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Encouraging organizational performance through the influence of technological distinctive competencies on components of corporate entrepreneurship

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Abstract Firms' technological distinctive competencies (TDCs) help CEOs to confront their reality based on technological knowledge to achieve and exploit competitive advantage by encouraging the different dimensions of corporate entrepreneurship (innovation, new business venturing, proactiveness and self-renewal). The main purpose of this paper is thus to highlight how companies that strive to improve technological competencies within the firm achieve higher organizational performance through different components of corporate entrepreneurship and their interrelationships. This study seeks to fill this research gap by analyzing theoretically and empirically how TDCs enhance innovation, new business venturing and proactiveness and their interrelationships to achieve self-renewal and thus improve firms' organizational performance. The methodology used is LISREL analysis. We test the model with data from 201 Spanish organizations. Our research contributes theoretical and empirical arguments on the value of TDCs to the organization, arguments that are especially important because organizations sometimes fail to achieve sustainable competitive advantage due to their limited understanding of the relationships between these strategic variables.

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Introduction

Organizations are aware that they are surrounded by conditions inherent in changing, turbulent environments with very intense competition. Factors change with increasing speed, technological advances cause more rapid innovation, etc. When organizations face such circumstances, it is quite difficult for them to maintain a competitive advantage achieved some time ago unless they adapt to the changes. Developed from the Resource-Based View (RBV) (Barney 1991), the theory of capabilities complements the RBV by arguing that only firms capable of developing dynamic capabilities will be able to generate sustainable competitive advantage (Teece et al. 1997). This study thus focuses on innovation capability as one of the most dynamic capabilities and as one capable of strengthening the entrepreneurial organization (Antoncic and Hisrich 2001; Kuratko and Audretsch 2013; Nonaka and Takeuchi 1995; Zaltman et al. 1973).

Over the past 20 years, the business environment has become more competitive due to a move toward globalization, rapid technological changes and increased sophistication in customer and employee behaviour (Jones et al. 2000). To face these technological changes, companies innovate using a process of continuous learning through which they generate new technological knowledge and competencies (Nonaka and Takeuchi 1995).

These current and changing conditions are especially well exploited by entrepreneurial organizations, which shift their strategic, structural and process contexts——sometimes quite frequently——to reflect current and changing conditions within and outside their organizations. Such organizations have developed this ability because they have had a clear needto connect these contexts to their broader environment, despite the form these contexts assumed at any one point (Kelley 2011).

Entrepreneurship also opens new opportunities for businesses (Woolley 2010). Among the constructs linked to the phenomenon of entrepreneurship, the study of competencies has recently received special theoretical attention (Danneels 2007; Martín-Rojas et al. 2011, Martín-Rojas et al. 2013; Real et al. 2006), where competency is understood as the ability to make functional use of knowledge and skills in different contexts. Competency involves understanding, reflection and discernment, simultaneously and interactively taking into account the social dimension of the actions to be performed (De los Ríos-Carmenado and Rodríguez 2015). It also assumes routinization of key abilities in which the firm is outstanding (Prahalad and Hamel 1990).

In technological sectors, technological competency refers to the ability to create and use a particular field of technology effectively. Such ability is gained through extensive experimentation and learning in the organization development and employment of the latter in production (Fai and Von Tunzelmann 2001, p. 1); it is collective learning in the organization, particularly the ability to coordinate diverse production skills and integrate multiple streams of technology (Patel and Pavitt 1997; Prahalad and Hamel 1990). Technological competencies have thus been accepted as extremely important

for achieving competitive advantage in the industry (Banerjee 2003) by adapting quickly to changing opportunities (Martín-Rojas et al. 2013; Prahalad and Hamel 1990; Walsh and Linton 2001). In this study, Technological Distinctive Competencies (TDCs)[1] represent the organization's expertise in mobilizing various scientific and technical resources through a series of routines and procedures that permit development and design of new products and/or production processes (Teece et al. 1994). TDCs indicate a company's ability to understand, use and exploit relevant state-of-the art technology internally. Consistent with dynamic capabilities theory, TDCs may be viewed as a bundle of intangible and valuable resources that accumulate over time (Drejer 2001).

Technological companies that develop and use TDCs could encourage corporate entrepreneurship and thus indirectly increase their organizational performance. Corporate entrepreneurship is a key element in organizational and economic development, due to its beneficial effect on firm revitalization and performance (Antoncic and Hisrich 2000; Clausen and Korneliussen 2012; Simsek and Heavey 2011; Zahra 1991, 1993; Zahra and Covin 1995). Corporate entrepreneurship is a behaviour or attitude that occurs in an organization, independently of its size. "The major impetus underlying corporate entrepreneurship is to revitalize innovation, creativity, and leadership in corporations" (Kuratko and Audretsch 2013, p. 332). It includes not only new business creation but other innovation-related activities, such as development of new products, services, technologies, administrative techniques, competitive strategies or positions (Archibugi and Iammarino 2002; Chen et al. 2013). To synthesize, the activities of an organization with corporate entrepreneurship are related to the following four dimensions: innovation, new business creation, proactiveness and self-renewal (Kazanjian et al. 2000; Rauch et al. 2009). We analyze TDCs' role in encouraging all dimensions of corporate entrepreneurship, directly or indirectly, and seek to determine how this effect spreads through interrelations between the entrepreneurial dimensions to cause improvements in organizational performance. If exploited properly, technological competitive advantages can be consolidated and extended across all dimensions of corporate entrepreneurship. We also seek to deepen understanding of how companies with higher levels of propensity to technological achievement effort come to demonstrate greater innovation, new business venturing and success in proactiveness than companies with lower levels.

Drawing on the entrepreneurship and strategy literature, this study's contribution is to analyze the direct relationship between TDCs and three dimensions of corporate entrepreneurship—innovation, new business venturing and proactiveness. Innovation is defined as a company's ability to create new products or modify existing ones to meet demands for current and future markets (Miller 1983). It is one of the essential traits of firms that overcome uncertainty in their competitive environment and manage to adapt (Dougherty and Hardy 1996; Melander and Tell 2014; Utterback 1994). Innovation depends clearly on the type of technological competencies the firm possesses. With respect to new business venturing—that is, to new business creation within the organization by redefining the company's products (or services) and/or developing new markets (Zahra 1991) without taking level of autonomy into account (Antoncic and Hisrich 2001)—TDCs can also help managers to exploit and extend their firm's

[1] Technological Distinctive Competencies will be noted as TDCs hereinafter.

activities. Firms can extend their portfolio of operations to respond to changing environments and take advantage of new technologies developed by creating new businesses. Finally, proactiveness—a stance that anticipates acting on future market lacks and needs, thereby creating advantage over competitors by being the first to act (Lumpkin and Dess 1996)—may be encouraged by TDCs, since TDCs enhance access to more and better opportunities and to resources that could be exploited for great future value. Companies with a high level of technological competencies will have greater innovation, new business venturing and success in proactiveness than those with a low level.

In the present study, we examine how innovation, new business venturing and proactiveness, and their interrelations, indirectly impact on self-renewal and performance. Innovation and proactiveness are of vital importance in the creation, exploitation, renewal and application of knowledge in new ways, thus creating the competencies essential for self-renewal. These dimensions arise from the synergies and opportunities presented in the marketplace and are promoted by new business venturing. All organizations must continually review their assumptions, structures, strategies and policies. Such flexibility is vital to long-term survival (Fernández-Pérez et al. 2013) and to improve corporate performance (Barrett and Sexton 2006; Grant 1995; Nonaka and Takeuchi 1995).

In sum, this research seeks to analyze consequences from TDCs across all corporate entrepreneurial dimensions, advancing knowledge of their direct and indirect effects through the interrelationships of the entrepreneurial variables to achieve improved performance. We fill part of the literature gap on technological management in corporate entrepreneurship by providing understanding of the path firms take to bid for technological entrepreneurship. We also attempt to show how firms that strive to improve their technological competencies achieve higher organizational performance through the different components of corporate entrepreneurship and their interrelationships.

To achieve our objectives, the article is structured as follows. Section 2 reviews prior research as the basis for proposing a series of hypotheses on TDCs' influence on organizational innovation, new business venturing and proactiveness, as well as their interrelations for achieving self-renewal and better organizational performance. Section 3 presents the data and method used to analyze empirically the hypotheses developed in Section 2 in Spanish technology firms. Section 4 presents the results obtained. Finally, Section 5 discusses the results and presents some limitations of this study.

Conceptual framework and hypotheses

The influence of TDCs on innovation

The application of TDCs is positively associated with organizational innovation (Bolívar Ramos et al. 2012). According to Cantwell and Fai (1999), innovation is manifested as the emergence of new products, the diversification of existing ones and the ability to adapt to changing market conditions. A major factor underlying innovation is whether the organization is able to create and perfect new products and

processes, on the basis of its accumulated TDCs (Bolívar Ramos et al. 2012; Cantwell and Fai 1999).

Through the application of TDCs, the process of organizational innovation is maintained and extended, through a flow magnitude that describes the generation of technological knowledge (Nieto 2004). TDCs embody the company's ability to generate, assimilate, transform and exploit knowledge (Zahra and George 2002). These processes must all be performed in order to successfully develop technological innovations (DeCarolis 2003), and in this process, the more creative and innovative the knowledge, the more dynamic and innovative can be the firm that makes use of it (Kazanjian et al. 2000). Firms with highly developed TDCs will be able to anticipate and respond to changing circumstances, and on many occasions thus obtain a competitive advantage (Larsen et al. 1991).

Researchers have taken diverse approaches to this question. Some studies have focused on a particular function of TDCs, such as the exploitation of technological knowledge (Bolívar Ramos et al. 2012; DeCarolis 2003), while others have examined the association between the long-term implementation of TDCs and the degree of organizational innovation achieved (Huang 2011). In any case, successful organizations must possess, and have previously developed, technological competencies in order to obtain effective internal practices (Lokshin et al. 2009).

It has been suggested that if companies are to innovate successfully, they must possess certain key competencies related both to technological aspects and to their customers (Danneels 2002, 2007, 2008; Lokshin et al. 2009). TDCs are vital to the development of innovations, and thus to the improvement of company performance, often but not always in high-tech industries (Lokshin et al. 2009). On the basis of the above considerations, we formulate the following hypothesis:

H1: Technological Distinctive Competencies (TDCs) are positively and significantly related to organizational innovation.

Influence of TDCs on new business venturing

An essential element in entrepreneurial activity is the creation of new businesses, which may or may not be related to existing ones (Antoncic and Hisrich 2000). Such new activities, from an intrapreneurship view point, may take place within a redefinition of the organization's established markets, by the creation of new units within the company, or be implemented by means of partially or completely autonomous firms; and a development of new markets. Large corporations (the focus of our analysis) include formation of incubative entrepreneurship with more formally autonomous or semi-autonomous units or autonomous business units, corporate start-ups, creation internal venturing and newstreams (Antoncic and Hisrich 2000; Hisrich and Peters 1984; Kanter and Richardson 1991; MacMillan et al. 1984; Schollhammer 1982).

The process of new business venturing depends on the existence and awareness of new opportunities to be developed and exploited. The application of new competencies expands a firm's strategic options and enables it to enter new markets (Berends et al. 2014; Woolley 2010; Zahra et al. 1999). With respect to technological markets, successful innovation depends on the firm possessing and being able to exploit its

technological competencies (Abetti 1997). And this is more likely to occur when significant demand for the goods or services thus obtained is perceived (Choi and Shepherd 2004).

The possession of appropriate TDCs enhances a firm's ability to enter a new business environment and to prosper within it (Buckley and Casson 1998; Girratana and Torrisi 2010). The implementation of TDCs, via appropriate strategies and policies, facilitates the exploitation of new technological opportunities (Girratana and Torrisi 2010) and enables the firm to overcome barriers to entry, such as economies of scale (Yip 1982) or acquired competencies (Tushman and Anderson 1986). For example, in biopharmaceutical industries, technological competencies such as new product development can act as catalysts for asset accumulation and thus contribute to the firm's renewal in new markets (Wang and Lestari 2013). They can also promote convergence and the development of cooperative relationships based on a common strategic purpose, thus contributing to business success in a competitive environment (D'Cruz and Rugman 1994; Berends et al. 2014). On the basis of the above considerations, we formulate the following hypothesis:

H2: Technological Distinctive Competencies (TDCs) are positively and significantly related to new business venturing.

The influence of TDCs on proactiveness

Proactiveness on the organizational level indicates how organizations face market opportunities. It is the degree to which they try to survive as leaders by taking the initiative, introducing new products and services, and exploiting new technologies (Antoncic and Hisrich 2000; Lumpkin and Dess 1996).

In the current business context, characterized by rapid technological change, firms may use different technological competencies to understand emerging opportunities and capitalize on promising new trends, stimulating proactiveness (Hussinger 2010). TDCs attempt to anticipate customer needs, facilitating companies' development of proactive proposals that have not even occurred to competitors (Schönsleben 2000). The company can thus achieve challenging/demanding knowledge and competency that no one else has.

Proactive firms identify such opportunities through technology (Alvarez and Barney 2007), that is, through their TDCs. Strong emphasis on TDCs enables work in new fields and exploitation of new possibilities (Hult and Ketchen 2001)—ultimately, a new way to create differentiation and develop solutions that weaken competitors by anticipating them (Hughes and Mortgan 2007). Since the learning needed to obtain TDCs in the company is ongoing and more creative, it is highly likely that proactiveness will be easier to achieve. For example, in a sector like software, in which user-driven innovations are a major source of product creation, technological competencies can aid in interpretation or anticipation of customer needs and encourage exploitation of them (Torrisi 1998). TDCs can thus enable a company to become a market pioneer through new product development and new production processes. TDCs also promote pioneering from the human perspective by promoting identification of employees' proactive features, such as innovative thinking, flexibility, decision-making agility

and self-motivation (Singh 2008). Companies with high levels of technological competency will excel more in proactiveness than companies with low ones. Therefore:

H3: Technological Distinctive Competencies (TDCs) are positively and significantly related to proactiveness.

Influence of new business venturing on innovation

Given today's competitive environments, firms can rarely trust their current products and services to ensure future success (Zahra 1993; Lumpkin and Dess 1996). In fact, customers are increasingly involved as active participants in firms, as changing product creation processes enable new firms to innovate and give users the power to customize their products (Di Tollo et al. 2012), although we have to take into account the structure of the industry (Alba et al. 2013). Each new venture must have high organizational innovation and market orientation (Olavarrieta and Friedmann 2008), that is, must create new business to stimulate production of new technological knowledge, especially knowledge focused on features of innovation and competitiveness (Van Hemert and Nijkamp 2010).

Taking into account that entrepreneurial organizations usually undertake regenerative transformations involving changes in their strategy, structure, process and behaviour (Muzyka et al. 1995), we would highlight that new business venturing is expected to produce competitive advantage in all fields of business activity, including technology (Girratana and Torrisi 2010). Although not every company triumphs and exploits this competitive advantage successfully (Kanter and Richardson 1991; Lant and Montgomery 1987), this expectation often promotes innovation, leading a company to adapt to new fields or combine current and new activities (García-Morales et al. 2014). As a result of these advances, the firm may extend its reach to previously foreign areas of activity (Kanter 1989). In studying the success of start-up biopharmaceutical firms, Nosella et al. (2006) assert that the birth of these firms currently requires improving the employees' professional background, the strength and type of relationships established with external partners, the nature and quality of the knowledge developed, the scientific and technological level of the innovations produced and the patents obtained. In sum, new business venturing in biopharmaceutical firms enables organizational innovation as well as innovative features in the firm. Technological firm formation thus involves industrial developments, innovative processes to commercialize products, and innovative analysis and research to provide services beyond those of current companies (Nosella et al. 2006). Thus:

H4: New business venturing is positively and significantly related to organizational innovation.

The influence of new business venturing on proactiveness

Crises may be overcome through progress in new development projects that proactively exploit creative strategic ideas (Kazanjian et al. 2000) to achieve an initial competitive

advantage. New business creation usually generates new opportunities, translating key competencies to new businesses with greater growth opportunities (Donahoe et al. 2001). Nevertheless, it is difficult for a company to define the business concept with total accuracy from the start to adapt perfectly to the opportunity presented (Andries and Debackere 2007). For instance, outsourcing seems an easy, economical way to run a business, but inter-organizational management within outsourcing may not be as simple as it appears (Chen et al. 2013). Proactive firms are prepared to anticipate actively and change internally to find a better position for achieving market share and customers by acting quickly when changes occur and mobilizing resources in advance of their rivals (Hughes and Mortgan 2007), even when they seek complementary knowledge or coordinate inter-organizational processes (Chen et al. 2013; Melander and Tell 2014).

Further, new business often not only affects a specific industry but provides an advantage across multiple industries (Walsh and Linton 2002), highlighting the need to be proactive to face different competitive environments skilfully (Martín-Rojas et al. 2011, 2013). For technology—where environment, social context, and both economic and know-how resources must be taken into account—creating a new business will mean being proactive and willing to take risks (Ulhoi 1997). In technological firms, implementing new businesses requires successfully fostering a technologically proactive attitude and dynamic initiatives in the firm (Chen et al. 2013; Thong et al. 1996; Wan et al. 2015) to respond to rapid shifts from one strategy to another and anticipate environmental changes and attend customers better. Thus:

H5: New business venturing is positively related to proactiveness.

The influence of innovation on self-renewal

Strategic renewal or self-renewal consists of transforming organizations by modifying their foundational ideas (Guth and Ginsberg 1990; Sharma and Chrisman 1999; Zahra 1991). It includes reformulation of strategies, redefinition of business and reorganization, and it reflects organizational change. The organization's need to renew its business continually to achieve adaptability and flexibility is considered a crucial characteristic of any entrepreneurial corporation (Antoncic and Hisrich 2001; Fernández-Pérez et al. 2013). Studying the interaction between supplier and customers, Håkansson and Waluszewski (2013) find it to be a means of innovation in the company, as it increases the company's importance in a globally, technologically connected world. Moreover, they find that innovation leads to solving thousands of problems by enhancing the company's efficiency and renewal. Corporate innovation and learning capabilities also enable strategic processes, specialized technological knowledge, stabilized networks and patterns of cooperation that drive successful renewal and greater efficiency in company capabilities (Heidenreich 2005).

When new ideas enter the market, companies that add those new ideas and innovation can prosper (Schumpeter 1934). Some authors show that, by strengthening the innovation capability of existing business, facilitating start-up activities and attracting new firms through intensification of research facilities, academic institutions, company incubators and technology transfer institutions may foster successful renewal of the

company (Heidenreich 2005). That is, becoming a leader in innovation for survival, self-renewal and growth has been the main point for researchers for decades (e.g., Nonaka and Takeuchi 1995; Zaltman et al. 1973). Although the relationship between organizational innovation and performance has been widely studied, a positive relationship between innovation and self-renewal has not been broadly confirmed by empirical studies using a global sample of firms. This may be the case because innovation and technology activities should be part of the redefinition of strategy configuration in technological organizations (Lengnick-Hall 1992). Thus:

H6: Organizational innovation is positively and significantly related to self-renewal.

Influence of proactiveness on self-renewal

Proactive behaviour consists of taking the initiative to attempt to improve current circumstances or to create other, new circumstances and involves questioning the status quo more than adapting passively to current conditions (Crant 2000). Proactiveness is thus defined as "firms' propensity to or aggressiveness in leading key areas better than their competitors" (Covin et al. 1986, p. 631).

This is why organizations possess a high degree of technological proactiveness, have the flexibility needed to conceptualize and develop innovations in the organization, and are able to respond more rapidly to changes (McCann 1991), adapting and reinventing themselves quickly as the situation requires. To achieve this goal, companies must renew themselves, facilitating organizational ability to respond effectively to new technological opportunities (Huang 2011).

Stam and Elfring (2008) study proactiveness as a part of entrepreneurial intention and assert that entrepreneurial orientation and proactiveness, in turn, require strategic orientation and change to obtain advantages over competitors. Likewise, Antoncic and Hisrich (2001) and Dess and Lumpkin (2005) view proactiveness as an enabler/promotor of entrepreneurial behaviour, driving the firm to make ongoing changes. Proactiveness enables development of strategic social changes in the firm and thus self-renewal by encouraging new opportunities.

Entrepreneurial firms that correctly identify their positions in the industry's competitive network are able to strengthen and manage opportunities and neutralize negative implications of threats and weaknesses, obtaining greater flexibility and self-renewal than more conservative firms (Fernández-Pérez et al. 2013). Proactiveness may lead to discovery of greater entrepreneurial opportunities in the form of new sales and supplier contracts, access to advertising channels, financial capital and important decisions, and participation in alliances and joint projects (Batjargal 2007). Such discoveries make it necessary to redesign the firm's strategies to achieve joint optimization of new and old resources and capabilities. Dwyer and Mellor (1993) show that Australian firms that adopt offensive tactics achieve a higher success rate in new products and self-renewal, encouraging better performance. Thus:

H7: Proactiveness is positively and significantly related to self-renewal.

The influence of self-renewal on performance

Both established firms and new business units must adapt their initial business model often, due fundamentally to uncertainty and ambiguity in the environment. This occurs more frequently in companies for which social networks are crucial and those with a high technological base, as such companies are more likely to face uncertain, ambiguous environments. Such companies tend to generate their own changes internally by acting proactively and adapt to new business or exploit innovations (Nadkami and Narayanan 2007). Self-renewal includes reformulating strategies to redefine business and reorganize, reflecting organizational change.

Organizational change or renewal is beginning to enable development of internal social capital (intrapreneurial social network) that improves the business result (Stam and Elfring 2008) because it involves a strong support from the firm's personnel and considers some of the most enterprising business ideas from lower levels to achieve a better overall result (Dess and Lumpkin 2005). Constant self-renewal permits better firm performance through more efficient performance of tasks (Rauch et al. 2009; Smart and Conant 1994).

This situation occurs in all kinds of firms, and the literature shows signs of a positive relationship between self-renewal and entrepreneurial performance (e.g., Andries and Debackere 2007; Antoncic and Hisrich 2001; Stoica and Schindehutte 1999; Zahra et al. 2000). Companies that perform frequent strategic and organizational changes (Eisenhardt and Martin 2000; Smart and Conant 1994) introduce new products and process technologies faster and more efficiently (Cottrell and Nault 2004; Nerkar and Roberts 2004) and are better able to survive in uncertain situations and industries. Nerkar and Roberts (2004) find that firms in fast-changing industries regularly introduce new products and market actions in the effort to sustain superior firm performance. Strategic organizational renewal is very likely to improve performance in all firms, from family businesses (Naldi et al. 2007; Robinson et al. 1986) to universities (Nery and Ville 2008) and technological firms (Stam and Elfring 2008; Van de Ven et al. 1984). Self-renewal will thus yield high returns in technological industries, since it renews the company's capabilities and increases its capacity to acquire and use new competencies that improve performance (Covin and Miles 2008; Zahra et al. 2000). Thus:

H8: Self-renewal is positively and significantly related to corporate performance.

Methodology

This section presents this study's research methodology. We first describe the sample used and then discuss how each variable included in the study is operationalized. Finally, we present the statistical analysis.

Study sample and analysis

The hypotheses were tested on a sample of Spanish technology organizations. We chose companies located in Spain because they share a relatively homogeneous

geographical, cultural, legal and political space that minimizes the impact of variables that cannot be controlled in empirical research (Hofstede 1980).

Starting from the information available at Dun and Bradstreet España (2005), we conducted stratified sampling with proportional allocation relative to size and geographic location to select a total of 1000 companies in Spain's technology sector. These companies were sent the structured questionnaire, of which 226 valid questionnaires were returned, but because of missing values only 201 questionnaires were included in the research. The response rate was 20.1 % (Table 1). The results for return on assets, return on equity, return on sales and number of employees indicate no significant difference between respondents and non-respondents. The different tests, such as chi-square and t-tests, show neither significant differences between early and late respondents (Armstrong and Overton 1977) nor significant differences due to geographical location or size in the variables studied.

We tested for common method bias using Harman's one-factor test (see Konrad and Linnehan 1995). Eight factors with eigenvalues greater than 1.0, accounting for 69 % of the total variance, emerged from a principal components factor analysis of the questionnaire measurement items (Podsakoff et al. 2003; Podsakoff and Organ 1986).

Measures

We used pre-tested constructs, employing two or more measures from past empirical studies to ensure their validity and reliability (see Appendix for all questions).

*Technological Distinctive Competencies (***TDCs)** We validated our scale and then verified each scale's one-dimensionality and its high validity and reliability (α = .879). Using scale established by Real et al. (2006), we drew up a 4-item scale (Appendix) to reflect TDCs in the organization and performed a confirmatory factor

Table 1 Technical details of the research

Sectors	High-tech services (computer science activities, r esearch and development services, postal and telecommunications services), high-tech manufacturing (chemical industry; aerospace construction; radio, television and communication manufacture; office machinery and computer science equipment; medical instruments, precision optics and watches)
Geographical location	Spain
Methodology	Structured questionnaire
Procedure	Stratified sample with proportional allocation (size)
Universe of population	50,000 firms
Sample (response) size	1000 (201) firms
Sample error	6.9 %
Confidence level	95 %, p-q = 0.50; Z = 1.96
Period of data collection	From April 2010 to May 2010

analysis ($\chi^2_2 = 9.08$; Normed Fit Index, NFI = .99; Non-Normed Fit Index, NNFI = .99; Goodness of Fit Index, GFI = .98; Comparative Fit Index, CFI = .99).

Organizational innovation The scale was one-dimensional with high reliability ($\alpha = .922$). Using the scale established by Zahra (1993) (Corporate Entrepreneurship Scale), we drew up a 12-item scale (Appendix) to reflect organizational innovation. After an exploratory factor analysis, however, we took only 8 items from the original scale. We developed a confirmatory factor analysis to validate our scale ($\chi^2_{27} = 53.09$; NFI = .95; NNFI = .97; GFI = .98; CFI = .98).

New business venturing The scale was one-dimensional with high reliability ($\alpha = .850$). Using scales established by Zahra (1993) (The Corporate Entrepreneurship Scale), we drew up a 5-item scale (Appendix) to reflect New Business Venturing and developed a confirmatory factor analysis to validate our scales ($\chi^2_5 = 28.17$; NFI = .95; NNFI = .92; GFI = .98; CFI = .96).

Proactiveness We developed a confirmatory factor analysis to validate the scale ($\chi^2_5 = 34.35$, NFI = .95, NNFI = .91, GFI = .98, CFI = .95) and showed that each scale was one-dimensional and had adequate validity and reliability ($\alpha = .822$). We used the 5-item scale developed by Knight (1997), "The Entrescale", to measure *proactiveness* (Appendix). These items were duly adapted to the present study.

Self-renewal We performed a confirmatory factor analysis to validate the scale for Self-Renewal ($\chi^2_5 = 22.06$, NFI = .97, NNFI = .96, GFI = .99, CFI = .98) and showed that the scale was one-dimensional, with adequate validity and reliability ($\alpha = .897$). We began with 9 items developed by Zahra (1993) to measure self-renewal on the Corporate Entrepreneurship Scale. These items were duly adapted to the present study (Appendix). We developed an exploratory factor analysis and obtained a 7-item scale for Self-Renewal. A 7-point Likert scale (1 '*totally disagree*', 7 '*totally agree*') for this and all prior variables allowed managers to express agreement or disagreement.

Organizational performance After reviewing how performance is measured in different strategic research studies, we used the 6-item scale developed by Murray and Kotabe (1999). We performed a confirmatory factor analysis to validate the scale ($\chi^2_9 = 30.21$, NFI = .97, NNFI = .96, GFI=. 99, CFI = .98) and showed that the scale was one-dimensional with high reliability ($\alpha = .888$). We used a 7-point Likert scale (1 '*Much worse than my competitors'*, 7 *'Much better than my competitors'*) to ask about the organization's performance as compared to that of its most direct competitors. Using scales to evaluate performance relative to main competitors is one of the most widely-used practices in recent studies (Choi et al. 2008; Douglas and Judge 2001). Many researchers use managers' subjective perceptions; others prefer objective data. The literature widely established high correlation and concurrent validity between objective and subjective data on performance, implying that both are valid when calculating firm performance (Homburg et al. 1999; Venkatraman and Ramanujam 1986). We included questions involving both types of assessment in the interviews, but the CEOs were more open to offering general views than to offering

precise quantitative data. When possible, we calculated the correlation between objective and subjective data, and this was high and significant.

Model and analysis

For the structural equation model, LISREL 8.70 was used to analyze data for the existence of an exogenous latent variable (TDCs [ξ_1]), first-grade endogenous latent variables (Organizational Innovativeness [η_1], New Business Venturing [η_2] and Proactiveness [η_3]), and second-grade endogenous latent variables (Self-Renewal [η_4] and Organizational Performance [η_5]) and to establish causal relationships among these variables. Structural equation modelling includes errors in measurement, variables with multiple indicators and multiple-group comparisons (Koufteros et al. 2009). We used a recursive non-saturated model to plot the hypotheses (Fig. 1).

Results

Table 2 shows the means and standard deviations, as well as the inter-factor correlation matrix for the study variables. Significant and positive correlations exist among TDCs, Organizational Innovation, New Business Venturing, Proactiveness, Self-Renewal and Organizational Performance. Second, we performed structural equations modelling to estimate direct and indirect effects using LISREL with the correlation matrix as input. This analysis has the advantage of correcting for unreliability of measures and providing information on direct and indirect paths between multiple constructs after controlling for potentially confounding variables (Hair et al. 2006). Figure 2 shows the standardized structural coefficients, whose magnitude reflects the relative importance of the variables.

As to quality of the measurement model for the sample, the constructs display satisfactory levels of reliability, indicated by composite reliabilities ranging from 0.644 to 0.923 and shared variance coefficients from 0.312 to 0.575 (Table 3). We

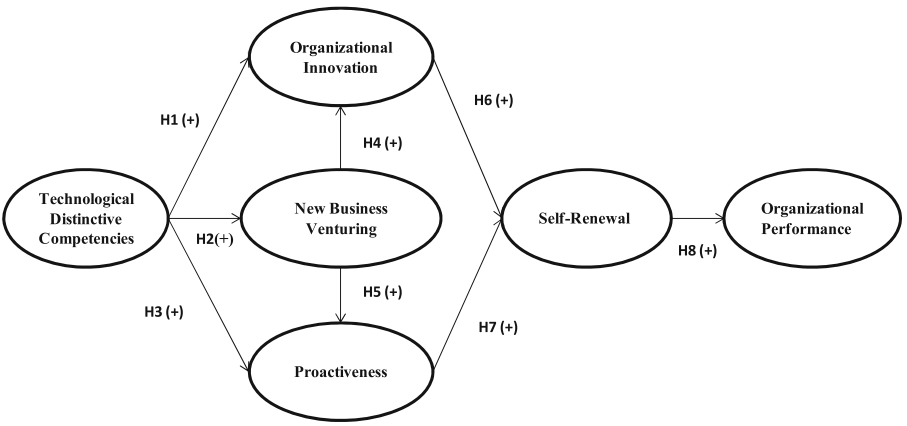

Fig. 1 Hypothesized model

Table 2 Means, standard deviations and correlations

Variable	Mean	S.D.	1	2	3	4	5	6
1. Tech. dist. competencies	4.8919	1.281	1.000					
2. Organizational innovation	4.1405	1.336	.415***	1.000				
3. New business venturing	4.3198	1.513	.343***	.724***	1.000			
4. Proactiveness	4.5609	1.211	.374***	.612***	.506***	1.000		
5. Self-Renewal	4.4306	1.290	.494***	.658***	.677***	.593***	1.000	
6. Organizational performance	4.4705	0.995	. 353***	.430***	.398***	.344***	.537***	1.000

*$p < .05$;**$p < .01$;***$p < .001$(two-tailed). $n = 201$

assessed convergent validity by examining both the significance of the factor loadings and shared variance. The amount of variance shared or captured by a construct should be greater than the measurement error (shared variance >0.50). All multi-item constructs meet this criterion, each loading (λ) being significantly related to its underlying factor (t-values >18.31) in support of convergent validity. To assess discriminate validity, we performed a series of chi-square difference tests on the factor correlations among all constructs (Anderson and Gerbing 1988) for each pair of latent variables. We constrained the estimated correlation parameter between them to 1.0 and performed a chi-square difference test on the values obtained for the constrained and unconstrained models (Anderson and Gerbing 1988). The resulting significant differences in chi-

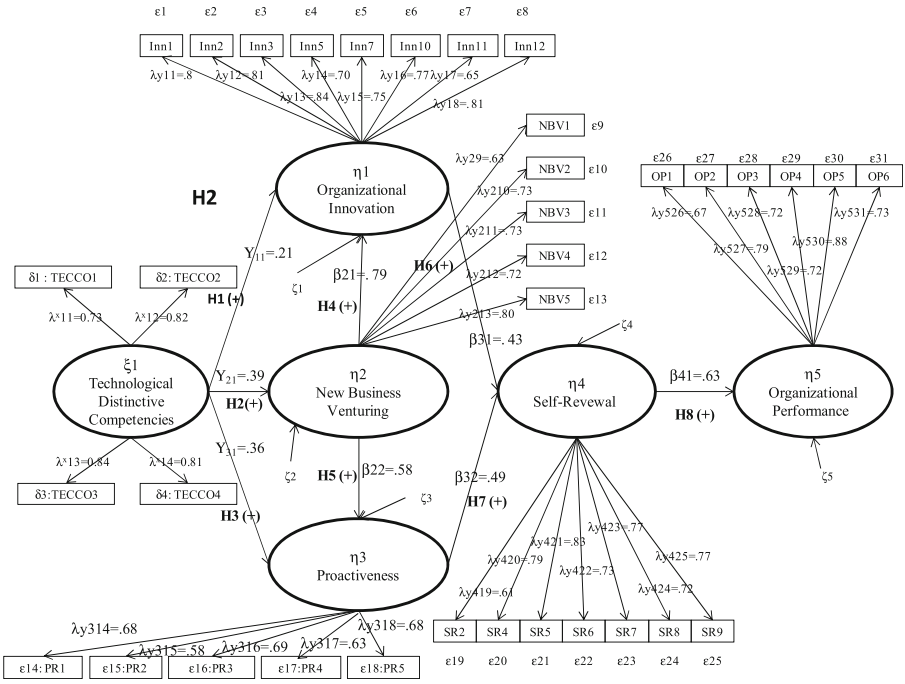

Fig. 2 Results of structural equation model

Table 3 Validity, reliability and internal consistency

Variable	Item	Parameter	Validity, reliability and internal consistency		
			λ*	R^2	A. M.
Technological distinctive competencies	TECCO1	λ^x_{11}	0.73***(f.p.)	0.53	α = 0.879 C.R. = 0.877 S.V. = 0.641
	TECCO2	λ^x_{12}	0.82***(18.15)	0.67	
	TECCO3	λ^x_{13}	0.84***(18.53)	0.70	
	TECCO4	λ^x_{14}	0.81***(18.10)	0.66	
Organizational innovation	EntInn1	λ^y_{11}	0.80***(f.p.)	0.64	α = 0.922 C.R. = 0.920 S.V. = 0.591
	EntInn2	λ^y_{12}	0.81***(25.44)	0.65	
	EntInn3	λ^y_{13}	0.84***(25.96)	0.70	
	EntInn5	λ^y_{14}	0.70***(23.87)	0.50	
	EntInn7	λ^y_{15}	0.75***(24.85)	0.56	
	EntInn10	λ^y_{16}	0.77***(25,28)	0.60	
	EntInn11	λ^y_{17}	0.65***(22,92)	0.42	
	EntInn12	λ^y_{18}	0.81***(25,79)	0.66	
New Business venturing	NBV1	λ^y_{29}	0.63***(f.p.)	0.40	α = 0.850 C.R. = 0.843 S.V. = 0.518
	NBV2	λ^y_{210}	0.73***(21.90)	0.51	
	NBV3	λ^y_{211}	0.73***(21.70)	0.54	
	NBV4	λ^y_{212}	0.72***(21.64)	0.50	
	NBV5	λ^y_{213}	0.80***(22.79)	0.63	
Proactiveness	EntPr1	λ^y_{314}	0.73***(f.p.)	0.53	α = 0.822 C.R. = 0.826 S.V. = 0.489
	EntPr2	λ^y_{315}	0.58***(17.65)	0.38	
	EntPr3	λ^y_{316}	0.75***(19.49)	0.56	
	EntPr4	λ^y_{317}	0.63***(17.69)	0.46	
	EntPr5	λ^y_{318}	0.68***(20.33)	0.53	
Self-Renewal	EntSR2	λ^y_{419}	0.61***(f.p.)	0.39	α = 0.897 C.R. = 0.898 S.V. = 0.560
	EntSR4	λ^y_{420}	0.79***(17.48)	0.36	
	EntSR5	λ^y_{421}	0.83***(16.11)	0.64	
	EntSR6	λ^y_{422}	0.73***(17.94)	0.69	
	EntSR7	λ^y_{423}	0.77 ***(18.27)	0.54	
	EntSR8	λ^y_{424}	0.72 ***(17.28)	0.60	
	EntSR9	λ^y_{425}	0.77***(18.06)	0.51	
Organizational performance	PERFOR1	λ^y_{526}	0.67***(f.p.)	0.45	α = 0.888 C.R. = 0.887 S.V. = 0.570
	PERFOR2	λ^y_{527}	0.79***(18.96)	0.63	
	PERFOR3	λ^y_{528}	0.72***(18.06)	0.52	
	PERFOR4	λ^y_{529}	0.72***(18.10)	0.52	
	PERFOR5	λ^y_{530}	0.88***(19.27)	0.77	
	PERFOR6	λ^y_{531}	0.73 ***(17.96)	0.53	

λ* = Standardized Structural Coefficient; R^2 = Reliability; α = Alpha Cronbach; C. R. = Compound Reliability; S. V. = Shared Variance; f. p. = fixed parameter; A. M. = Adjustment Measurement

*$p < .05$; ** $p < .01$; *** $p < .001$(two-tailed)

square indicate that the constructs are not perfectly correlated and that discriminant validity is achieved.

All significance levels of the path coefficients and R^2s indicate that the model fits the data well ($\chi^2_{552} = 1387.67$, $p > .001$; $\chi^2_{ratio} = 1.02$; NFI = .99; NNFI = .99; GFI = .97, CFI = .99, IFI = .99, PGFI = .86). The hypothesized model is a significantly better fit than the null model ($\chi^2_{595} = 18{,}273.29$, $p > .001$; $\Delta\chi^2_2 = 25.2$, $p > .001$). The residuals of the covariances were small and centred around zero. All modification indices for the beta pathways between major variables were also small, and some were negative, suggesting that additional paths would not significantly improve the fit.

The statistics in Table 4 show that TDCs are related to and affect Organizational Innovation ($\gamma_{11} = .21$, $p < .001$), New Business Venturing ($\gamma_{21} = .39$, $p < .01$) and Proactiveness ($\gamma_{31} = .36$, $p < .001$), as predicted in Hypotheses 1, 2 and 3, respectively. If we compare these relationships, TDCs affect New Business Venturing more than they affect Organizational Innovation and Proactiveness. We also show an indirect effect (.23, $p < .05$) of TDCs on organizational innovation by New Business Venturing. (.23×.99). The total effect of TDCs on organizational innovation is thus 0.46 ($p < .001$), supporting Hypotheses 1 and 4. Proactiveness is also influenced by TDCs directly ($\beta_{21} = .58$, $p < .001$) and indirectly (.62, $p < .05$) with the help of New Business Venturing (.34×.62), supporting Hypotheses 2 and 5. Comparing these two effects, we can assert that TDCs affect Proactiveness more than Organizational Innovation.

Self-Renewal is directly influenced by Organizational Innovation ($\beta_{31} = .33$, $p < .001$) and Proactiveness ($\beta_{32} = .43$, $p < .001$), supporting Hypotheses 6 and 7, respectively; and indirectly influenced by New Business Venturing through Organizational Innovation (.99×.33) and Proactiveness (.62×.43). The total effect of New Business Venturing on Self-Renewal is thus the sum of both relationships .60(<.05).

We also show an indirect effect (.43, $p < .001$) of TDCs on Self-Renewal by Organizational Innovation (.23×.33), Proactiveness (.34×.43) and New Business Venturing through both Organizational Innovation (.34×.99×.33) and Proactiveness (.34×.62×.43). TDCs' global influence on Self-Renewal is 0.43 ($p < .001$). Comparing the magnitudes of these effects shows that the total effect of TDCs on Self-Renewal is larger than the total effect of Organizational Innovation on Self-Renewal. Globally, the model explains Self-Renewal well ($R^2 = .72$).

Finally, the significant relationship of Organizational Performance to Self-Renewal ($\beta_{43} = .69$, $p < .001$) supports Hypothesis 8. Globally, organizational performance is explained well by the model ($R^2 = .39$). Other indirect effects are shown in Table 4.

In testing the theoretical framework, we fit several nested models, each incorporating different assumptions on parameters. Comparisons with reasonable alternative models are recommended as a means of showing that the hypothesized model is the best representation of the data. Comparison is important in assessing model fit (Bollen and Long 1993; Hair et al. 2006). The summary statistics in Table 5 indicate that Model 1 was preferred to the others, supporting inclusion of a model with these relationships among the constructs analyzed. For example, if we compare the theoretical model (Model 1) to a model that does not consider the relationship between TDCs and organizational innovation (Model 2), the latter has a worse Root Mean Square Error of Approximation (>RMSEA = .009), Expected Cross-Validation Index (>ECVI = .11), Akaike Information Criterion (>AIC = 23.20), Consistent Akaike Information Criterion

Table 4 Structural model result (direct, indirect and total effects)

Effect from		To	Direct Effects [a]	*t*	Indirect Effects [a]	*t*	Total Effects[a]	*t*
Tech. Dist. Competencies	➡	Organizational Innovation	0.23***	5.26			0.23***	5.26
Tech. Dist. Competencies	➡	New Business Venturing	0.34***	10.91			0.34***	10.91
Tech. Dist. Competencies	➡	Proactiveness	0.34***	8.45	0.21**	3.02	0.55**	3.02
Tech. Dist. Competencies	➡	Self-Renewal			0.43**		0.42**	2.83
Tech. Dist. Competencies	➡	Organizational Performance			0.30**	2.83	0.29**	2.83
Organizational Innovation	➡	Self-Renewal	0.33***	4.31			0.33*	4.31
Organizational Innovation	➡	Organizational Performance			0.23**	8.38	0.23***	8.38
New Business Venturing	➡	Organizational Innovation	0.99***	16.47			0.99	16.47
New Business Venturing	➡	Proactiveness	0.62***	13.94			0.62***	13.94
New Business Venturing	➡	Self-Renewal			0.60***	6.15	0.60***	6.15
New Business Venturing	➡	Organizational Performance			0.41***	6.32	0.41***	6.32
Proactiveness	➡	Self-Renewal	0.43***	4.15	0.17***	6.16	0.43***	6.16
Proactiveness	➡	Organizational Performance			0.30**	3.00	0.30**	3.00
Self-Renewal	➡	Organizational Performance	0.69***	17.76			0.69***	17.76
Goodness of Fit Statistics	χ^2_{552} = 1387.67 ($P > 0.01$) GFI = 0.97 AGFI = 0.98 ECVI = 7.72 AIC = 1260.67 CAIC = 1879.33 NFI = 0.99 NNFI = 0.99 IFI = 0.99 PGFI = 0.86 NCP = 835.67 RFI = 0.99 CFI = 0.99 RMSEA = 0.079							

[a] Standardized Structural Coefficients; † $p < .10$, * $p < .05$, ** $p < .01$, *** $p < .001$

Table 5 Model statistics against theoretical model

Model	Description	χ^2	*df*	$\Delta\chi^2$	RMSEA	ECVI	AIC	NCP	CAIC
1	Theoretical	1387.67	552		0.079	7.72	1543.67	835.67	1879.33
2	W.R. Tech. Dist. Competencies ➡Org. Innovation	1412.87	554	25.20	0.088	7.83	1566.87	859.87	1898.22
3	W.R.Tech.Dist.Competencies➡New Business Venturing	1397.67	552	10.00	0.079	7.78	1544.67	855.68	1880.00
4	W.R.Tech. Dist. Competencies ➡Proactiveness	1414.04	553	26.37	0.088	7.84	1568.04	861.04	1899.40
5	W.R. New Business Venturing ➡ Org. Innovation	1821.30	553	433.63	0.110	9.88	1975.30	1268.30	2306.66
6	W.R. New Business Venturing ➡ Proactiveness	1566.25	553	178.58	0.096	8.60	1720.25	1013.25	2051.61
7	W.R. Org. Innovation ➡Self-Renewal	1444.58	553	56.91	0.090	7.99	1598.36	891.36	1929.71
8	W.R. Proactiveness ➡ Self-Renewal	1472.42	553	84.75	0.091	8.13	1626.42	919.42	1957.78

W.R. = Without Relationship; $n = 201$

(>CAIC = 19.91) and Estimated Non-Centrality Parameter (>NCP = 24.21). The theoretical model is preferable to the other models formulated (Table 5).

Discussion, conclusions and future research

Discussion and conclusions

A wide range of studies shows that entrepreneurial organizations undertake regenerative transformations involving changes in their strategy, structure, process, and behaviour (Muzyka et al. 1995). These transformations include strategic objectives to guide entrepreneurs, a management structure to support entrepreneurial activities, and processes to inform assessment and decision making, as well as projects moving through the pipeline toward commercialization, or programs demonstrating greater effectiveness. These companies receive increased commitment from top management and a higher level of credibility throughout the organization. Such firms become more capable of and receptive to entrepreneurship over time (Kelley 2011).

The relation between entrepreneurial results and the TDCs the firm uses currently inspires much research to aid academics and company professionals. Few studies analyze empirically how these essential competencies or capabilities motivate entrepreneurial orientation and improve firm performance (e.g., Autio et al. 2000; Danneels 2007, 2008; Girratana and Torrisi 2010; Martín-Rojas et al. 2011, 2013; Real et al. 2006) or firms' action on each different component composing corporate entrepreneurial spirit (Antoncic and Hisrich 2001; Fayolle and Basso 2010). Our study deepens understanding of the results of these key capacities for corporate entrepreneurship, its components (organizational innovation, new business creation, proactiveness and self-renewal), and their interrelations in order ultimately to study their indirect effect on performance.

This procedure enables us to stress the importance of TDCs for the organization and to show that their benefits can stimulate corporate entrepreneurial spirit to translate into better performance. Individualized development of TDCs' effects on each variable of entrepreneurial spirit enables organizations to avoid failure when achieving competitive advantage, stimulating actions and interrelations between them that are economically or strategically more profitable for the firm. Further, individuals in charge of policy can exploit this knowledge to make more effective decisions when establishing budgets, incentives or subsidies to motivate firms' technological management, extending corporate entrepreneurial spirit. We thus reinforce the view of entrepreneurial orientation as a result of TDCs (Martín-Rojas et al. 2011, 2013), and specifically as a very important determiner of entrepreneurial activities or components performed effectively. The relationship with and between the main entrepreneurial components has hardly been studied, as corporate entrepreneurial spirit is usually discussed as a single aggregate concept or treated through some of its dimensions, with a few exceptions (Antoncic and Hisrich 2001; Brazeal et al. 2008; Martín-Rojas et al. 2013), and has almost never been studied in disaggregated form.

Since we have focused on intrapreneurship—that is, entrepreneurship by an established firm (Antoncic and Hisrich 2001)—we highlight the concept of entrepreneurial spirit in corporations as part of a wider repositioning or restructuring strategy of

the entire organization or even industry in which the organization operates. This type of corporate entrepreneurship can be practiced at all levels—corporate, divisional, business, unit, business function and project team (Paunovic 2012). It is a concept that emphasizes not only flexibility, collaboration, insight, initiative and good spirits (DeSimone et al. 1995), but also *why* entrepreneurs take calculated risks as they identify often-disguised opportunities that go unnoticed by others (Brazeal et al. 2008; Fayolle and Basso 2010; Shane and Venkataraman 2000).

In the field of technology firms, in which TDCs are more fundamental than in other sectors (e.g., Lee et al. 2001; Tushman and Anderson 1986), it seems appropriate to stress that only firms endowed with more evolved technological competencies can face technological problems more competitively and find satisfactory solutions (Autio et al. 2000). This paper thus shows that the development of certain specific technological competencies is essential to prepare employees for success and satisfaction in their jobs. The fact that all employees influence such competencies and thus shape corporate entrepreneurial spirit (Dos Santos and Spann 2011) strengthens our argument that firms must train employees in entrepreneurship and design actions to enhance individual and organizational performance. We thus also confirm that such competencies are "trainable" and could be influenced by organizational climate or education (Dos Santos and Spann 2011).

Likewise, this study shows TDCs to have a high impact on all variables of corporate entrepreneurial spirit, whether directly or indirectly. It shows that TDCs influence the firm's organizational performance indirectly through innovation, new business creation and proactiveness, contributing to its self-renewal. This in turn leads to and drives greater performance. CEOs should thus strengthen TDC development on all levels of the firm, strengthening future competitive advantage. Further, throughout this study, we demonstrate that it is critical for high-technology firms to develop their workers' entrepreneurial spirit, since workers are the agents who make the firm's entrepreneurship reality. Developing programs that strengthen good development of employees' technological competencies and entrepreneurial capacities thus merits special attention.

If we analyze each effect of the dimensions of corporate entrepreneurial spirit, the findings show that TDCs affect organizational innovation, new business creation and proactiveness positively and significantly. First, organizational innovation is a strategic factor enabling growth and wealth creation (Damanpour et al. 2009; Hurley and Hult 1998). We thus confirm that fostering TDCs stimulates recognition and application of new capabilities in firms, permitting them to create and distribute innovative products or services that consumers seek and desire (Lokshin et al. 2009; Wang et al. 2004). To improve organizational innovation levels, firms create environments that encourage innovation, dedicating resources to this goal and improving firm structure and culture by stimulating and executing innovations (Danneels 2002, 2007, 2008; Senge et al. 1994; Van de Ven 1986). And what better way to achieve innovation throughout the entire firm than having these capabilities already established as organizational routines? Further, organizational innovation has become essential because innovation improves self-renewal over time, the firm's adaptation to change, and development of new demands on the market (Heidenreich 2005; Smith et al. 2008).

In the case of new business creation, TDCs must also have been established previously. For example, in the technological life cycle, TDCs must be developed in

the latent phase of the technology, prior to the creation phase, as TDC superiority in the latent phase prepares the firm to exploit possible advantages by being first to develop these capabilities—advantages such as founding business and obtaining resources that favour rapid growth and the firm's capacity to adapt to new changes (Abetti 1997).

TDCs will thus encourage new business creation in any sector, increasing the firm's strategic options and enabling redefinition of competitive areas while the firm expands toward new markets (Zahra et al. 1999). New business creation permits a certain degree of autonomy to exploit the firm's technological diversification and enable rapid technological development. Firms with more new business in different environments can adjust their structure better and more rapidly to enable better results than other firms in similar conditions. The main result is that each new autonomous business continues to innovate to adapt to its new competitive environment. We also confirm that, as new businesses increase, organizations stimulate their proactiveness to manage each better, pulling ahead or themselves generating the more innovative changes needed to achieve a better organization and to improve all of its businesses. We thus see that TDCs promote new business creation directly, while these new businesses in turn encourage proactiveness and innovation.

In addition to stimulating new business creation, we find that TDCs permit the firm to develop its proactiveness directly by strengthening employees' proactive characteristics, such as innovative thinking, flexibility, decision-making agility and self-control to motivate them to be strategically adapted to global changes that occur continuously. Such action enables firms to improve their competitive position (Singh 2008).

In the current scenario, proactiveness strengthened by technological competencies will permit generation of new opportunities to create new tendencies through which companies can benefit from competitive advantages and thus new opportunities (Girratana and Torrisi 2010). Further, empirical evidence shows that organizations willing to take the initiative, take risks, and not wait until the environment changes to adapt can contribute actively to these changes, becoming more flexible and facilitating self-renewal (Fernández-Pérez et al. 2013), growing importance of overconfidence in entrepreneurship (Robinson and Marino 2015).

To conclude on entrepreneurial competencies, we stress that proactiveness and organizational innovation are keys to executing and exploiting the new technological opportunities continually emerging in competitive environments to achieve good performance (García Morales et al. 2006).

The key element among the components of corporate entrepreneurial spirit is self-renewal as influenced by the other entrepreneurial components, directly by organizational innovation and proactiveness and indirectly by new business creation.

Finally, we affirm that sources of competitive advantage in technological firms are based on a set of key technological competencies that in turn stimulate entrepreneurial capabilities.

Practical implications

The relatively slight attention paid in practice to the topics studied in this article contrasts with their importance for technicians and practitioners in firms. Consequently, this section presents the many practical implications for managers that our research offers. First, organizations should foster TDC creation as a source of competitive

advantage, as these competencies provide an opportunity to develop and exploit recent technologies that are difficult for competitors to imitate (Alvarez and Barney 2007). These capabilities can be strengthened strategically if exploited in an entrepreneurial way, generating improved organizational performance (Hurley and Hult 1998; Martín-Rojas et al. 2013; Real et al. 2006). CEOs must thus perform numerous actions that depend on TDCs, actions involving more modern organizational structures, compensation policies and stimulation of organizational flexibility to encourage internal knowledge exchange in the firm (Lane and Lubatkin 1998; Nonaka and Takeuchi 1995; Van den Bosch et al. 1999). Human resources management is fundamental when discussing technological competencies to achieve better effectiveness (Benitez-Amado et al. 2010).

Second, to achieve successful internal technological capability, a firm must be complemented by social and technological network capabilities, as these are especially necessary for making important strategic investments that guarantee longer-term survival of the business (Slotte-kock and Coviello 2010; Toledano et al. 2010). In this regard, the importance of networks becomes fully apparent in the concept of Open Innovation, i.e., the process by which internal and external areas of knowledge are combined to enable R&D projects to progress and succeed. This type of innovation reflects the application of what has been termed collective intelligence, and its incorporation into our analysis confers many advantages, although it is not without dangers, too. Further consideration of this question would greatly enrich our understanding and encourage social change through them.

Finally, to develop technological capabilities within innovation systems, managers should prioritize development of a set of policies and interventions that help them to master technology in the firm completely (Archibugi and Iammarino 2002). These technological incentives should be combined with incentives for entrepreneurship to achieve better exploitation of capabilities and expansive synergies that occur at the level of both firm and economic system in general. Within entrepreneurial components, self-renewal has become a wonderful opportunity to increase organizational performance through internal social changes such as introduction of new products, services, technological operations, administrative techniques, internal coordination, multifunctional teams and the introduction of new intrafirm networks or networks with firm suppliers and customers (Chen et al. 2013; Covin et al. 1986; Fernández-Pérez et al. 2013; Kazanjian et al. 2000; Melander and Tell 2014).

To address these challenges, a company must to undertake some truly innovative initiatives, that is, promotion of invention and commercialization of new product and process innovations within a coherent employee involvement program that focuses on technology throughout the company. Such initiatives will motivate employees and enable them to act as entrepreneurs, use collective intelligence to source and select the most valuable innovative ideas, and promote their development and commercialization in a corporate setting (DeSimone et al. 1995; Dos Santos and Spann 2011).

Limitations and future research

This research has several limitations to consider. Among these, we highlight:

First, survey data based on self-reports may be subject to social desirability bias (Podsakoff and Organ 1986). However, assurance of anonymity can reduce such bias

even when responses relate to sensitive topics (Konrad and Linnehan 1995). The low risk of social desirability bias in this study was indicated by several managers who commented that it made no sense at all for their companies to go beyond regulatory compliance. Still, the responses are subject to interpretation by individual managers.

Second, although Harman's one-factor test and other method tests did not identify common method variance as a problem, it still might have been (Podsakoff and Organ 1986; Konrad and Linnehan 1995). Although Spector (2006) argues it is incorrect to assume that the use of a single method automatically introduces systematic bias, it is advisable for future research to gather measures of independent and dependent variables from different data sources to minimize the effects of any response bias (Podsakoff et al. 2003).

Third, our data are cross-sectional, making it difficult to examine the evolution of the different variables in our study. This aspect is of particular interest considering the dynamic nature of some of our variables. Although we tested the most plausible directions for the pathways in our model, longitudinal research is needed to assess the direction of causality in the relationship and to detect possible reciprocal processes. We have tried to temper this limitation through attention to theoretical arguments justifying the relationships analyzed and by integrating temporal considerations into measurement of the variables (Hair et al. 1999). Fourth, futures studies should be based on a larger sample, preferably in more than one country and in other sectors, as this study focuses on Spanish firms only. Empirical research could be conducted on the same relationship in Europe to generalize results across the European economy and thus throughout the world.

Finally, the model only analyzes the relation between TDCs and organizational performance through corporate entrepreneurship, including 4 key components (organizational innovation, new business venturing, proactiveness, self-renewal). Selected variables explain an acceptable amount of variance in organizational performance, but other, intermediate constructs could be analyzed, such as absorptive capacity or social networks (e.g., García Morales et al. 2006; Martín-Rojas et al. 2013).

More empirical papers supporting (or rejecting) our results in different contexts, would be welcome (especially longitudinal studies).

Appendix

❖ **Technological distinctive competencies**

Indicate the degree to which you agree or disagree with the following statements regarding whether the organization has:

1. Capability to obtain information about the status and the progress of science and relevant technologies and advanced technological processes.
2. Capability to assimilate new technologies and useful innovations.
3. Capability to attract and retain qualified scientific-technical staff.
4. Capability to dominate, generate or absorb basic and key business technologies.

❖ **Organizational innovation**

In the last three years, the organization has significantly increased:

2.1 The emphasis on developing new products/services.
2.2 The rate of new product/service introduction into the market.
2.3 Spending on new product/service development activities.
2.4 The number of products/services added by the organization and already existing in the market.
2.5 The number of new products/services introduced in the market for the first time by the organization.
2.6 Percentage of revenue generated from new businesses/services that did not exist three years ago.

❖ **New business venturing**

3.1 The organization has stimulated new demands for existing products/services in currents markets through aggressive advertising and marketing.
3.2 The organization has broadened the business lines in current industries.
3.3 The organization has pursued new business in new industries related to its current business.
3.4 The organization has found new niches for its products/services in current markets.
3.5 The organization has entered new businesses by offering new lines and products/services.

❖ **Proactiveness**

4.1. In dealing with competitors, the organization is very often the first business to introduce new products/services, administrative techniques, operating technologies, etc.
4.2. In dealing with competitors, our organization typically adopts a very competitive, undo-the-competitors posture.
4.3. In general, the top managers at our firm have a strong propensity for high-risk projects (with chances of very high returns).
4.4. In general, the top managers at our firm believe that, owing to the nature of the environment, bold, wide-ranging actions are necessary to achieve the firm's objectives.
4.5. When confronted with decision-making situations involving uncertainty, our organization typically adopts a bold, aggressive posture in order to maximize the probability of exploiting potential opportunities.

❖ **Self-renewal**

5.1 The organization has revised the business concept.
5.2 The organization has redefined the industries in which the company will compete.
5.3 The organization has reorganized units and divisions to increase organizational innovation.

5.4 The organization has coordinated activities among units to enhance organizational innovation.
5.5 The organization has increased the autonomy (independence) of different units to enhance their innovation.
5.6 The organization has adopted flexible organizational structures to increase innovation.
5.7 The organization has rewarded employees for creativity and innovation.
5.8 The organization has trained and encouraged employees to be creative and innovative.

❖ **Organizational performance**

Relative to your main competitors, what is your firm's performance in the last three years in the following areas?

6.1 Organizational performance measured by return on assets (economic profitability or ROA).
6.2 Organizational performance measured by return on equity (financial profitability or ROE).
6.3 Organizational performance measured by return on sales (percentage of profits over billing volume).
6.4 Organization's market share in its main products and markets.
6.5 Growth of sales in its main products and markets.

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