomous.

Table 2. Descriptive statistics

Variab.	Mean	S.d.	1	2	3	4	5	6	7	8	9	10	11	12	13	14
E-export	.29	.45														
L-export	.32	.47	.39													
Size	34.02	58.9	.06	.16												
Group	.27	.44	.21	.13	.33											
Prodinn	.94	.23	.06	-.01	-.13	-.09										
Procinn	.95	.21	.04	-.03	-.16	-.16	.81									
N-strat	.38	.48	.03	.04	-.05	-.02	.02	-.05								
N-mgmt	.39	.48	-.06	-.04	-.02	.01	-.05	-.05	.46							
N-org	.40	.49	.15	.13	.03	.07	-.01	-.04	.51	.56						
N-mkt	.33	.47	.08	.02	-.07	-.01	-.01	.01	.52	.27	.31					
CoopC	.12	.32	.02	.05	-.11	-.04	-.03	.08	,17	.06	.12	.08				
CoopS	.11	.31	.06	.16	-.05	.01	.02	.08	.04	.09	.08	.11	.10			
CoopCo	.09	.28	.01	.02	-.01	-.04	.07	.07	.06	.05	.04	.02	-.01	-.01		
CoopRD	.08	.26	.01	.06	-.04	-.05	.07	.06	.07	.06	.09	.14	.11	.23	.03	
CoopRI	.14	.34	.13	.07	-.10	.04	-.02	-.04	.08	.02	.07	-.01	.15	-.01	.11	.04

Table 3 shows the results of our logistic binary regression models. We measure the effect of several variables at start-up on firms' early export activity and later export activity.

Model 1 shows a positive and significant effect of the firm being part of a group on the dependent variable, that is, early international orientation is initially promoted by corporate ownership. Those start-up SMEs that are part of an enterprise group have a greater propensity to internationalise their activity within their early first years (coef. 1.071; $p<0.01$). This result is in congruence with recent studies on Spanish SMEs that show that internationalization is negatively related to family ownership and positively related to corporate ownership (Fernández and Nieto, 2006). Basile (2001), on Italian manufacturing firms, also found that belonging to a business group increases the likelihood to export. Recently and for knowledge-intensive business services in Spain Rodríguez and Nieto (2010) found a positive and significant effect of group membership on the firms' export intensity.

Moreover, and consistent with recent research (Harris and Li, 2009; European Commission, 2010) our findings show the importance of the size of the start-up and its impact on the likelihood of exporting, although this impact is delayed on time. The effect of size on early export activity is not significant, whereas, its effect on later export activity is positive and significant (coef. .010; $p<0.05$). Previous literature on the relationship between size and export propensity has pointed to the use of size as a surrogate indicator of resource availability. According to Katsikeas el al (1997: 56) "there is consensus in the international business literature that larger companies possess more financial and human resources as well as production capacity, attain higher levels of economies of scale, and tend to perceive lower levels of risk about overseas markets and operations", hence, size facilitates export activity. However, empirical studies on the topic have found mixed results (see Sousa, Martínez-López and Coelho, 2008, for a review). This empirical controversy may arise from the use of different measures for firm size, from samples that include firms from many sectors, or in part from the size variable being itself moderated by variables such as industrial concentration or product life cycle. In our paper, we have controlled for industry including sector dummies in our models to capture the effect of sector characteristics related to concentration and life cycles on export propensity.

Regarding CE and its impact on young SMEs' international orientation, our findings show inconclusive results. Apparently, technological innovation either in product or process does not seem to have a significant effect neither on early export activity nor in later export activity, on the contrary as we anticipated. Neither product nor process innovation significantly affect export propensity of young SMEs. This could be due to the fact that more than 95 per cent of these firms show an innovative behaviour. Therefore hypotheses H1a and H1b are not corroborated.

Hypothesis 2 is partially corroborated since H2c in relation to organizational structures is supported and, contrary to our expectations H2b, which proposes a positive impact of advanced management techniques on international orientation, is rejected. With regards to the former, firms focused on introducing and implementing advanced management techniques, such as knowledge management systems, show a negative and significant effect both on early and later export propensity (coef. -1.645 and -1.028; $p<0.01$ respectively). Despite this practices being associated with higher flexibility and competitive advantage; some studies find a weak relation between knowledge management practices and performance (Chen et al., 2004), may be due to the high costs generated by the implementation of such a strategy (Shin, 2004) and its nature of long-term maturity strategy that is associated normally to a significant delay with its profitability (Mothe and Thi, 2010). The later could be related to the smaller coefficient of the later export activity in comparison with the earlier one.

Nevertheless, corporate entrepreneurship activities that involve changes in organizational structures, such as outsourcing of business functions, etc. do significantly have a positive effect on start-up firms early export activity (coef. 2.048; $p<0.01$). Moreover, the effect of these initial changes on firm's export activity remains significant five years later. Implementing changes on how the organization works could result in more organizational flexibility, firm efficiency – output levels and product quality- (Ichniowski et al., 1997) and performance.

Marketing innovation does not impact exporting behaviour, despite its potential benefits: a better ability to increase customer satisfaction and to adapt to changing market needs. These results can be explained by the fact that the firms' environmental context might have a moderating impact, decreasing its positive impact if the economy is in a recession and/or the market is very turbulent and competitive (Kohli and Jaworki, 1990).

Table 3. Logistic regression

	International orientation	
Independent variables (At start-up)	Early export activity	Later export activity
Intercept	-4.392*	.384*
Firm size	.007	.010*
Group	1.071**	.476
Corporate Entrepreneurship		
- Product innovation	1.640	1.186
- Process innovation		
- Implementation of new or significantly changed corporate strategies	-.296	-2.878
- Implementation of advanced management techniques		
- New or significantly changed organisational structures	-.453	.160
- Changing significantly the firm's marketing concepts/strategies		
Cooperation in entrepreneurial activities	-1.645**	-1.028*
- Cooperation with clients	2.048**	1.018*
- Cooperation with suppliers		
- Cooperation with competitors	.651	-.452
- Cooperation with consultants and R&D firms		
- Cooperation with R&D Centers and Universities		
Sector dummies		
	.597	.888
	1.347*	1.739**
	1.221*	.996
	.389	-.056
	.222	.154
	n.s.	n.s.
X^2 Model	97.055**	24.564*
Nagelkerke R^2	.532	.156
-2 Log likelihood	154.959	236.745
% correctly predicted	80.6	67.5
N	206	206

Finally, the third hypothesis is partially corroborated; as we found mixed results on the relationship between cooperation and export propensity –only H3b and H3c are supported-. Our results show that the effect of cooperation with different agents on start-up SMEs' propensity to export depends on the chosen partner. Initially, cooperation with competitors seems to marginally and positively influence early export activity in young SMEs (coef. 1.221; $p<0.05$). The interest for horizontal cooperation with competitors is complex (Hamel et al., 1989; Tether, 2002) and would deserve further research to ascertain the causes. New and small firms could suffer difficulties to mobilize strategical resources that can be related to a greater age and experience and, because of this; they need more help from other firms in order to develop with success large projects. In this line, the maximum level of intra-network co-opetition is expected for low levels of prior experience (Schiavone and Simoni, 2011). However, we cannot lose sight that, while reducing costs and risks for large projects, cooperation with competitors can be dangerous because of the potential for opportunistic behavior on their part and the risks related to involuntary "outgoing spillovers" (Cassiman and Veugelers, 2002; Tether, 2002; Belderbos et al., 2004).

However, cooperation with suppliers is the relationship that significantly influence sustained export propensity (coef. 1.739; $p<0.01$). Cooperation in entrepreneurial activities with suppliers seems to increase the probabilities of young SMEs to expand their markets internationally. Vertical cooperation with suppliers is theoretically assumed to enhance firm efficiency by reducing the uncertainty related to the provision of inputs, contributing vital information on technologies.

Our findings that cooperation with R&D centres and universities have no effect on export behaviour, despite being the most frequently chosen partner, might have relation with this type of cooperation having a long-term nature, since research tends to be of a more generic and basic nature. Furthermore cooperation with universities and research institutes often involves large firms which have internal R&D structures and benefit from public funding (Sakakibara, 1997, 2001). These results contradict Flor and Oltra (2005) findings, in the Ceramic Tiles Industry in Spain, related with the fact that cooperation with universities and research institutions was positively linked with export performance, whereas cooperation with other companies seemed to have no effect –maybe because of the paper being focused in a supplier-dominated single industry-.

The industry dummies included in the model do not have a significant effect in the international orientation, which might reveal that the differences within each industry are even greater than those between the types of industries.

5. CONCLUSIONS

The main contribution of this paper is its analysis on the relationship of cooperation and CE activities on start-up SMEs' export propensity. Traditionally, literature on cooperation, internationalization and corporate entrepreneurship activities has mainly focused on large companies. The analysis of these phenomena on start-up SMEs increases our understanding of the relationship between these activities and its implications on firms' international orientation.

The results of this paper have implications both for firms and public administration. Exporting is traditionally concentrated among large firms with higher capital-intensity, higher growth rate and greater probability of survival. Our findings show that start-up SMEs can successfully achieve international activity, being this affected positively by being part of a group in a first moment and by the current size of the firm later on. An entrepreneurial behaviour focused on organizational renewal and cooperation with competitors and suppliers in a first phase and suppliers in a second one will help young SMEs to achieve this goal. Implementing changes on how the organization works could result in more organizational flexibility, which enables the firm to undergo a process of international expansion. However, the implementation of knowledge management practices might have high costs and firms' members are involved in a process of adaptation and learning which does not have immediate results, making it a long-term maturity practice. In a first stage of exporting, an important part of the process of acquiring and accumulating technological capabilities is based on the relations with competitors within whom firms may form relations for the creation and improvement of technology. Cooperation with suppliers in technological innovation plays an outstanding role in achieving sustained export activity, as this cooperation procures SMEs the capabilities that enable them to successfully compete in foreign markets. Business-owners have to be aware that management innovation –changes in what managers do and how they do it- is very ambiguous and hard to replicate, hence more likely to lead to sustainable competitive advantage

Regarding, public administration, the linkage between CE and export activity is often regarded to be of paramount importance to an economy. Promotion of CE activities, specifically related to management innovation, will have a double effect on firms' competitiveness, letting them to improve their efficiency and grow in markets and possibly in products too.

In relation with the later, we propose as a future line of research the study of the interrelation between technological and non-technological (management) types of innovation. In this line, Schmidt and Rammer (2007) study the determinants of the various types of innovation and showed that they were very much identical and, furthermore, the combination of organizational and product innovation has a positive impact on a firms' return on sales. Furthermore, not all firms are R&D intensive and those with a relatively lower level normally attribute their innovation performance to strategies that focus on competitiveness, marketing, or distribution channels (Hall and Bagchi-Sen, 2007). Mothe and Thi (2010) find also that organizational innovation is related to the propensity to innovate although not to firms' innovative performance. And, it appears that the impact of innovation on organizational performance depends on co-adoption of different innovation types which effects have to be examined over time (Damanpour et al., 2009).

Another interesting avenue of research would be explaining the transitions from exporters to non-exporters and viceversa, using the firm's CE and cooperation activities as explanatory variables.

One potential limitation is the measurement of technological innovation as the propensity/capacity to innovate –firms declare to-be-innovative or not- and it might have been interesting to use the innovative performance –the percentage of total turnover from product innovation that is new to the firm-, since firms more able to use efficiently their innovative capabilities might be more prone to international orientation. This could be surmounted by the fact that small innovating firms have a smaller product portfolio and when engaging in product innovation, that part will be higher in the overall turnover than for large firms (Mothe and Thi, 2010). Among the set of control variables, we have not included the impact of R&D intensity by the fact that R&D investment is usually made by big firms.

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