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Organizational innovation as an enabler of technological innovation capabilities and firm performance☆

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ABSTRACT

This study assesses the relationship between organizational innovation and technological innovation capabilities, and analyzes their effect on firm performance using a resource-based view theoretical framework. The article presents empirical evidence from a survey of 144 Spanish industrial firms and modeling of a system of structural equations using partial least squares. The results confirm that organizational innovation favors the development of technological innovation capabilities and that both organizational innovation and technological capabilities for products and processes can lead to superior firm performance.

1. Introduction

Organizational innovation (OI) is the introduction of new organizational methods for business management in the workplace and/or in the relationship between a company and external agents (OECD, 2005). OI currently represents one of the most important and sustainable sources of competitive advantage for firms because of its context-specific nature (Hamel, 2006, 2007, 2009). However, OI remains poorly understood (Hamel, 2006: 82).

Few conceptual and methodological contributions address the monitoring of OI (Armbruster, Bikfalvi, Kinkel, & Lay, 2008: 645). The number of studies on OI development (Armbruster et al., 2008; Birkinshaw, Hamel, & Mol, 2008; Hamel, 2006, 2007, 2009) and the factors that promote this development (Battisti & Stoneman, 2010; Birkinshaw & Mol, 2006; Mol & Birkinshaw, 2009) have increased in the last few years. However, few studies report on the consequences of OI (Damanpour & Aravind, 2011), and those that do are limited in scope (Mol & Birkinshaw, 2009: 1270). The present study addresses this issue through analysis of: (1) the effect of OI on the generation of technological product and process innovation capabilities (IC); and (2) the impact of OI and technological IC on firm performance (FP).

The present study expands current knowledge on OI in two ways. First, Damanpour and Aravind (2011) encourage research on the effect of OI on technological IC. To date, the main arguments identifying OI as a prerequisite for technological IC stem from reports on organizational change published in the 1950s (Lawrence, 1954; Lewin, 1958). Although there are more recent reports showing a direct correlation between these types of innovation (Damanpour & Evan, 1984; Kimberly & Evanisko, 1981), few studies extend the original reasoning (Damanpour, Szabat, & Evan, 1989). The importance of both organizational and technological innovation has only been shown very recently, but has as yet little advanced our understanding of the connection between them (Battisti & Stoneman, 2010; Damanpour, 2010; Damanpour, Walker, & Avellaneda, 2009). The present study contributes to an understanding of the association between OI and technological IC and supports the hypothesis that while OI is a positive factor in the development of process IC, its effect on product IC is mediated by process IC. This is an important issue in strategic management given that innovative activity is an important source of sustainable competitive advantage (Damanpour & Schneider, 2006; Damanpour & Wischnevsky, 2006). Identification of internal factors that stimulate technological IC can promote a better understanding of the innovative process within a firm (Galende & de la Fuente, 2003) and will enable advancement of the study of the interrelationship between innovation types and IC (Damanpour, 2010).

Second, as Mol and Birkinshaw (2009: 1270) state, "The literature offers very little evidence of the empirical relationship between the introduction of new management practices and FP". Consequently, debate on the impact of OI on FP is ongoing, with one side maintaining that OI has a positive effect on FP (Armbruster et al., 2008; Mol & Birkinshaw, 2009) and is an essential source of competitive advantage (Hamel,

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2009) and the other maintaining that its existence has a weak effect on FP (Cappelli & Neumark, 2001). This paper sheds light on this question by building on the stream of research that proposes that OI positively affects FP.

Furthermore, unlike previous research, this study specifically considers how product and process IC separately affect FP and how they interrelate to achieve a positive effect on FP. This research question is important because provides a better understanding of how firms benefit from these two types of technological IC to obtain superior FP. Until now, the impact of product and process IC on FP has mainly been studied by considering both of them in a construct (Calantone, Cavusgil, & Zhao, 2002; Tsai, 2004) and this paper tries to shed light on whether they provide the same (or different) results for a firm considering them separately.

The structure of the remainder of the article is as follows. Section 2 includes a review of relevant literature and a sound theoretical model of the relationships among OI, technological IC, and FP. Section 3 describes the procedures used to test the hypotheses. Section 4 comprises the results of the analysis. The discussion and conclusions with academic and practical implications follow in Section 5.

2. Literature review and hypotheses

2.1. Resource-based view (RBV) of innovation

Among numerous classifications of types of innovation, one of the most commonly accepted is that of the OECD (2005) in the *Oslo Manual*, which distinguishes four types of innovation: product innovation, process innovation, marketing innovation, and OI. Technological innovation involves product and process innovations, while non-technological innovation involves marketing and organizational innovations. This paper focuses on all of the types identified by the OECD (2005) except for marketing innovation, consideration of which would be beyond the scope of this study. Schumpeter (1934) and other important innovation researchers such as Damanpour (Damanpour, 1991; Damanpour & Evan, 1984) and Edquist, Hommen and McKelvey (2001) have classified innovation types in several ways. Without detracting from these classifications, the classification of the *Oslo Manual* synthesizes and homogenizes these previous important innovation classifications. Specifically, this paper focuses on the role of OI, technological (product and process) IC and its effects on FP.

The theoretical framework provided by the resource-based view (RBV) facilitates clear analysis of innovation and its association with performance (Damanpour et al., 2009; Galende & de la Fuente, 2003; Mol & Birkinshaw, 2009; Yang, Marlow, & Lu, 2009). RBV uses the internal characteristics of firms to explain their heterogeneity in strategy and performance. According to the main assumption of RBV, only firms with certain resources and capabilities with special characteristics will gain competitive advantages and, therefore, achieve superior performance. The distinctiveness of a factor depends on its rarity, value, durability, nonsubstitutability, inimitability and appropriability of generated rents (Amit & Schoemaker, 1993; Barney, 1986, 1991; Grant, 1991; Peteraf, 1993; Wernerfelt, 1984). Sustainable competitive advantage determines the ability of an organization to reconfigure and to constantly renew its supply of valuable and idiosyncratic resources and capabilities to foster innovation (Eisenhardt & Martin, 2000; Grant, 1996; Nelson & Winter, 1982; Teece, Pisano, & Shuen, 1997; Winter, 2000).

According to RBV, a capability refers to the deployment and reconfiguration of resources to improve productivity and achieve strategic goals (Makadok, 2001). A capability is a lower-order functional, operational or technological capability (Ortega, 2009). Technological IC is identified as one of the most important sources of competitive advantage (Coombs & Bierly, 2001, 2006) owing to its causal ambiguity (González-Álvarez & Nieto-Antolín, 2005). Specifically, technological IC is the ability to perform any relevant technical function or volume activity within the firm, including the ability to develop new products and processes, and to operate facilities effectively (Teece, Pisano & Shuen, 1997). Recent empirical research provides statistical evidence that technological IC is an important determinant of FP (Ortega, 2009; Tsai, 2004).

The next section examines OI, given the necessity to clarify this concept.

2.2. Organizational innovation

The definition of OI is not as easily agreed in innovation literature as those for technological IC (Armbruster et al., 2008). This is due to the fact that literature on OI is still scarce and scattered (Armbruster et al., 2006, 2008; Mol & Birkinshaw, 2009), reflecting various definitions of the concept (Table 1).

The first scientific studies on innovation in firms were on administrative innovation (Daft, 1978; Damanpour, 1991; Damanpour & Evan, 1984; Damanpour, Szabat & Evan, 1989; Ettlie & Reza, 1992), defined as innovation concerning changes in organizational structure and human resource (HR) practices. More recent papers, however, refer to management innovation (Hamel, 2006, 2007, 2009; Mol & Birkinshaw, 2009), managerial innovation (Damanpour & Aravind, 2011) or OI (Armbruster et al., 2006; Battisti & Stoneman, 2010; OECD, 2005). As Damanpour and Aravind (2011: 35) posit, the definitions of administrative, organizational and management innovations overlap markedly.

The present study uses the terminology and definition proposed by the OECD, which encompass the essence of both the traditional and more recent definitions. Specifically, the OECD (2005) defines OI as the implementation of a new organizational method in a firm's business practices, workplace organization, or external relationships. The feature that distinguishes OI from other organizational changes is the implementation of an organizational method that has not been used before in the firm and that is the result of strategic management decisions (OECD, 2005).

In particular, the OECD (2005) considers that OI in business practice involves the implementation of new methods for organizing routines and procedures, such as establishing databases of best practice, improving worker retention, or introducing management systems. Innovation in workplace organization involves the implementation of new methods for distributing responsibilities and decision-making among employees for the division of work, as well as new concepts for the structuring of activities. Finally, innovation in organization methods for external relationships involves the implementation of new ways of organizing relationships with other firms or public institutions, such as collaboration with research organizations or customers, methods for integration with suppliers, or outsourcing.

This OECD (2005) definition of OI has similarities to and differences from previous definitions (Table 1). With regard to the similarities, most of the definitions establish that OI (or management innovation, depending on the terminology used by the authors) consists of the use of new managerial and working concepts and practices (e.g. Armbruster et al., 2006, 2008; Birkinshaw et al., 2008). Therefore, OI refers to the implementation of a new organizational method in a firm. With regard to the differences among definitions, the OECD (2005) and other authors such as Armbruster et al. (2006, 2008) and Battisti and Stoneman (2010) introduce a further twist to the definition of OI. These definitions include inter- and intra-organizational dimensions to OI. Intra-organizational OI occurs within an organization or company, whereas inter-organizational OI includes new structures or procedures outside the company boundaries (e.g. cooperation agreements) (Armbruster et al., 2008). This difference suggests that OI is different from management innovation and the terms are not interchangeable. On the contrary, the OECD (2005) definition of OI includes the concept of management innovation (intra-organizational innovation) and expands the definition by considering the case of inter-organizational innovation. This enriches the definition of management innovation because considers intra- and inter-organizational innovations simultaneously with regard to the use of new managerial and working concepts and practices.

Table 1
Organizational innovation definitions.

Study	Terminology	Definition
Daft (1978)	Administrative innovation	Concerns organizational structure and administrative processes
Kimberly and Evanisko (1981)	Administrative innovation	Adoption of electronic data processing for a variety of internal information storage, retrieval and analytical purposes, indirectly related to the basic work activity of the hospital and more immediately related to its management
Damanpour and Evan (1984)	Administrative innovation	Innovations introduced into the organizational structure, into administrative processes and/or human resources
Damanpour et al. (1989)	Administrative innovation	Innovations in the administrative component that affect the social system of an organization
Hwang (2004)	Managerial innovation	Design of an appropriate organizational structure and processes, and a human resource system
OECD (2005)	Organizational innovation	Implementation of a new organizational method in the business practices, workplace organization or external relations
Hamel (2006)	Management innovation	A marked departure from traditional management principles, processes and practices or a departure from customary organizational forms that significantly alters the way the work of management is performed
Armbruster et al. (2006, 2008)	Organizational innovation	Changes in the structure and processes of an organization due to implementation of new managerial and working concepts and practices, such as teamwork in production, supply chain management, or quality management systems
Birkinshaw et al. (2008)	Management innovation	Invention and implementation of a management practice, process, structure or technique that is new and is intended to further organizational goals
Mol and Birkinshaw (2009)	Management innovation	Introduction of management practices that are new to the firm and intended to enhance firm performance
Battisti and Stoneman (2010)	Organizational innovation	Innovation involving new management practices, new organization, new marketing concepts and new corporate strategies
Damanpour and Aravind (2011)	Managerial innovation	New approaches in knowledge for performing management functions and new processes that produce changes in the organization's strategy, structure, administrative procedures, and systems

The literature on OI is scarce (Armbruster et al., 2006, 2008), particularly in terms of empirical evidence (Battisti & Stoneman, 2010). Apart from some early contributions (Damanpour et al., 1989), the importance of OI as a distinct innovation type has only emerged in the last decade. The OECD (2005) recognition of OI as separate from product, process, and marketing innovations partly triggered this change in direction. Recent studies have expanded the concept of OI (Armbruster et al., 2006, 2008; Hamel, 2006, 2007, 2009) and carry out various empirical papers (Armbruster et al., 2008; Battisti & Stoneman, 2010). Some studies address the development of OI (Birkinshaw et al., 2008; Hamel, 2006, 2007, 2009) and factors favoring its development (Mol & Birkinshaw, 2009). Others consider business responses to the inclusion of OI (O'Mahoney, 2007) and its effect on organizational performance (Camisón & Villar-López, 2010; Walker, Damanpour, & Devece, 2010) or FP (Damanpour et al., 2009; Mazzanti, Pini & Tortia, 2006; Mol & Birkinshaw, 2009). Specific innovation practices are also the focus of research (Cappelli & Neumark, 2001; Mazzanti et al., 2006; Perdormo-Ortiz, González-Benito, & Galende, 2009; Prajogo & Sohal, 2006; Ulusoy, 2003). Nevertheless, knowledge of the consequences of OI remains limited (Damanpour & Aravind, 2011: 35).

2.3. OI and technological IC

Researchers have for a long time been aware of the close relationship between organizational and technological innovations (Burns & Stalker, 1961; Damanpour & Evan, 1984; Kimberly & Evanisko, 1981). However, although the role of OI in promoting technological IC development has been proposed theoretically (Armbruster et al., 2006, 2008), no conclusive empirical proof exists. The study by Damanpour et al. (1989) is a noteworthy exception. Their empirical study of a sample of libraries in the United States shows that administrative innovation promotes technological innovation over time. Some recent studies emphasize the complementary nature of organizational and technological innovations (Battisti & Stoneman, 2010; Damanpour et al., 2009; Martínez-Ros & Labeaga, 2009; Piva, Santarelli & Vivarelli, 2005), showing that synergism between the two types of innovation renders them complementary processes rather than substitute processes.

Using RBV, the present study proposes that OI favors the development of technological IC. In particular, with respect to the relationship between OI and process IC, the paper states that OI directly favors the development of process IC.

According to RBV, introduction of OI in a firm, which comprises rare, valuable, inimitable and non-substitutable working practices, can favour development of the ability to perform a technical function. OI in business practices, innovations in workplace organization or new organizational methods in external relations can favor a more efficient organization and the use of innovative manufacturing and technological processes.

In the empirical area, OI is directly linked to the generation of process IC. For example, business practices such as quality control can promote an increase in efficiency and can therefore improve the capability to develop process IC (Damanpour & Gopalakrishnan, 2001). Inter-organizational collaboration is also an important method for the generation of process IC (Shoenmakers & Duysters, 2006). Previous empirical studies have demonstrated that external relationships and participation in cooperative agreements are positively associated with the development of process IC (Camisón, Boronat, & Villar, 2010).

H1a. A positive relationship exists between the firm's introduction of new management practices (OI) and its development of process innovation capabilities.

The introduction of certain new organizational practices *per se* does not directly lead to the development of product IC. On the contrary, this paper argues that the effect of OI on product IC is mediated by the generation of process IC. When a firm has introduced OI, to accumulate capabilities to introduce new products in the market, OI needs an appropriate organizational infrastructure as well as engineering and technological skills to design the production processes, layout, and logistics to efficiently support the new product design and its commercialization.

Empirical proof of this can be found, for example, in Prajogo and Sohal (2006), who demonstrate that the use of total quality management does not directly favor product innovation if that relationship is mediated by technology/R&D management. If OI is utilized to improve process IC, this will favor the development of product IC. Fritsch and Meschede (2001: 345) demonstrate empirically that process innovation positively affects product innovation and that the development of process innovation will enable a firm to improve its product quality or produce completely new products.

The effect of OI on product IC is not direct but is mediated by process IC.

H1b. The effect of the introduction by a firm of new management practices (OI) on product innovation capabilities is mediated by its generation of process innovation capabilities.

The positive effect of the adoption by a firm of new organizational practices does not have to be limited to the extension of OI. The continuous improvement of management systems and techniques can stimulate technological innovation capabilities by opening new opportunities to exploit and explore innovative combinations of resources.

2.4. OI, technological IC, and FP

According to RBV reasoning, OI is an immediate source of competitive advantage (Goldman, Nagel, & Preiss, 1995) that can lead to an improvement in performance (OECD, 2005). RBV regards differences in business performance as consequences of an organization's internal characteristics. The main assumption of this approach is that only firms with strategic assets will obtain sustainable competitive advantage and will, therefore, achieve superior performance.

First, strategic assets are characterized by their scarcity, their similarity to key success factors in the industry, their durability, the difficulty of substitution or imitation of products, and the appropriateness of generated rents (Amit & Schoemaker, 1993; Barney, 1986, 1991; Grant, 1996; Peteraf, 1993; Wernerfelt, 1984). Second, sustainable competitive advantage relies on a firm's dynamic capabilities to innovate, understood as the ability to adapt and reconfigure resources and capabilities (Eisenhardt & Martin, 2000; Grant, 1996). Therefore, OI is a fundamental strategic asset for the development of sustainable competitive advantage capable of generating superior income.

Innovation scholars have also pointed out the importance of OI for performance, yet have not conducted adequate empirical studies to explain this relationship fully (Damanpour & Aranvind, in press: 28–29). Although contrasting points of view exist in the literature, a greater number of studies support the beneficial effect of OI on FP. For example, Mazzanti et al. (2006) use quantitative analysis to demonstrate a positive and significant correlation between FP and OI, and conclude that companies with better performance participate more extensively in organizational changes. A large number of studies show that specific OI practices, such as quality management systems (Osterman, 1994; Perdormo-Ortiz et al., 2009; Prajogo & Sohal, 2006) and high-performance management methods (Caroli & Van Reene, 2001; Greenan, 2003; Osterman, 1994), positively affect FP.

In the present study, RBV reasoning leads to the proposal that OI has a positive effect on FP. OIs are specific to the system that generates them, which is normally a highly complex social system involving a wide array of participants and the relationships among them (Birkinshaw & Mol, 2006). In addition, OI is by nature, more so than technological innovations (Birkinshaw & Mol, 2006).

These basic OI characteristics provide a unique capability to create long-term competitive advantage (Hamel, 2009). In addition, the goal of OI introduction is to improve FP (Hamel, 2009).

H2. A positive relationship exists between introductions of new management practices (OI) and firm performance.

Numerous studies focus on the relationship between technological innovation and FP (Damanpour & Evan, 1984; Damanpour et al., 1989; Ortega, 2009). Most of the empirical studies analyze how technological innovation performance—innovation as output—or technological effort for innovation—innovation as input—affect FP (Jiménez Jiménez & Sanz Valle, 2011; Martínez-Sánchez, Vela-Jiménez, Pérez-Pérez, & de-Luis-Carnicer, 2009). A smaller group of studies based on RBV focuses on the analysis of IC—innovation as organizational capability—and its effect on FP (Calantone et al., 2002; García-Morales, Matías-Reche, & Hurtado-Torres, 2008; Ortega, 2009; Tsai, 2004; Yang et al., 2009). The current article grows on this last body of research to analyze the relationship between product and process technological IC and FP.

Most papers on technological IC consider different types of IC simultaneously, such as the cumulative impact of product and process IC on FP. These studies either consider innovation as a second-order factor with two dimensions, one for each type of innovation (Sanz-Valle, Jiménez-Jiménez, & Hernández-Espallardo, 2007) or include the different innovation types within one latent construct (Calantone et al., 2002; Ortega, 2009; Yang et al., 2009). This empirical research supports the strategic potential of technological IC to generate a higher FP. However, although this research is valuable, extension of this line of research requires the analysis of the independent effect of each type of IC on FP. This paper empirically tests the separate effects of product and process IC on FP because as product and process innovations are distinct phenomena (Damanpour & Aravind, 2006) that contribute to organizational competitiveness and growth in different ways (Damanpour, 2010), so may product and process IC similarly operate.

With regard to the relationship between product IC and FP, this study argues that the first will positive and directly influence the latter. The objective of product innovation is to respond to customers' demand for new products or executives' desire to capture new markets (Damanpour, 2010). In essence, product innovation enables the organization to differentiate its products (Porter, 1985) and changes what the organization offers to the outside world (Bessant, Lamming, Noke, & Philips, 2005). Consequently, from RBV, product IC can be considered essential for the generation and sustainability of competitive advantage (Barney, Wright, & Ketchen, 2001; Prahalad & Hamel, 1990) owing to the inherent difficulty in imitating such products (González-Álvarez & Nieto-Antolín, 2005), and, therefore, having a positive impact on FP.

H3a. A positive relationship exists between product innovation capabilities and firm performance.

However, the effect of process IC on FP is mediated by the generation of product IC. Process innovation is pursued to reduce delivery lead-time or decrease operational cost (Damanpour, 2010), which changes the way an organization produces and delivers its products (Bessant et al., 2005). Thus, process innovation has an internal focus (Martínez-Ros, 2000) orientated towards efficiency, facilitating firms to follow cost leadership strategies (Porter, 1985). Therefore, to influence FP, these capabilities must favor the development of product IC. In this way, a congruent development of process and product IC is achieved, resulting in improvement in FP. Previous studies have demonstrated that additive effect of innovation types favors FP (Damanpour et al., 2009). From RBV, the synergistic interrelationship between both types of IC that allows firms to achieve competitive advantage that will result in improvement in FP.

H3b. The effect of process innovation capabilities on firm performance is mediated by the development of product innovation capabilities.

3. Research method

3.1. Sample population

In this paper, the empirical study was undertaken by Spanish industrial companies. The contact information was obtained by the Sistema de Análisis de Balances Ibéricos (SABI) database, which offers identification and financial data of Spanish industrial companies. The following prerequisites were included in the population under study: First, the availability of complete contact details was necessary. Second, the population excludes the energy sector and micro-businesses (companies with <10 workers) to avoid heterogeneity problems (Spanos & Lioukas, 2001). Third, firms had to have only one production plant. Please note that this condition is due to the fact that the sample was generated in the context of wider research on competitiveness of industrial Spanish firms and that the inclusion of this requisite does not affect to the results of this paper. The number of industrial companies meeting these conditions held in the SABI database at the end of 2005 was 2145 from a total of 30 industrial sectors (2-digit SIC).

To gather the data, the submitted questionnaires to the firms based on a wide literature review. Before sending the questionnaire, a pre-test validation of the design with seven companies. The questionnaire was subsequently revised to improve understanding of its content. Fieldwork on the final questionnaire occurred during April–November 2006 asking about data from 2005. The questionnaire was distributed by postal mail with follow-up telephone calls to request firms' participation.

175 companies answered. Of these, 16 were eliminated from the sample because of incomplete or incorrectly completed questionnaires. This left 159 questionnaires that were satisfactorily completed, with a sample error of 7.6% ($p = q = 0.5$). However a final requirement to be included in the sample was that firms had to have complete financial data available in the SABI database to measure FP. Thus, the final sample comprises 144 companies. Of these, 25% are small (10–250 employees), 46.5% are medium-sized (250–500 employees), and 28.5% are large (>500 employees) firms, covering 19 industries. To examine if the sample reflects the population for some of the control variables, the organizational size variable are checked for correspondence. The distribution by number of employees of the sample reflects the population characteristics in terms of organizational size, where most of the firms are medium-sized. In the population of this study, 16.4% are small (10–250 employees), 53.1% are medium-sized (250–500 employees), and 30.5% are large (>500 employees). With this data a significant difference between the number of employees and sales volume of the firms in the sample compared with those that did not respond to the survey. Therefore, non-response bias does not seem to be a major concern.

3.2. Statistical analysis

The study uses the partial least squares (PLS) approach (Chin, 1998a, 1998b, 2001; Wold, 1966) to test the theoretical model, specifically PLS-Graph 3.0 Build 1126 (Chin, 2003). This technique is preferable to a covariance-based approach for the following reasons. First, the sample contains 144 observations, which can be considered small, which PLS is particularly suitable for. Second, the research model contains both formative and reflective constructs. In particular, formative second-order factors can only be modeled using PLS (Chin & Newsted, 1999). Other structural equation models (e.g., covariance-based model performed by EQS or LISREL) make it impossible to run these models (Diamantopoulus & Winklhofer, 2001).

3.3. Measurement variables

In the research model, all variables correspond to first-order factors with multi-item scales using a seven-point Likert scale for managerial perceptions, except for OI, which is a second-order factor. This approach requires a choice between molar and molecular factors. Whereas the molar approach represents an emergent construct that is formed from first-order factors, the molecular approach hypothesizes that an overall latent construct exists and is indicated and reflected by first-order factors (Chin & Ghopal, 1995). If a change in one of the dimensions necessarily results in similar changes to the other dimensions, then a molecular model is appropriate. Otherwise, a molar model is more suitable (Chin & Ghopal, 1995).

A list of items for each measurement scale is presented in Appendix A. The measurement approach for each construct in the model is described below.

3.3.1. OI

The measurement of this variable is derived from the OECD (2005) definition and adapted from Camisón and Villar-López (2010), the resulting scale capturing assessment of the implementation of a set of advanced management practices for the first time in the firm. The measurement scale distinguishes between three dimensions that coincide with the categorization provided by the OECD OI definition: The first dimension is called *OI in business practices*, which includes three reflective indicators that involve the implementation of new methods such as the use of a database of best practices or quality management systems.

The second dimension is named *Innovations in workplace organization*, which includes three reflective indicators regarding the implementation of new practices related to organizational design. The last dimension is named *New organizational methods in the external relationships*, which is made up of three reflective items that involve the implementation of new ways of organizing relationships with other agents such as customers or suppliers (see Appendix A for details). This latter variable has been defined as a molar second-order factor because an increment in one of the dimensions does not imply that the remaining dimensions will change similarly. Participants in the survey assessed the degree to which the firm had recently used the management practices listed for the first time.

3.3.2. Product IC

Numerous researchers have analyzed IC using reliable valid scales that allow its measurement (e.g., Miller & Friesen, 1983; Spanos & Lioukas, 2001). However, most of these scales measure product and process IC jointly. To develop a specific measurement scale for product IC, the OECD's (2005) definition of product innovation was adapted. And, the scales to achieve the objective of this paper was undertaken by Tuominen and Hyvönen (2004), Menguc and Auh (2010), and Camisón and Villar-López (2010). Five reflective items make up the final measurement scale. This scale assesses a firm's ability to develop new or significantly improved products (see Appendix A for details). Participants in the survey assessed the extent to which product IC constitutes a particular strength for the firm in comparison with competitors.

3.3.3. Process IC

To develop a specific measurement scale for process IC, this paper used the OECD's (2005) definition of process innovation and adapted previously validated scales by Tuominen and Hyvönen (2004), and Camisón and Villar-López (2010). Eleven reflective items make up the measurement scale. These items represent a firm's ability to develop new or significantly changed productive and technological processes (see Appendix A for details). Participants in the survey assessed the extent to which process IC constitutes a particular strength for the firm in comparison with competitors.

3.3.4. FP

Previous literature defends the use of different performance measures which vary mainly on the objective/subjective character of the measure. In principle, objective measurements have greater validity than subjective ones. However, it has been widely demonstrated in the literature that there is a high correlation and concurrent validity between objective and subjective measurements (Dess & Robinson, 1984; Homburg, Krohmer, & Workman, 1999; Venkatraman & Ramanujan, 1987). Therefore, this paper measures FP by adapting a scale developed by Calantone et al. (2002) which combines both objective and subjective performance measures. Specifically, the scale contains three objective items (return on shareholders funds, return on capital employed, and return on total assets) and three subjective items (mean economic profitability, mean financial profitability, and mean sales profitability). Although this study uses cross-sectional data, to introduce a certain dynamic component in the model, the objective FP indicators date from 2006 while the subjective indicators refer to 2005. The indicators making up the measurement scale are commonly used in other studies (Yamin, Mavondo, Gunasekaran, & Sarros, 1997).

Given the potential of implicit deviations in managerial perceptions of the performance of their firms (Conant, Mokwa, & Varadarajan, 1990), caution is necessary in evaluating the risk of common variance when all the variable data come from the same source. A process to test for such bias involves verification of the convergent validity of the performance measure using correlation coefficients for the self-evaluation of objective measures exogenous to the firm. This process is applied to the three 2005

subjective indicators included in the performance scale (economic profitability, financial profitability, and sales profitability). The objective indicators referring to 2005 were obtained from the SABI database. However, because these exogenous indicators are not available for all the sample firms, only 105, 99, and 112 companies, respectively, are analyzed.

Correlations between the objective and subjective performance indicators are statistically significant (economic profitability = 0.269; financial profitability = 0.243; mean sales profitability = 0.299; $p<0.01$). However, some studies in the literature on social psychology (e.g., Wall et al., 2004) report correlations of around 0.8 for good measures of subjective and objective performance; therefore, only weak convergent validity of the measures exists.

3.4. Control variables

The study includes controls for contextual variables that might potentially confound the results. Previous studies show that organization size, age, and environmental uncertainty influence a firm's IC (Camisón-Zornoza, Lapiedra-Alcamí, Segarra-Ciprés, & Boronat-Navarro, 2004; Damanpour, 1991; Damanpour & Aravind, 2006; Mintzberg, 1979) and FP (Blau & Schoenherr, 1971; Dess, Lumpkin, & Covin, 1997). As some studies have cautioned that FP in time Y is a function of FP in time Y-1 (Walker et al., 2010), previous year's performance was also included as a control variable affecting FP.

The metric for organizational size is the logarithm of the number of employees of the firm. Organizational age is measured as the number of years since the foundation of the firm. Environmental uncertainty comprises the dimensions dynamism, munificence, and complexity, as identified by Dess and Beard (1984) and applied in relevant research (Ketchen, Thomas, & Snow, 1993; Lawles & Finch, 1989). A subjective measurement scale comprising 18 items measured on a seven-point Likert scale (see Appendix A) developed by Camisón (2004) measures this variable, which appears in the model as the average for the items comprising each dimension. Finally, FP in time Y-1 was measured with the objective indicator "Return on Total Assets", obtained from the SABI database for the year 2004.

Table 2 shows the descriptive statistics for all the variables, together with the correlation matrix.

4. Results

Analysis of a PLS model comprises two stages: (1) assessment of the measurement model; and (2) testing of the structural model.

4.1. Measurement model

4.1.1. Reliability

The individual reliability of the items depends on the use of factor loadings. Carmines and Zeller (1979) recommend factor loadings ≥ 0.707. Table 3 lists the factor loadings for all the constructs in the theoretical model. All the factor loadings are above this minimum value except for items PCI1, PCI6, PCI8, PCI9, and PCI10 from the process IC scale and FP4, FP5, and FP6 from the FP scale. However, some researchers recommend not removing items from the original measurement scales if they are different from zero because this would eliminate valid information, even though relatively small with respect to the rest of the items (Chin, 1998b). Therefore, the calculations include these items.

In the case of the OI construct, which is measured by a molar second-order factor, the loadings are misleading because the estimation process does not take into account the intraset correlations for each block. Therefore, reliability is interpreted using weights (Chin, 1998a). The weights provide information about how each indicator contributes to the respective construct, which obviates the need for a minimum level (Table 3). However, potential multicollinearity among the items is a concern for formative measures (Diamantopoulus & Winklhofer, 2001). If high collinearity exists among indicators, unreliable estimates may arise, leading to difficulty in separating the different effects of individual indicators in the construct. A collinearity test using SPSS 15.0 for Windows reveals minimal collinearity with the variance inflation factor (VIF) for all items (Table 3) since the values are all much less than the common cutoff threshold of 5–10 (Kleinbaum, Kupper, & Muller, 1988).

The reliability of the constructs is evaluated by analyzing the joint reliability indicator. Nunnally (1978) recommends a value of 0.7 as a suitable level for this indicator. The values of this index in Table 3 exceed the minimum levels required for all the constructs.

4.1.2. Validity

The average variance extracted (AVE) index provides an assessment of convergent validity. Fornell and Larcker (1981) recommend an AVE value ≥ 0.5. All the constructs have an AVE value above this minimum, except for the FP construct which is very close to this value (0.455, see Table 3). However, the FP measure possesses convergent validity as FP relates significantly with other FP indicators (appearing in Section 3.3 Measurement variables).

Assessment of discriminant validity involves comparison of the AVE for all latent constructs that include reflective indicators. For discriminant validity to exist, the AVE square root must be higher than the correlation between the constructs. Table 4 shows that this condition is met in all cases.

4.2. Structural model

4.2.1. Model predictability and fit

The model predictability is evaluated by means of R^2 values for the dependent latent variables. Table 5 shows that the R^2 value for the endogenous constructs exceeds the minimum value of 0.1 recommended by Falk and Miller (1992: 80). Moreover, the R^2 value for the performance variable indicates that the theoretical model proposed explains

Table 2
Means, standard deviations, and correlations for the study variables.

	Variable	Mean	SD	1	2	3	4	5	6	7
1	OI	4.83	0.94	1.00						
2	Product IC	4.86	1.08	0.47**	1.00					
3	Process IC	5.06	0.97	0.77**	0.65**	1.00				
4	FP	5.17	14.04	0.12	0.06	0.05	1.00			
5	Age	37.41	31.58	0.13	0.11	0.15	−0.05	1.00		
6	Size	4.68	1.29	0.12	0.07	0.18*	0.08	0.21**	1.00	
7	EU	4.03	0.52	0.05	0.16	0.09	0.01	0.02	0.02	1.00
8	FP-1	3.32	9.79	0.12	0.06	0.13	0.54**	−0.05	0.04	−0.00

Notes: OI, organizational innovation; IC, innovation capabilities; FP, firm performance; EU, environment uncertainty; FP-1, firm performance in 2004.
** Statistically significant at 0.01.
* Statistically significant at 0.05.

Table 3
Measurement model results[a].

Construct	VIF	Weight	SL	SE	*t*-value[b]	CR	AVE[c]
OI (molar second-order factor)						n.a.	n.a.
Business practices	2.80	0.95****		0.03	28.96		
Workplace	2.62	0.85***		0.05	16.13		
External relations	1.40	0.75****		0.06	11.46		
Product IC (reflective)						0.87	0.58
PDI1			0.70****	0.06	10.71		
PDI2			0.72****	0.07	9.18		
PDI3			0.73****	0.07	9.74		
PDI4			0.79****	0.05	15.26		
PDI5			0.83****	0.04	19.04		
Process IC (reflective)						0.92	0.53
PCI1			0.69****	0.05	13.12		
PCI2			0.77****	0.04	17.24		
PCI3			0.82****	0.03	25.20		
PCI4			0.84****	0.03	23.62		
PCI5			0.73****	0.07	9.85		
PCI6			0.69****	0.06	10.49		
PCI7			0.73****	0.05	14.38		
PCI8			0.61****	0.05	10.68		
PCI9			0.68****	0.05	11.55		
PCI10			0.66****	0.06	10.17		
PCI11			0.72****	0.05	12.47		
FP						0.78	0.45
FP1			0.88****	0.05	16.59		
FP2			0.91****	0.03	24.15		
FP3			0.88****	0.05	15.60		
FP4			0.13	0.35	0.36		
FP5			0.27	0.17	1.56		
FP6			0.49***	0.15	3.27		
Size			1.00	0.00	0.00	1.00	1.00
Age			1.00	0.00	0.00	1.00	1.00
Uncertainty			1.00	0.00	0.00	1.00	1.00
FP-1			1.00	0.00	0.00	1.00	1.00

Notes: CR, composite reliability; SE, standard error; SL, standardized loading; VIF, variance inflation factor; n.a., not applicable; OI, organizational innovation; FP, firm performance; IC, innovation capabilities.
****$p<0.001$, ***$p<0.01$, **$p<0.05$, *$p<0.1$.
[a] See Appendix A for item descriptions.
[b] Absolute *t*-values greater than 1.645 are one-tailed significant at 5%.
[c] Percentage of variance of item explained by the latent variable.

43.1% of the variance of the construct, which is a very satisfactory level of predictability.

The PLS technique does not require the use of traditional goodness-of-fit (GoF) measures (Hulland, 1999). However, inevitable comparison between the PLS technique and other more traditional methods for modeling of systems of equations, such as EQS, LISREL, and AMOS, has promoted *a posteriori* development of such an adjustment criterion. The GoF index (Tenenhaus, Esposito Vinzi, Chatelin & Lauro, 2005) is calculated by taking the square root of the mean product of the AVE for the latent variables, and the reflective indexes and the mean R^2 for the endogenous variables. This index varies between the values of 0 and 1. Although a minimum threshold does not exist, a value > 0.31 is recommended. The GoF index reaches a value of 0.519, which is above the minimum recommended to ensure the quality of the adjustment of the model being studied.

4.2.2. Hypotheses testing

To determine the significance level of the path coefficients using the PLS technique, a resampling bootstrap procedure with 500 subsamples (Chin, 1998a,b). As can be observed in Table 5, which summarizes the results, OI has a significant effect on process IC ($\beta = 0.702^{****}$, $t = 22.632$), supporting H1a. Also, process IC has a significant effect on product IC ($\beta = 0.736^{****}$, $t = 6.487$). However, the direct effect of OI on product IC is not significant ($\beta = -0.005^{n.s}$, $t = 0.686$). These results confirm H1b, which posits an indirect effect of OI on product IC through process IC.

Table 4
Comparison of the AVE square root and correlation between reflective constructs.

	Product IC	Process IC
Product IC	(0.76)	
Process IC	0.66	(0.73)
FP	0.50	0.41

Note: IC, innovation capabilities; FP, firm performance; EU, environment uncertainty; FP-1, firm performance in 2004. Diagonal elements (values in parentheses) are the AVE square root. Off-diagonal elements are the correlations between constructs.

With regard to innovation–FP relationships, OI has a significant effect on FP ($\beta = 0.230^{**}$, $t = 1.795$), supporting H2. Product IC ($\beta = 0.448^{***}$, $t = 5.054$) also has a significant effect on FP, giving support to H3a. However, process IC does not have a significant direct effect on FP ($\beta = 0.101^{n.s}$, $t = 0.738$). Therefore, as stated in H3b, the effect of process IC on FP is indirect through product IC. With regard to the control variables, size, environmental uncertainty, and age are not significant either when affecting IC or FP. However, FP in year 2004 significantly affects the FP construct ($\beta = 0.365$, $t = 3.422$, $p < .001$).

4.3. Additional analysis

The model presented is a partially mediated model. To shed more light on the mediated relationships proposed in H1b and H3b, and based on recommendations for the evaluation of causal models in management research, we compared our hypothesized model with other rival models (Piccolo & Colquitt, 2006; Rindova, Williamson, Petkova & Sever, 2005). The rival model strategy consists of comparing the best fit for a set of restricted models with the ideal fit for a saturated model (Hair, Anderson, Tatham & Black, 1999). Previous studies on strategic management have

Table 5
Structural equation model results.

Structural path	Standardized coefficient	*t*-value	Conclusion
Direct effects			
OI → Process IC	0.79****	22.63	H1a supported
OI → Product IC	-0.08 n.s.	0.68	
Process IC → Product IC	0.73****	6.48	
OI → FP	0.23**	1.79	H2 supported
Product IC → FP	0.44***	5.05	H3a supported
Process IC → FP	0.10 n.s.	0.73	
Indirect effects			
IO → Process IC → Product IC	0.51		H1b supported
Process IC → Product IC → FP	0.32		H3b supported
Non-hypothesized (control variables)			
Size → Product IC	−0.03 n.s.	0.73	
Age → Product IC	−0.04 n.s.	1.27	
Uncertainty → Product IC	0.00 n.s.	0.00	
Size → Process IC	0.02 n.s.	0.73	
Age → Process IC	0.06 n.s.	1.15	
Uncertainty → Process IC	−0.07 n.s.	1.33	
Size → FP	0.05 n.s.	0.92	
Age → FP	−0.07n.s.	0.63	
Uncertainty → FP	−0.05 n.s.	0.76	
FP-1 → FP	0.36****	3.42	
Goodness-of-fit statistic			
R^2	0.43		
GoF	0.52		

Notes: OI, organizational innovation; IC, innovation capabilities; FP, firm performance.
****$p<0.001$, ***$p<0.01$, **$p<0.05$, *$p<0.1$, n.s. non-significant.

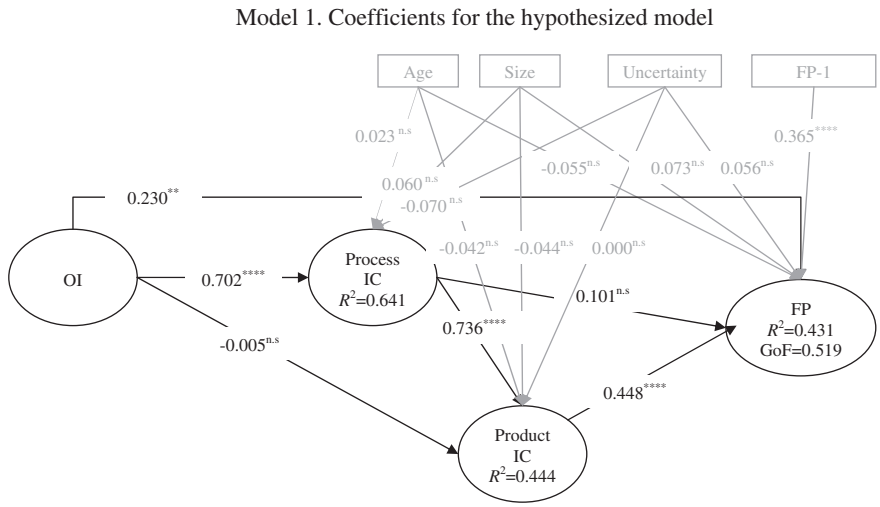


Fig. 1. Model 1. Coefficients for the hypothesized model. Note: OI, organizational innovation; IC, innovation capabilities; FP, firm performance; FP-1, firm performance in 2004. ****$p<0.001$, ***$p<0.01$, **$p<0.05$, *$p<0.1$, n.s. non-significant.

used this technique to analyze the strength of proposed structural models (Walker et al., 2011). The results of this analysis appear in Fig. 2.

Model 2 is the hypothesized model without the direct relationship between OI and FP. Model 3 is a fully-mediated model. The fit of the hypothesized model (Model 1) and the alternative models (Models 2 and 3) use the R^2 and GoF indexes. Comparing Figs. 1 and 2, one can see Models 2 and 3 present lower fit indexes, indicating that they do not represent any improvement in explaining FP. Therefore, these results suggest that the hypothesized model in this paper (Model 1) is better than the other models included in the comparison.

5. Conclusions

5.1. Theoretical implications

The two main objectives of the present study are: (1) to study the relationship between OI and technological IC; and (2) to analyze the effect of OI and technological IC on FP. Given the relatively new significance of OI in academic studies and the recent interest in the interrelationships among innovation types and FP, existing studies do not provide conclusive results on these questions. This is mainly because of inconsistencies in the perception and use of the OI concept (Damanpour & Aravind, 2011) and to the tendency to study the joint effect of different types of IC on FP (Calantone et al., 2002; Ortega, 2009) without paying attention to the fact that different types of IC can have different effects on FP.

The results presented here show that OI favors the development of product and process IC. This effect is achieved differently depending on the specific type of IC. While OI directly positively affects the development of process IC, the relationship between OI and product IC is mediated by process IC. This result highlights the fact that simply implementing new advanced management practices (OI) is not sufficient to favor product IC. Otherwise, would be necessary to put them through process IC to be developed. Furthermore, empirical evidence from the present study also demonstrates that OI and technological IC both positively affect FP, emphasizing the importance of distinguishing between IC types because behavior affecting FP is different in each case. While product IC, as OI, has a direct effect on FP, the procedure to achieve an improvement in FP through the development of process IC is mediated by product IC. These results are in accordance with RBV as the complex interrelationships among innovations types and capabilities that generate the most valuable, distinctive, and difficult to imitate strategic assets that allow the firm to achieve superior performance.

Some important contributions can be derived from these results. First, the results obtained enhance the understanding of the effect of OI on the generation of technological IC. Although a causal relationship between OI and IC cannot be established owing to the cross-sectional nature of the data, the present study expands on the original research supporting a correlation between OI and technological IC (Damanpour et al., 1989) and more recent studies revealing complementarity between these different types of innovation (Battisti & Stoneman, 2010; Damanpour et al., 2009). Second, the empirical evidence this paper offers on the effect of OI on FP sheds light on an area that is still limited in scope and unclear (Armbruster et al., 2008; Damanpour & Aravind, 2011; Mol & Birkinshaw, 2009).

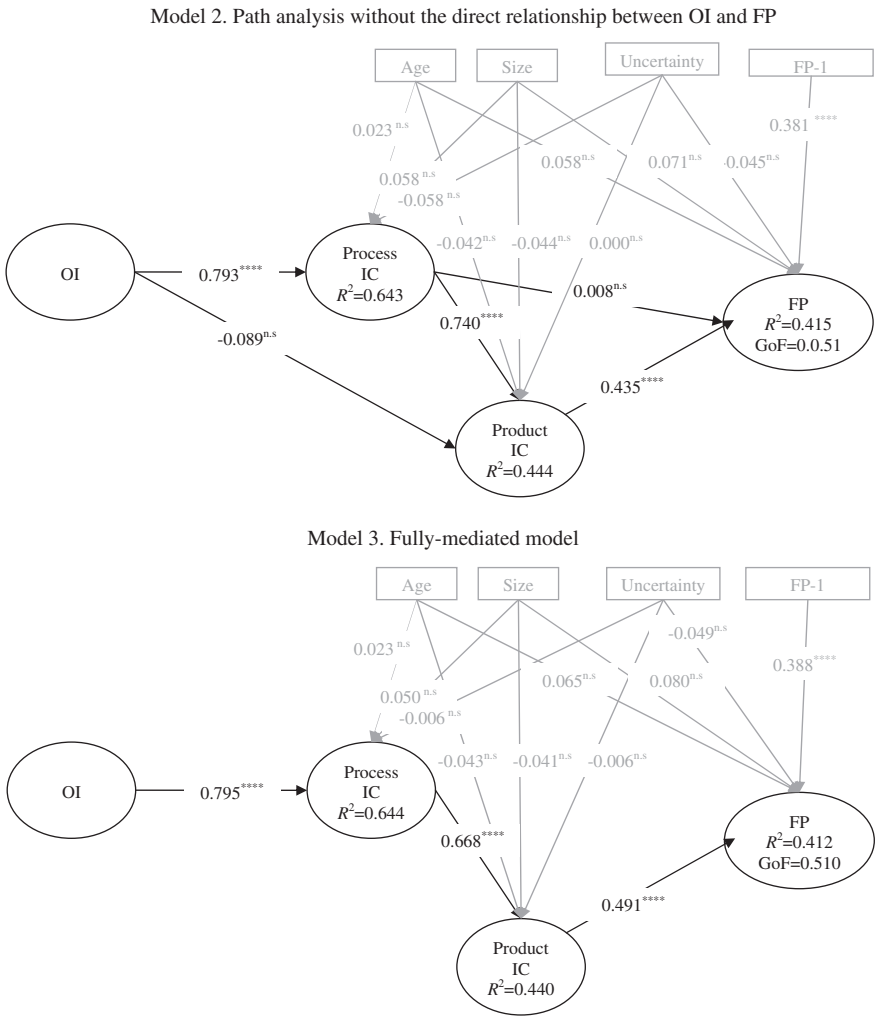
This result reinforces the line of research that argues that OI is positively associated with FP (Mazzanti et al., 2006; Mol & Birkinshaw, 2009). Finally, the interrelationship found among OI, product and process IC affecting FP also helps better understanding of the complex process through which different types of IC affect performance. All these results support the idea offered by the RBV that OI and IC can be seen as rare, valuable, durable, non-substitutable, inimitable and appropriable of sources of competitive advantage that can generate economic rents.

5.2. Managerial implications

Mol and Birkinshaw (2009: 1278) state that "firms stand to benefit from investing in their capacity for management innovation alongside their capacity for product and process innovation". The results of this paper seem to support this idea. Therefore, the most important practical implication of this paper is that managers should be aware of the joint strategic potential of OI and product and process IC for reinforcing the development of each to improve FP. Managers should concentrate solely neither on the technological nor non-technological side of innovation. The introduction of new management practices (OI) is important for the positive effect FP and facilitates the development of process IC as well as product IC, although in this latter case the effect is indirect through process IC. Also, technological product and process IC have a strategic character because they both positively affect FP, although the first does so directly and the latter indirectly through product IC.

5.3. Limitations and future lines of research

The limitations of this study will become the focus of future studies. First, the cross-sectional nature of the study prevents consideration of the dynamic character of innovation and causality among constructs. Although included a 1-year lag in the model (through a control



Note: OI, organizational innovation; IC, innovation capabilities; FP, firm performance; FP-1, firm performance in 2004. **** $p<0.001$, *** $p<0.01$, ** $p<0.05$, * $p<0.1$, n.s. non significant.

Fig. 2. Alternative SEM models for the rival models strategy. Model 2. Path analysis without the direct relationship between OI and FP. Model 3. Fully-mediated model. Note: OI, organizational innovation; IC, innovation capabilities; FP, firm performance; FP-1, firm performance in 2004. ****$p<0.001$, ***$p<0.01$, **$p<0.05$, *$p<0.1$, n.s. non-significant.

variable) and the FP measure contains objective indicators referring to one year after the fieldwork was carried out, the results of this paper should be interpreted with caution.

Future studies should address the relationships proposed in the hypothesized model using longitudinal data to overcome such limitations and to allow for more accurate evaluation of the causality in the relationship among OI, technological IC, and FP. An especially important consideration is the empirical possibility that FP causes OI and technological IC. In principle, RBV states that superior endowment with strategic assets is necessary to achieve innovative capabilities that favor achievement of superior performance, but longitudinal research on this issue is still necessary.

Second, measuring FP is a complex task. In this paper, was measured using a combination of objective and subjective items. However, the ideal would have been only used objective items. Furthermore, as we showed a weak convergent validity between the subjective and objective indicators, this limitation has to be accounted for when interpreting the results of the paper. More complex relationships may emerge among the constructs studied when only considering objective data.

Third, other recent studies specifically emphasize the relationship of complementarity (or synergism) between the different types of innovation (Battisti & Stoneman, 2010; Damanpour et al., 2009; Martínez-Ros & Labeaga, 2009). Although this paper moves incrementally towards this question when studying the interrelationship among OI, product IC, and process IC, future analyses should advance this question by introducing an interaction effect between OI and product and process IC to test whether this complementarity also exists in the context of the theoretical model proposed here.

Fourth, this paper has only focused on OI and technological IC and its effect on FP. The complexity of the hypothesized model has prevented us from introducing the depth of practices and capabilities in the model. Future research should analyze how the incremental/radical character of OI and IC influences their interrelationship and FP. Similarly, to study the effects of OI and technological IC on innovation performance would be interesting.

Fifth, the questionnaires have no qualitative data. To carry out interviews with members of the firms included in the sample would have enriched the paper by favoring a better understanding of the causal mechanisms for the proposed sequential effect among OI, technological IC and FP. Therefore, future research should complement the quantitative data with qualitative data to obtain a more complete view of the relationships studied in this paper.

Finally, the theoretical model presented here provides a partial analysis of the effects of OI and organizational capabilities. OI can be a

determining factor in the generation of other organizational capabilities, such as the capability to generate and absorb knowledge, which could have a significant effect on FP. This suggestion is particularly relevant in light of the question raised by Wu (2010) in his essay on management innovation: Which companies should implement management innovation?

Appendix A. Scales and items

A.1. Organizational innovation

Indicate the extent to which your company has recently used for the first time the following organizational instruments on a scale from 1 to 7, where 1 equals *Never* and 7 *Very often*

Dimension 1: organizational innovations in business practices	
OI1	Use of databases of best practices, lessons and other knowledge
OI2	Implementation of practices for employee development and better worker retention
OI3	Use of quality management systems
Dimension 2: innovations in workplace organization	
OI4	Decentralization in decision-making
O15	Use of inter-functional working groups
OI6	Flexible job responsibilities
Dimension 3: new organizational methods in external relations	
OI7	Collaboration with customers
OI8	Use of methods for integration with suppliers
OI9	Outsourcing of business activities

A.2. Product innovation capabilities

Evaluate the product innovation capabilities in your firm compared to the average for your competitors on a scale from 1 to 7, where 1 equals *Much worse* and 7 *Much better*

Items	Description
PDI1	My firm is able to replace obsolete products
PDI2	My firm is able to extend the range of products
PDI3	My firm is able to develop environmentally friendly products
PDI4	My firm is able to improve product design
PDI5	My firm is able to reduce the time to develop a new product until its launch in the market

A.3. Process innovation capabilities

Evaluate the process innovation capabilities in your firm compared to the average for your competitors on a scale from 1 to 7, where 1 equals *Much worse* and 7 *Much better*

Items	Description
PCI1	My firm is able to create and manage a portfolio of interrelated technologies
PCI2	My firm is able to master and absorb the basic and key technologies of business
PCI3	My firm continually develops programs to reduce production costs
PCI4	My firm has valuable knowledge for innovating manufacturing and technological processes
PCI5	My firm has valuable knowledge on the best processes and systems for work organization
PCI6	My firm organizes its production efficiently
PCI7	My firm assigns resources to the production department efficiently
PCI8	My firm is able to maintain a low level of stock without impairing service
PCI9	My firm is able to offer environmentally friendly processes
PCI10	My firm manages production organization efficiently
PCI11	My firm is able to integrate production management activities

A.4. Firm performance

Evaluate your firm's performance compared to the average for your competitors on a scale from 1 to 7, where 1 equals *Much worse* and 7 *Much better*.

Items	Description
FP1	Mean economic profitability 2005 (pre-interest and pre-tax profits/total net assets)
FP2	Mean financial profitability 2005 (after-tax profits/own funds)
FP3	Mean sales profitability 2005 (pre-interest and pre-tax profits/sales)
FP4	Return on total assets 2007
FP5	Return on capital employed 2007
FP6	Return on shareholders funds 2007

Note: Items FP4, FP5 and FP6 are objective indicators that where obtained from SABI database.

A.5. Environmental uncertainty

When responding to the following items, consider the uncertainty present in the firm's national environment. Evaluate each item on a scale from 1 to 7, where 1 equals *very low*, and **7** *very high*

Items	Description
Dynamism	
E1	Frequency of change in the most relevant areas of the environment
E2	Instability of demand
E3	The degree of radical change in market structure
E4	Frequency of product innovation
E5	Customer pressure shown through radical changes in attitude
E6	Unpredictability of challenges presented by changes in the environment
E7	The degree of radical change in technology
E8	The degrees of social, political, and cultural change that influence environment turbulence
Munificence	
E9	Abundance of resources
E10	Growth of sales in the industry
E11	Implicit risk in the activity
E12	Degree of environmental hostility
Complexity	
E14	Number of competitors in the industry
E15	Diversity of consumers in terms of their purchasing habits
E16	Diversity of suppliers
E17	Extent of the presence of differentiated products within the industry
E18	Technological diversity

References

Amit, R., & Schoemaker, P. J. H. (1993). Strategic assets and organizational rent. *Strategic Management Journal*, *14*, 33–46.

Armbruster, H., Bikfalvi, A., Kinkel, S., & Lay, G. (2008). Organizational innovation: The challenge of measuring non-technical innovation in large-scale surveys. *Technovation*, *28*, 644–657.

Armbruster, H., Kirner, E., Lay, G., Szwejczewski, M., Corita, B., Leguehennec, C., et al. (August). Patterns of organisational change in European industry (PORCH). Ways to strengthen the empirical basis of Research and Policy. *DG Enterprise and Industry: Innovation policy unit. Final Report*. Karlsruhe: Institute Systems and Innovation Research.

Barney, J. (1986). Strategic factor markets: Expectations, luck and business strategy. *Management Science*, *32*(10), 1231–1241.

Barney, J. (1991). Firm resources and sustained competitive advantage. *Journal of Management*, *17*(1), 99–120.

Barney, J., Wright, M., & Ketchen, J., Jr. (2001). The resource-based view of the firm: Ten years after 1991. *Journal of Management*, *27*, 625–641.

Battisti, G., & Stoneman, P. (2010). How innovative are UK firms? Evidence from the fourth UK community innovation survey on synergies between technological and organizational innovations. *British Journal of Management*, *21*, 187–206.

Bessant, J., Lamming, R., Noke, H., & Philips, W. (2005). Managing innovation beyond the steady state. *Technovation*, *25*(12), 1366–1376.

Birkinshaw, J., Hamel, G., & Mol, M. J. (2008). Management innovation. *Academy of Management Review*, *33*(4), 825.

Birkinshaw, J., & Mol, M. (2006). How management innovation happens. *MIT Sloan Review*, *47*(4), 81–88.

Blau, M., & Schoenherr, R. A. (1971). *The structure of organizations.* New York: Basic Books.

Burns, T., & Stalker, G. M. (1961). *The management innovation.* London: Tavistock.

Calantone, R. J., Cavusgil, S. T., & Zhao, Y. (2002). Learning orientation, firm innovation capability, and firm performance. *Industrial Marketing Management*, *31*, 515–524.

Camisón, C. (2004). On how to measure managerial and organizational capabilities. *Management Research*, *3*(1), 27–48.

Camisón, C., Boronat, M., & Villar, A. (2010). Technological strategic alliances and performance: The mediating effect of knowledge-based competencies. *Journal of Strategic Management Education*, *6*(1), 1–22.

Camisón, C., & Villar-López, A. (2010). An examination of the relationship between manufacturing flexibility and firm performance: The mediating role of innovation. *International Journal of Operations and Production Management*, *30*(8).

Camisón-Zornoza, C., Lapiedra-Alcamí, R., Segarra-Ciprés, M., & Boronat-Navarro, M. (2004). A meta-analysis of innovation and organizational size. *Organization Studies*, *25*(3), 331–361.

Cappelli, P., & Neumark, D. (2001). Do "high-performance" work practices improve establishment level outcomes? *Industrial and Labor Relations Review*, *54*(4), 737–776.

Carmines, E. G., & Zeller, R. A. (1979). *Reliability and validity assessment.* Newbury Park, CA: Sage Publications.

Caroli, E., & Van Reene, J. (2001). Skill biased organizational change? Evidence from a panel of British and French establishments. *Quarterly Journal of Economics*, *116*(4), 1149–1192.

Chin, W. W. (1998a). Issues and opinion on structural equation modelling. *MIS Quarterly*, *22*(1), xvii-xv.

Chin, W. W. (1998b). The Partial Least Squares approach to structural equation modelling. In G. A. Marcoulides (Ed.), *Modern methods for business research* (pp. 295–336). Mahwah NJ: Lawrence Erlbaum Associates Publisher.

Chin, W. W. (2001). *PLS-Graph User's Guide. Version 3.0.* Texas: University of Houston.

Chin, W. W. (2003). *PLS-Graph (Version 3.00, Build 1126) (Computer Software).* Texas: University of Houston.

Chin, W. W., & Ghopal, A. (1995). Adoption intention in GSS: relative importance of beliefs. *Database*, *26*, 42–64.

Chin, W. W., & Newsted, P. R. (1999). Structural equation modeling analysis with small samples using Partial Least Squares. In R. Hoyle (Ed.), *Statistical Strategies for Small Samples Research* (pp. 307–341). : Sage Publications.

Conant, J. S., Mokwa, M. P., & Varadarajan, P. R. (1990). Strategic types, distinctive marketing competencies and organizational performance: A multiple measures-based study. *Strategic Management Journal*, *11*(5), 365–383.

Coombs, J. E., & Bierly, P. E. (2001). Looking through the kaleidoscope: Measuring technological capability and performance. *Academy of Management Proceedings*, B1–B7.

Coombs, J. E., & Bierly, P. E. (2006). Measuring technological capability and performance. *R&D Management*, *36*(4), 421–438.

Daft, R. L. (1978). *Essentials of organizations theory and design.* Cincinnati, Ohio: South-Western College Publishing.

Damanpour, F. (1991). Organizational innovation: A meta-analysis of effects of determinants and moderators. *Academy of Management Journal*, *34*, 555–590.

Damanpour, F. (2010). An integration of research findings of effects of firm size and market competition on product and process innovations. *British Journal of Management*, *21*(4), 996–1010.

Damanpour, F., & Aravind, D. (2006). Product and process innovations: A review of organizational and environmental determinants. In J. Hage, & M. Meeus (Eds.), *Innovation, Science, and Industrial Change: A Research Handbook* (pp. 38–66). : Oxford University Press.

Damanpour, F., & Aravind, D. (2011). Managerial innovation: Conceptions, processes, and antecedents. *Management and Organization Review*. http://dx.doi.org/10.1111/j.1740-8784.2011.00233.x.

Damanpour, F., & Evan, W. M. (1984). Organizational innovation and performance: The problem of organizational lag. *Administrative Science Quarterly*, *29*, 392–409.

Damanpour, F., & Gopalakrishnan, S. (2001). The dynamics of the adoption of product and process innovations in organizations. *Journal of Management Studies*, *38*(1), 45–65.

Damanpour, F., & Schneider, M. (2006). Phases of the adoption of innovation in organizations: Effects of environment, organization, and top managers. *British Journal of Management*, *17*, 215–236.

Damanpour, F., Szabat, K. A., & Evan, W. M. (1989). The relationship between types of innovation and organizational performance. *Journal of Management Studies*, *26*(6), 587–601.

Damanpour, F., Walker, R. M., & Avellaneda, C. N. (2009). Combinative effects of innovation types and organizational performance: A longitudinal study of service organizations. *Journal of Management Studies*, *46*(4), 650–675.

Damanpour, F., & Wischnevsky, J. D. (2006). Research on organizational innovation: Distinguishing innovation-generating from innovation-adopting organizations. *Journal of Engineering and Technology Management*, *23*, 269–291.

Dess, G. G., & Beard, D. W. (1984). Dimensions of organizational task environments. *Administrative Science Quarterly*, *29*, 52–73.

Dess, G., Lumpkin, G., & Covin, J. (1997). Entrepreneurial strategy making and firm performance. Test of contingency and configurational models. *Strategic Management Journal*, *18*, 677–695.

Dess, G. G., & Robinson, R. (1984). Measuring organizational performance in the absence of objective measures: The case of the privately-held firm and conglomerate. *Business Unit*, *5*, 265–273.

Diamantopoulus, A., & Winklhofer, H. M. (2001). Index construction with formative indicators: An alternative to scale development. *Journal of Marketing Research*, *38*, 269–277.

Edquist, C., Hommen, C. L., & McKelvey, M. (2001). *Innovation and employment: Process versus product innovation.* Cheltenham, UK: Edward Elgar.

Eisenhardt, K. M., & Martin, J. A. (2000). Dynamic capabilities: What are they? *Strategic Management Journal*, *21*(10–11), 1105–1121.

Ettlie, J. E., & Reza, E. M. (1992). Organizational integration and process innovation. *Academy of Management Journal*, *35*, 795–827.

Falk, R. F., & Miller, N. B. (1992). *A primer for soft modelling.* Ohio: The University of Akron.

Fornell, C., & Larcker, D. (1981). Evaluating structural equation models with unobservable variables and measurement error. *Journal of Marketing Research*, *18*, 39–50.

Fritsch, M., & Meschede, M. (2001). Product innovation, process innovation and size. *Review of Industrial Organization*, *19*(3), 335–350.

Galende, J., & de la Fuente, J. M. (2003). Internal factors determining a firm's innovative behavior. *Research Policy*, *32*, 715–736.

García-Morales, V., Matías-Reche, F., & Hurtado-Torres, N. (2008). Influence of transformational leadership on organizational innovation and performance depending on the level of organizational learning in the pharmaceutical sector. *Journal of Organizational Change Management*, *21*(2), 188–212.

Goldman, S., Nagel, R., & Preiss, K. (1995). *Agile competitors and virtual organisations: Strategies for enriching the customer.* New York: Van Nostrand Reinhold.

González-Álvarez, N., & Nieto-Antolín, M. (2005). Protection and internal transfer of technological competencies: The role of causal ambiguity. *Industrial Management & Data Systems*, *105*(7), 841–856.

Grant, R. M. (1991). The resource-based theory of competitive advantage: Implications for strategy formulation. *California Management Review*, *33*(3), 114–135.

Grant, R. M. (1996). Prospering in dynamically-competitive environments: Organizational capability as knowledge integration. *Organization Science*, *7*(4), 375–387.

Greenan, N. (2003). Organisational change, technology, employment and skills: An empirical study of French manufacturing. *Cambridge Journal of Economics*, *27*, 287–316.

Hair, J. R., Anderson, R., Tatham, W., & Black, W. (1999). *Multivariate data analysis.* Madrid: Prentice-Hall Ibérica.

Hamel, G. (February). The why, what and how of management innovation. *Harvard Business Review*, 72–84.

Hamel, G. (2007). *The future of management.* Boston: Harvard Business School Press.

Hamel, G. (2009). Management innovation. *Leadership Excellence*, *26*(5), 5.

Homburg, C., Krohmer, H., & Workman, J. P. (1999). *Strategic consensus and performance: The role of strategy type and market-related dynamism*, *20*. (pp. 339–357).

Hulland, J. (1999). Use of partial least squares (PLS) in strategic management research: A review of four recent studies. *Strategic Management Journal*, *20*, 195–204.

Hwang, A. S. (July-August). Integration technology, marketing and management innovation. *Research Technology Management*, 27–31.

Jiménez Jiménez, D., & Sanz Valle, R. (2011). Innovation, organizational learning and performance. *Journal of Business Research*, *64*, 408–417.

Ketchen, D. J., Thomas, J. B., & Snow, C. C. (1993). Organizational configurations and performance: A comparison of the theoretical approaches. *Academy of Management Journal*, *36*(6), 1278–1314.

Kimberly, J. R., & Evanisko, M. J. (1981). Organizational innovation: The influence of individual, organizational, and contextual factors on hospital adoption of technological and administrative innovations. *Academy of Management Journal*, *24*(4), 689–713.

Kleinbaum, D. G., Kupper, L. L., & Muller, K. E. (1988). *Applied regression analysis and other multivariate analysis methods.* Boston: PWS-Kent Publishing Company.

Lawles, M. W., & Finch, L. K. (1989). Choice and determinism: A test of Hrebiniak and Joyce's framework on strategy-environment fit. *Strategic Management Journal*, *10*, 351–365.

Lawrence, P. (1954). How to deal with resistance to change. *Harvard Business Review*, *32*(3), 49–57.

Lewin, K. (1958). Group decisions and social change. In E. Maccoby, T. Newcomb, & E. Hartley (Eds.), *Readings in social psychology*. New York: Rhinehart & Winston.

Makadok, R. (2001). Toward a synthesis of the resource-based and dynamic-capability views of rent creation. *Strategic Management Journal*, *23*(5), 387–401.

Martínez-Ros, E. (2000). Explaining the decisions to carry out product and process innovations: The Spanish case. *Journal of High Technology Management Research*, *10*(2), 223–242.

Martínez-Ros, E., & Labeaga, J. M. (2009). Product and process innovation: Persistence and complementarities. *European Management Review*, *6*(1), 64–75.

Martínez-Sánchez, A., Vela-Jiménez, M. J., Pérez-Pérez, M., & de-Luis-Carnicer, P. (2009). Inter-organizational cooperation and environmental change: Moderating effects between flexibility and innovation performance. *British Journal of Management*, *20*, 537–561.

Mazzanti, M., Pini, P., & Tortia, E. (2006). Organizational innovations, human resources and firm performance. The Emilia–Romagna food sector. *The Journal of Socio-Economics*, *35*, 123–141.

Menguc, B., & Auh, S. (2010). Development and return on execution of product innovation capabilities: The role of organizational structure. *Industrial Marketing Management*, *39*, 820–831.

Miller, D., & Friesen, P. H. (1983). Archetypes of strategy formulation. *Management Science*, *24*, 921–933.

Mintzberg, H. (1979). *The structuring of organizations.* Englewood Cliffs, NJ: Prentice-Hall.

Mol, M. J., & Birkinshaw, J. (2009). The sources of management innovation: When firms introduce new management practices. *Journal of Business Research*, *62*, 1269–1280.

Nelson, R. R. y, & Winter, S. G. (1982). *An evolutionary theory of economic change.* Boston: The Bleknap Press of Harvard University Press.

Nunnally, J. (1978). *Psychometric theory.* New York: McGraw-Hill.

O'Mahoney, J. (2007). The diffusion of management innovations: The possibilities and limitations of memetics. *Journal of Management Studies*, *44*(8), 1324–1348.

OECD (2005). *The measurement of scientific and technological activities* Oslo Manual. Guidelines for collecting and interpreting innovation data (3rd ed.). Paris: OECD EUROSTAT.

Ortega, M. J. (2009). Competitive strategies and firm performance: Technological capabilities' moderating role. *Journal of Business Research*. http://dx.doi.org/10.1016/j.jbusres.2009.007.

Osterman, P. (1994). Supervision, discretion, and work organization. *The American Economic Review*, *84*(2), 380–384.

Perdormo-Ortiz, J., González-Benito, J., & Galende, J. (2009). The intervening effect of business innovations capability on the relationship between Total Quality Management and technological innovation. *International Journal of Production Research*, *47*(18), 5087–5107.

Peteraf, M. A. (1993). The cornerstones of competitive advantage: A resource-based view. *Strategic Management Journal*, *14*, 179–191.

Piccolo, R. F., & Colquitt, J. A. (2006). Transformational leadership and job behaviors: The mediating role of core job characteristics. *Academy of Management Journal*, *49*, 327–340.

Piva, M., Santarelli, E., & Vivarelli, M. (2005). The skill bias effect of technological and organisational change: Evidence and policy implications. *Research Policy*, *34*, 141–157.

Porter, M. E. (1985). *Competitive advantage*. New York: Free Press.

Prahalad, C. K., & Hamel, G. (1990). The core competence of the corporation. *Harvard Business Review*, *68*(3), 79–91.

Prajogo, D. I., & Sohal, A. S. (2006). The integration of TQM and technology/R&D management in determining quality and innovation performance. *Omega*, *34*, 296–312.

Rindova, V. P., Williamson, I. O., Petkova, A. P., & Sever, J. M. (2005). Being good or being known: An empirical examination of the dimensions, antecedents, and consequences or organizational reputation. *Academy of Management Journal*, *48*(6), 1033–1049.

Schumpeter, J. A. (1934). *The theory of economic development*. Cambridge, MA: Harvard Business Press.

Sanz-Valle, R., Jiménez-Jiménez, D., & Hernández-Espallardo, M. (September). Fostering organisational innovation: The role of organisational learning and market orientation. *Paper presented in XVII ACEDE National Conference, Seville, Spain*.

Shoenmakers, W., & Duysters, G. (2006). Learning in strategic technology alliances. *Technology Analysis and Strategic Management*, *18*(2), 245–264.

Spanos, Y. E., & Lioukas, S. (2001). An examination into the causal logia of rent generation: Contrasting Porter's competitive strategy framework and the resource based perspective. *Strategic Management Journal*, *22*, 907–934.

Teece, D. J., Pisano, G., & Shuen, A. (1997). Dynamic capabilities and strategic management. *Strategic Management Journal*, *18*(7), 509–533.

Tenenhaus, M., Esposito Vinzi, D., Chatelin, Y. M., & Lauro, C. (2005). PLS path modeling. *Computational Statistics and Data Analysis*, *48*(1), 159–205.

Tsai, K. H. (2004). The impact of technological capability on firm performance in Taiwan's electronics industry. *Journal of High Technology Management Research*, *15*, 183–195.

Tuominen, M., & Hyvönen, S. (2004). Organizational innovation capability: A driver for competitive superiority in marketing channels. *International Review of Retail, Distribution and Consumer Research*, *14*(3), 277–293.

Ulusoy, G. (2003). An assessment of supply chain and innovation management practices in the manufacturing industries in Turkey. *International Journal of Production Economics*, *86*, 251–270.

Venkatraman, N., & Ramanujan, V. (1987). Planning system success: A conceptualization and an operational model. *Management Science*, *33*(6), 687–705.

Walker, R. M., Damanpour, F., & Devece, C. A. (2010). Management innovation and organizational performance: The mediating effect of performance management. *Journal of Public Administration Research and Theory*, *18*, 1–20.

Wall, T. B., Michie, J., Patterson, M., Wood, S. J., Sheenan, M., Clegg, C. W., et al. (2004). On the validity of subjective measures of company performance. *Personnel Psychology*, *57*, 95–118.

Wernerfelt, B. (1984). A resource-based view of the firm. *Strategic Management Journal*, *5*(2), 171–180.

Winter, S. G. (2000). The satisficing principle in capability learning. *Strategic Management Journal*, *21*(10–11), 147–178.

Wold, H. (1966). Nonlinear estimation by iterative least squares procedures. In F. N. David (Ed.), *Research Papers in Statistics: A Festschrift for J. Neyman* (pp. 411–444). New York: John Wiley and Sons.

Wu, L. Y. (2010). Which companies should implement management innovation? A commentary essay. *Journal of Business Research*, *63*, 321–323.

Yamin, S., Mavondo, F., Gunasekaran, A., & Sarros, J. C. (1997). A study of competitive strategy, organisational innovation and organisational performance among Australian manufacturing companies. *International Journal of Production Economics*, *52*, 161–172.

Yang, C. C., Marlow, P. B., & Lu, C. S. (2009). Assessing resources, logistics service capabilities, innovation capabilities and the performance of container shipping. *International Journal of Production Economics*, *122*, 4–20.