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The influence on corporate entrepreneurship of technological variables

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Abstract

Purpose – The aim of this paper is to highlight the importance of different technological aspects of organizations on Spanish high-technology firms' performance.

Design/methodology/approach – The relationships studied are confirmed empirically using a structural equation model to demonstrate our hypotheses. The sample was selected from the database "Dun & Bradstreet España" in the year 2005 and includes 201 Spanish firms. CEOs were our main informants.

Findings – The results obtained show that support from top managers will directly influence the organizational learning (OL) process and technological distinctive competencies (TDCs) (antecedents of corporate entrepreneurship) and that corporate entrepreneurship finally influences organizational performance.

Research limitations/implications – The paper is exploratory in character, and its goal is to show whether interrelations exist between the variables. The main limitations are: the sectors chosen refer only to Spain; the analysis is cross-sectional in character; the study uses a single method and self-reports (CEOs).

Practical implications – To obtain perfect adaptation of the firm to its environment, it is crucial that managers develop corporate entrepreneurship to improve high-technology sector firms' performance. The paper shows the important role of the top manager's support in developing TDCs and OL. Success in such issues is of vital importance to corporate entrepreneurship in the firm.

Originality/value – The paper seeks to stimulate new lines of research on one variable (TDCs) and to relate it to other constructs, producing new relationships and observing their repercussions for the firm.

Keywords Spain, Technological distinctive competencies, Top management support, Organizational learning, Corporate entrepreneurship, Organizational performance

Paper type Research paper

1. Introduction

The 1990s might well be considered the beginning of the era called the new or e-economy because of the appearance of the internet in the economy. In today's globally competitive environment, the internet has led to tremendous expansion in technology for business and rapid growth in investments (Skerlavaj and Dimovski, 2006).

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Assessing the value of technology has never been easy. The application of technology throughout the company (Andreu and Ciborra, 1996; Giarratana and Torrisi, 2010; Leonard-Barton, 1992) has increased the importance of technological distinctive competencies (TDCs), which permit the exploitation of the technological opportunities for the development of corporate entrepreneurship, reduction of costs, and generation of organizational competitive advantage (Alvarez and Barney, 2007; Autio *et al.*, 2000; Real *et al.*, 2006; Woolley, 2010).

In this research, TDCs represent "the organization's expertise in mobilizing various scientific and technical resources through a series of routines and procedures which allow new products and production processes to be developed and designed" (Real *et al.*, 2006, p. 508).

This study contributes to prior research by linking TDCs to other strategic constructs, such as the necessity of top management support (TMS) for technology to obtain these competencies and the learning processes needed throughout the organization, that analyze globally and empirically their repercussions for corporate entrepreneurship in order to achieve a higher value firm. The study thus first seeks to analyze empirically the influence of TMS on TDCs (Byrd and Davidson, 2003; Haro-Domínguez *et al.*, 2010). Second, we seek to analyze how these TDCs and TMS influence organizational learning (OL) (Alvarez and Barney, 2007; Autio *et al.*, 2000; Leonard-Barton, 1992; Shane and Venkataraman, 2000; Teece, 1986; Woolley, 2010). Third, we analyze the direct relationships between both TDCs and OL on corporate entrepreneurship (Alvarez and Barney, 2007; Leonard-Barton, 1992; Woolley, 2010). Organizations that engage in entrepreneurial activities achieve higher levels of growth and profitability than organizations that do not, thus also achieving higher organizational performance (Antoncic and Hisrich, 2001). Corporate entrepreneurship involves "extending the firm's domain of competency and corresponding opportunity set through internally generated new resource combinations" (Covin and Slevin, 1991, p. 1). Thus, corporate entrepreneurship refers to "the process by which firms notice opportunities and act to creatively organize transactions between factors of production so as to create surplus value" (Jones and Butler, 1992, p. 735).

All of these technological variables demand strong and committed TMS to guide the initiative and develop a working environment that supports technology (Ghosh *et al.*, 2001). TMS "reflects, in many ways, the importance that top management executives place on technology" (Byrd and Davidson, 2003, p. 246). For Leonard-Barton and Deschamps (1988, p. 1254), TMS is a "perceived powerful source".

TDCs influence corporate entrepreneurship, improving organizational performance. They also impact corporate entrepreneurship directly because they permit entrepreneurs to earn their status by demonstrating excellence in technological and professional skills and knowledge (Leonard-Barton, 1992). TMS has been closely linked to TDCs (Byrd and Davidson, 2003; Ghosh *et al.*, 2001; Leonard-Barton and Deschamps, 1988).

Although corporate entrepreneurship is directly influenced by TDCs, it may also be influenced indirectly through OL (Benitez-Amado *et al.*, 2010; Chenhall, 2005; González-Álvarez and Nieto-Antolín, 2005; Leonard-Barton, 1992; Omerzel and Antoncic, 2008; Rerup, 2005), because OL disseminates the knowledge acquired and uses it to encourage entrepreneurial behaviour (García-Morales *et al.*, 2006; Senge *et al.*, 1994). OL can be considered a process whereby members of an organization are stimulated

to strive continually for new approaches and to acquire, as well as to share, knowledge that influences their interactions with their environments (Argyris, 1993; Nonaka and Takeuchi, 1995).

In the section on hypotheses, we draw on prior research to develop a number of testable hypotheses concerning the influence of TMS on TDCs, the influence of TMS and TDCs on OL, the influence of TDCs and OL on corporate entrepreneurship, and the way corporate entrepreneurship improves organizational performance. The section on hypotheses constitutes the theoretical foundation for the paper. The following sections present the research methodology and discuss the results. The final section makes some concluding observations and points out some of the study's limitations and lines for future research.

2. Hypotheses

2.1 The influence of TMS on TDCs and OL

TMS has long been recognized as one of the most important factors for ensuring successful implementation of distinctive competencies (Byrd and Davidson, 2003; Ghosh *et al.*, 2001; Leonard-Barton and Deschamps, 1988; Petroni and Panciroli, 2002). It reflects the importance that the top management executives place on technology competencies (Byrd and Davidson, 2003).

TMS helps the firm to obtain more TDCs and competitive advantage in key business areas (Byrd and Davidson, 2003). An innovation-supportive culture from top managers can generate higher business value (Petroni and Panciroli, 2002), which translates into higher TDCs in the firm (Benitez-Amado *et al.*, 2010).

In the technological innovation literature, management support is seen as an important power-tool to promote TDCs (Kanter, 1984). Zmud (1984) finds that managerial influence is stronger for technological innovations because they require more skilled individuals who may achieve excellence in technology (Leonard-Barton and Deschamps, 1988).

Torkkeli and Tuominen (2001) find TMS to be very advantageous and appropriate to core competency-based technology because it offers many potential benefits for supporting core distinctive competency-based technology, such as skilled technological entrepreneurs (Antoncic, 2007), exceptional skills managers (Leonard-Barton, 1992) and better-trained employees (Andreu and Ciborra, 1996; Torkkeli and Tuominen, 2001).

Such support is vital to obtaining TDCs and to successful implementation of TDC strategies to improve competitiveness, as well as to achieving a sustainable competitive advantage that is truly difficult to imitate (Haro-Domínguez *et al.*, 2010). Thus:

H1. TMS will be positively related to TDCs in technological organizations.

TMS is one of the most important factors of systematic knowledge management and OL. Omerzel and Antoncic (2008) studied TMS in small- and medium-sized enterprises and concluded that one person is usually in charge of OL, combining both knowledge ownership and the managerial function. According to these authors, the main manager is the person who provides employees with a knowledge technological framework by means of an OL process. Fineman (1996) provides insight into the influence of TMS, as TMS plays a key role in shaping the climate for such a learning culture. Managers should understand company culture and values, and they should maintain what is good and promotes knowledge creation through an OL process. This can be achieved

if the manager is willing to observe and talk to employees, to recognize obstacles, problems and success, and to train employees (Leonard-Barton, 1992). Top management characteristically requires different knowledge during different growth periods and thus continuously develops its OL process to obtain that knowledge (Omerzel and Antoncic, 2008).

Furthermore, expert managerial culture may provide an overarching frame of reference, helping to align the behaviour of employees, who will have more precise knowledge of the organizational objectives for innovation and will make a greater effort to achieve these objectives more efficiently if they implement a technology-supportive culture (Andreu and Ciborra, 1996; Leonard-Barton, 1992). Such a culture can be provided by top management (Chenhall, 2005). In practice, top management designs OL processes for employees to learn, making it possible for the firm to obtain a competitive advantage that it would otherwise not achieve (González-Álvarez and Nieto-Antolín, 2005).

Successful managers develop a variety of practical skills during their work and exert considerable effort to build support systems for disseminating technological knowledge and initiating an OL process to teach it (Andreu and Ciborra, 1996; Leonard-Barton, 1992; Omerzel and Antoncic, 2008).

TMS enables the organization to learn through experimentation, communication, dialogue, personal mastery and the process of organizational knowledge creation in order to become an intelligent organization (Leonard-Barton, 1992; Lloréns-Montes *et al.*, 2005). Consequently, OL needs strong technological commitment and TMS to achieve competitive advantage (Lei *et al.*, 1999; Lloréns-Montes *et al.*, 2005). Thus:

H2. TMS will be positively related to OL in technological organizations.

2.2 The influence of TDCs on OL and corporate entrepreneurship

Technological competencies are one important element of the firm's core competencies. Management usually strengthens TDCs as a means of nurturing strengths in technological knowledge and production routines to exploit potential outcomes, create potential markets and beat potential competition (Banerjee, 2003).

TDCs may become institutionalized over a long period of time and form part of the company's knowledge creation system (Leonard-Barton, 1992). Andreu and Ciborra (1996) share this idea and observe that the development of central competencies (e.g. TDCs) is linked to the process of OL. TDCs constitute the roots of a firm's sustainable competitive advantage, since the competencies comprise patents protected by law, technological knowledge, and production skills that are valuable and difficult for competitors to imitate (Lee *et al.*, 2001). Such competencies are even more central in high-technology firms because they comprise technological knowledge – internal know-how generated by R&D and other technology-specific intellectual capital such as OL (Lee *et al.*, 2001). OL programs enable effective incorporation of the firm's TDCs into the firm's organizational context, making them apparent on all organizational levels and giving them meaning (Andreu and Ciborra, 1996).

Along similar lines, Real *et al.* (2006) argue that developing competencies involves OL about how to combine and use resources, as well as the learning already embedded in the organizational routines employed.

An educational system or OL program is required for the entire production staff, involving both classroom education and on-the-job training to exploit technological competencies (Alvarez and Barney, 2007; Leonard-Barton, 1992). Management actions

aim at giving learning processes the appropriate direction at any point in time (Argyris, 1993). The goal is for employees to understand TDCs (Real *et al.*, 2006) on all levels of the organization so that the organization can obtain a competitive advantage and stand out from its competitors (Real *et al.*, 2006). Thus:

H3. TDCs will be positively related to OL in technological organizations.

TDCs are typical of entrepreneurs who support the generation of corporate entrepreneurship. These entrepreneurs have exceptional skills or distinctive competencies that enable corporate entrepreneurship by fostering distinguishing technological competencies. Entrepreneurs can invent their way out of difficulties using their technological excellence (Leonard-Barton, 1992). TDCs enable entrepreneurship (Leonard-Barton, 1992; Rerup, 2005).

Technology-intensive firms should be more flexible in order to combine their technology with other complementary assets, such as competencies in exploiting international growth opportunities (Autio *et al.*, 2000; Haro-Domínguez *et al.*, 2010). Woolley (2010) applies this insight to technological firms and underscores the fact that TDCs provide opportunities for entrepreneurs in the firm. Technological competencies provide an ownership advantage that enables entrepreneurs to increase the firm's likelihood of survival (Giarratana and Torrisi, 2010).

TDCs are a necessary but not a sufficient condition for generating a sustainable competitive advantage (Giarratana and Torrisi, 2010). Such advantage requires that TDCs be combined with other complementary assets that the firm may or may not be able to develop or acquire and that could have negative consequences for profitability (Teece, 1986).

Thus, the entrepreneur must take existing technological knowledge and assimilate it to obtain TDCs. Because entrepreneurs must identify potential market opportunities and then act upon them (Woolley, 2010) to obtain an outstanding advantage, TDCs are a brilliant way for entrepreneurs in the corporation to demonstrate their technological knowledge. Thus:

H4. TDCs will be positively related to corporate entrepreneurship in technological organizations.

2.3 The influence of OL on corporate entrepreneurship

OL models are usually appropriate for the study of corporate entrepreneurship (García-Morales *et al.*, 2006; Yang and Rui, 2009). When used strategically, OL and information systems promote entrepreneurial actions by efficiently filtering, sorting, routing, and contextualizing relevant information for senior managers (Simsek *et al.*, 2009). Simsek *et al.* (2009) consider OL to be a central mechanism in an organization, a mechanism that is likely to grant the firm an adaptive advantage via corporate entrepreneurship.

Many organizations make considerable efforts to build systems for acquiring and disseminating knowledge, developing OL processes for all employees in the firm so that they may achieve corporate entrepreneurship (Leonard-Barton, 1992; Omerzel and Antoncic, 2008). If an organization wishes to have well-constructed corporate entrepreneurship, entrepreneurs should view the need for different knowledge during different growth periods as characteristic and thus continuously develop OL processes to satisfy their need for knowledge (Omerzel and Antoncic, 2008).

OL is usually analyzed as an antecedent of entrepreneurship, which increases the organization's capability to carry out actions to improve organizational performance (García-Morales *et al.*, 2006; Yang and Rui, 2009). In addition, corporate entrepreneurship requires an OL framework that involves search activities such as expending resources on the exploration of alternative possibilities, attempting to understand the relationship between organizational characteristics and outcomes, and determining the viability of organizational change (García-Morales *et al.*, 2006). Thus, information flows confirm that OL is expected to be positively related to corporate entrepreneurship (Antoncic, 2007; Antoncic and Hisrich, 2001; Yang and Rui, 2009). Thus:

H5. OL will be positively related to corporate entrepreneurship in technological organizations.

2.4 The influence of corporate entrepreneurship on organizational performance

Corporate entrepreneurship is a strategic variable in successful organizations (Antoncic and Hisrich, 2001; Antoncic and Prodan, 2008; Kanter, 1984). It is positively related to the firm's growth and profitability (Covin and Slevin, 1991; Zahra, 1993). Organizations that engage in entrepreneurial activities achieve higher levels of growth and profitability than organizations that do not (Antoncic and Hisrich, 2001). A study by Zahra and Garvis (2000) shows that international corporate US companies' entrepreneurship was positively associated with the firm's overall profitability and growth, as well as its foreign profitability and growth. Furthermore, corporate entrepreneurship enables organizational performance (Antoncic and Prodan, 2008). Entrepreneurs who identify their firms' positions in the competitive network of the industry correctly strengthen and engage new sales, financial capital and important decisions about alliances and joint projects (Batjargal, 2007). Wood and McKinley (2010) suggest that entrepreneurs are not simply filters and interpreters of information; rather, they are an integral part of opportunity emergence, as they invent part of what they believe to be viable in order to improve organizational performance (Weick, 1979).

Nevertheless, it is not expected that all firms will demonstrate strong corporate entrepreneurship and subsequently higher performance (Lengnick-Hall, 1992). For instance, some organizations avoid responding to the need for change as long as possible (Lengnick-Hall, 1992).

For technological organizations, various recent studies indicate a positive relationship between corporate entrepreneurship and organizational performance. Pearce *et al.* (2010) assert that corporate entrepreneurship has a positive effect on commercial organizations, as it leads to a beneficial first-mover advantage. Audretsch *et al.* (2008) show that positive economic performance in high-tech or information and communication technology companies depends on entrepreneurship capital, the capacity of a region to support entrepreneurs. Thus:

H6. Corporate entrepreneurship will be positively related to organizational performance in technological organizations.

3. Methodology

3.1 Sample and procedure

The population for this study consisted of technological organizations possessing the greatest turnover in Spain. Technological organizations are firms that place emphasis

on an orientation towards R&D and on innovativeness and entrepreneurship and that maintain a special pattern of work relations (a corporate culture of technology). These elements describe shared values, beliefs and symbols, as well as the way things are done in the firm (Grinstein and Goldman, 2006). The sample was selected by means of stratified sampling with proportional allocation (size and geographical location) from the database Dun & Bradstreet España, S.A. (2005). Choosing a sample of firms located in a relatively homogeneous geographical, cultural, legal and political space enables us to minimize the impact of the variables that cannot be controlled in the empirical research. The Spanish market is relatively well developed and wholly integrated in the European Union. However, Spain is in a geographical area that has received relatively little attention from organizational researchers in the field of technological competencies.

We developed a structured questionnaire to send to the CEOs of the organizations selected. CEOs were our main informants because they constitute a valuable source for evaluating and moulding the different variables under study throughout the organization by determining the types of behaviour that are expected and supported (Baer and Frese, 2003).

Surveys were mailed to the 1,000 selected organizations along with a cover letter. We used this method because it enabled us to reach a greater number of organizations at a lower cost, to exert less pressure for immediate reply, and to provide the interviewees with a greater sense of autonomy. The cover letter explained the goal of the study and offered recipients the option of receiving the results once the study was completed. It also explained that all responses obtained in the questionnaires would be used on an aggregate level to prevent the identification of any organization in order to reduce desirability bias.

We mailed each manager who had not yet responded two reminders. A total of 226 valid questionnaires were returned, but because of missing values only 201 questionnaires were included in the research. The response rate was 20.1 percent (Table I), and we found no significant difference between early and late respondents. The characteristics of the responding businesses were compared to those of the non-responding businesses to reduce the possibility of non-response bias. The results for return on assets (ROA), return on equity (ROE), return on sales and number of employees indicated that there was no significant difference between respondents and non respondents. Nor did we find significant differences due to geographical location

Sectors	High-tech services (computer science activities, research and development services, postal and telecommunications services), high-tech manufacturing (chemical industry; aerospace construction; radio, television and communications 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	1,000 (201) firms
Sample error	6.9 percent
Confidence level	95 percent, $p - q = 0.50$; $Z = 1.96$
Data collection period	From April 2010 to May 2010

Table I.
Technical details of the research

or size in the variables studied in the different tests, which included χ^2 and *t*-tests. Since all measures were collected with the same survey instrument, the possibility of common method bias was tested using Harman's one-factor test (Konrad and Linnehan, 1995). A principal components factor analysis of the questionnaire measurement items yielded four factors with eigenvalues greater than 1.0, which accounted for 71 percent of the total variance. A substantial amount of method variance does not appear to be present, since several factors, not just one single factor, were identified and because the first factor did not account for the majority of the variance (Podsakoff and Organ, 1986).

3.2 Measures

Given that developing new constructs or scales of measurement is a complex task, wherever possible, we use pre-tested constructs from past empirical studies to ensure the constructs' validity and reliability. Subsequently, we performed an exploratory factor analysis using the method of extraction of principal components with varimax rotation to provide a clear framework for the five factors of our study (Table II):

(1) *TMS*. Using scales established by Byrd and Davidson (2003) and Ray *et al.* (2005), we drew up a four-item scale (the Appendix) to reflect TMS. We developed a confirmatory factor analysis to validate our scales ($\chi^2_2 = 11.42$; NFI = 0.99; NNFI = 0.98; GFI = 0.99; CFI = 0.99). The scale was one-dimensional and showed high reliability ($\alpha = 0.926$).

(2) *TDCs*. Using scales established by Real *et al.* (2006), we drew up a six-item scale (the Appendix) to reflect TDCs in the organization. We developed

Items	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5
MANSUP1		0.82			
MANSUP2		0.72			
MANSUP3		0.753			
MANSUP4		0.782			
TECCO1	0.798				
TECCO2	0.666				
TECCO3	0.721				
TECCO4	0.783				
TECCO5	0.732				
TECCO6	0.427				
ORLEAR1			0.783		
ORLEAR2			0.801		
ORLEAR3			0.784		
ORLEAR4			0.662		
COREN1					0.538
COREN2					0.849
COREN3					0.553
COREN4					0.817
PERFO1				0.857	
PERFO2				0.863	
PERFO3				0.875	
PERFO4				0.589	
PERFO5				0.57	

Table II.
Exploratory factor analysis

a confirmatory factor analysis to validate our scales ($\chi_9^2 = 19.39$; NFI = 0.99; NNFI = 0.99; GFI = 0.99; CFI = 0.99). The scale was one-dimensional and showed high reliability ($\alpha = 0.917$).

(3) *OL*. We used the scale of four items developed by Aragón *et al.* (2007) and García-Morales *et al.* (2006, 2008) to measure OL (the Appendix). These items have been duly adapted to the present study. We developed a confirmatory factor analysis to validate the scales ($\chi_2^2 = 5.74$; NFI = 0.99; NNFI = 0.99; GFI = 0.99; CFI = 0.99) and showed that the scale was one-dimensional and had adequate validity and reliability ($\alpha = 0.908$).

(4) *Corporate entrepreneurship*. We used five items developed by Knight (1997) to measure proactiveness, five items developed by Zahra (1993) to measure new business venturing, eight items developed by Zahra (1993) to measure self-renewal, and six items developed by Zahra (1993) to measure organizational innovation. These items have been duly adapted to the present study (the Appendix). A seven-point Likert scale (1 – totally disagree, 7 – totally agree) for this and all prior variables allowed managers to express agreement or disagreement. We calculated the arithmetical mean of these items (a high score indicated a good level of proactiveness, new business venturing, self-renewal and organizational innovation) and obtained a four-item scale for corporate entrepreneurship. We developed a confirmatory factor analysis to validate the scale ($\chi_2^2 = 16.39$; NFI = 0.98; NNFI = 0.95; GFI = 0.99; CFI = 0.98) and showed that the scale was one-dimensional and had adequate validity and reliability ($\alpha = 0.867$).

(5) *Organizational performance*. We used the five-item scale developed by Murray and Kotabe (1999). The use of scales for evaluating performance relative to the main competitors is one of the most widely employed practices in recent studies (Choi *et al.*, 2008). Many researchers have used managers' subjective perceptions to measure beneficial outcomes for firms. Others have preferred objective data, such as ROA. The literature has established widely that there is high correlation and concurrent validity between objective and subjective data on performance, which implies that both are valid when calculating a firm's 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 their general views than to offering precise quantitative data. When possible, we calculated the correlation between objective and subjective data, and these were high and significant. We developed a confirmatory factor analysis to validate the scales ($\chi_5^2 = 34.92$; NFI = 0.97; NNFI = 0.95; GFI = 0.98; CFI = 0.97) and showed that the scale was one-dimensional and had high reliability ($\alpha = 0.867$). We used a seven-point Likert scale (1 – much worse than my competitors, 7 – much better than my competitors) to ask about the organization's performance as compared with that of its most direct competitors.

3.3 Model and analysis

The data were analyzed using a structural equation model (LISREL 8.30 program) to determine the existence of exogenous latent variables (TMS [ξ_1]), first-grade endogenous

latent variables (TDCs [η_1] and OL [η_2]), second-grade endogenous latent variables (corporate entrepreneurship [η_3] and organizational performance [η_4]) and to establish the causal relationships among these variables. This process allowed us to translate the theoretical constructs into mathematical models so that the constructs could be estimated and evaluated empirically (Jöreskog and Sörbom, 1996). The hypotheses are plotted graphically in the theoretical model shown in Figure 1. We used a recursive non-saturated model. Structural equation modelling takes into account errors in measurement, variables with multiple indicators and multiple-group comparisons.

4. Results

In this section, we present the main research results. First, Table III shows the means and standard deviations as well as the inter-factor correlation matrix for the study variables. There are significant and positive correlations among TMS, TDCs, OL, corporate entrepreneurship and organizational performance.

Second, a structural equations model was performed to estimate direct and indirect effects using LISREL with the correlation matrix as input. This type of analysis has

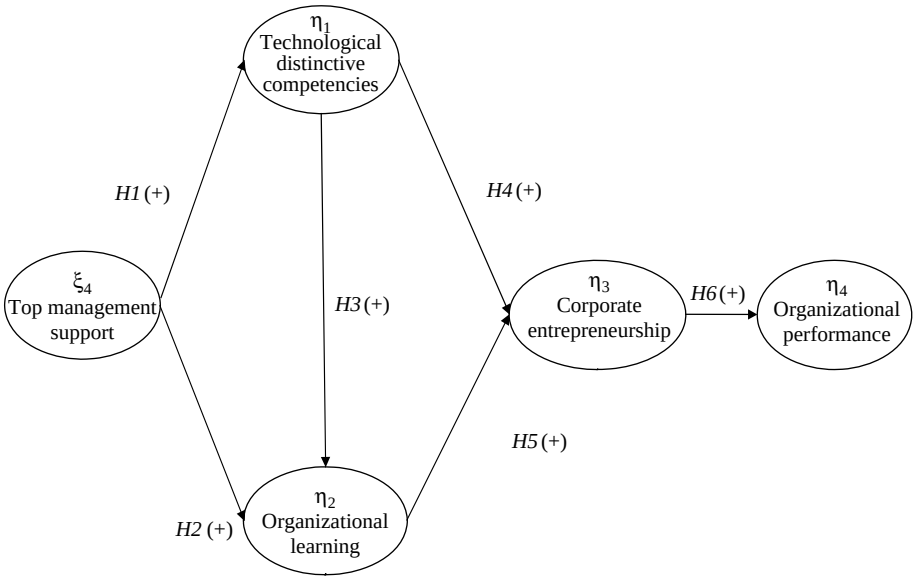

Figure 1.
Hypothesized model

Variable	Mean	SD	1	2	3	4	5
1. Top management support	4.706	1.438	1.000				
2. Tech. dist. competencies	4.664	1.273	0.748***	1.000			
3. Organizational learning	4.791	1.404	0.670***	0.681***	1.000		
4. Corporate entrepreneurship	4.339	1.154	0.637***	0.639***	0.641***	1.000	
5. Organizational performance	4.477	0.987	0.390***	0.466***	0.464***	0.505***	1.000

Notes: $n = 201$; $^{*}p < 0.05$, $^{**}p < 0.01$ and $^{***}p < 0.001$ (two-tailed)

Table III.
Means, standard deviations and correlations

the advantage of correcting for unreliability of measures and also gives information on the direct and indirect paths between multiple constructs after controlling for potentially confounding variables. Figure 2 shows the standardized structural coefficients. The relative importance of the variables is reflected by the magnitude of the coefficients.

Concerning the quality of the measurement model for the sample, the constructs display satisfactory levels of reliability, as indicated by composite reliabilities ranging from 0.84 to 0.92 and shared variance coefficients ranging from 0.57 to 0.87 (Table IV). Convergent validity can be judged by observing both the significance of the factor loadings and the shared variance. The amount of variance shared or captured by a construct should be greater than the amount of measurement error (shared variance > 0.50). All of the multi-item constructs meet this criterion, each loading (λ) being significantly related to its underlying factor (t-values > 15.55) in support of convergent validity. To assess discriminant validity, we performed a series of χ^2 difference tests on the factor correlations among all constructs (Anderson and Gerbing, 1988). We did this for each pair of latent variables by constraining the estimated correlation parameter between them to 1.0 and then performing a χ^2 difference test on the values obtained for the constrained and unconstrained models (Anderson and Gerbing, 1988). The resulting significant differences in χ^2 indicate that the constructs are not perfectly correlated and that discriminant validity is achieved.

The overall fit measures, multiple squared correlation coefficients of the variables (R^2s), and signs and significance levels of the path coefficients all indicate that the model

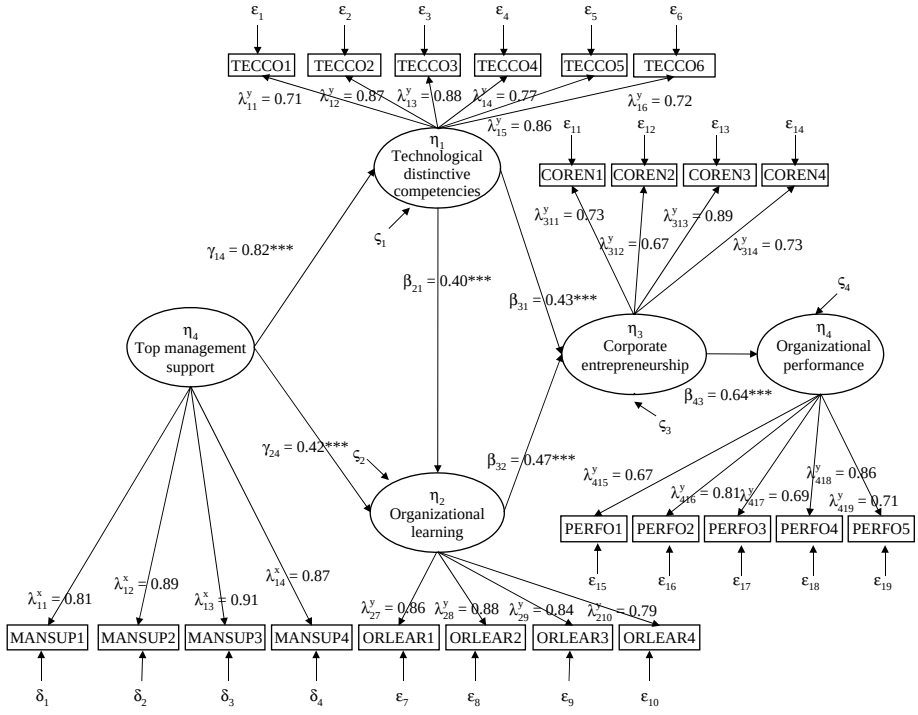

Figure 2.
Results of structural equation model

Variable	Item	Parameter	Validity, reliability and internal consistency λ^*	R^2	A.M.
Top management support	MANSUP1	λ^x_{11}	0.81^{***} (f.p.)	0.66	$\alpha = 0.926$
	MANSUP2	λ^x_{12}	0.89^{***} (23.13)	0.79	C.R. = 0.925
	MANSUP3	λ^x_{13}	0.91^{***} (23.28)	0.82	S.V. = 0.757
	MANSUP4	λ^x_{14}	0.87^{***} (22.88)	0.76	
Technological distinctive competencies	TECCO1	λ^y_{11}	0.71^{***} (f.p.)	0.50	$\alpha = 0.917$
	TECCO2	λ^y_{12}	0.87^{***} (22.76)	0.76	C.R. = 0.916
	TECCO3	λ^y_{13}	0.88^{***} (22.94)	0.78	S.V. = 0.877
	TECCO4	λ^y_{14}	0.77^{***} (21.63)	0.60	
	TECCO5	λ^y_{15}	0.86^{***} (22.69)	0.73	
	TECCO6	λ^y_{16}	0.72^{***} (21.21)	0.53	
Organizational learning	ORLEAR1	λ^y_{27}	0.86^{***} (f.p.)	0.74	$\alpha = 0.908$
	ORLEAR2	λ^y_{28}	0.88^{***} (23.17)	0.77	C.R. = 0.906
	ORLEAR3	λ^y_{29}	0.84^{***} (22.87)	0.70	S.V. = 0.708
	ORLEAR4	λ^y_{210}	0.79^{***} (22.44)	0.62	
Corporate entrepreneurship	COREN1	λ^y_{311}	0.73^{***} (f.p.)	0.54	$\alpha = 0.867$
	COREN2	λ^y_{312}	0.67^{***} (19.61)	0.51	C.R. = 0.849
	COREN3	λ^y_{313}	0.89^{***} (22.04)	0.80	S.V. = 0.588
	COREN4	λ^y_{314}	0.73^{***} (20.43)	0.54	
Organizational performance	PERFO1	λ^y_{415}	0.67^{***} (f.p.)	0.55	$\alpha = 0.867$
	PERFO2	λ^y_{416}	0.81^{***} (16.59)	0.65	C.R. = 0.872
	PERFO3	λ^y_{417}	0.69^{***} (15.84)	0.51	S.V. = 0.579
	PERFO4	λ^y_{418}	0.86^{***} (16.58)	0.74	
	PERFO5	λ^y_{419}	0.71^{***} (15.55)	0.50	

Notes: $^{*}p < 0.05$, $^{**}p < 0.01$ and $^{***}p < 0.001$ (two-tailed); λ^*, standardized structural coefficient; R^2, reliability; α, Cronbach's alpha; C.R., compound reliability; S.V., shared variance; f. p., fixed parameter; A.M., adjustment measurement

Table IV.
Validity, reliability and internal consistency

fits the data well ($\chi^2_{224} = 574.86$; $p > 0.001$; $\chi^2_{\text{ratio}} = 2.56$; NFI = 0.99; NNFI = 0.99; GFI = 0.99; CFI = 0.99; IFI = 0.99; PGFI = 0.80). The hypothesized model was a significantly better fit than the null model ($\chi^2_{253} = 11,984.91$; $p > 0.001$; $\Delta\chi^2_{29} = 11,410.05$; $p > 0.001$). All modification indices for the beta pathways between major variables were small, suggesting that additional paths would not significantly improve the fit. The residuals of the covariances were also small and centred around zero.

If we examine the standardized parameter estimates (Table V), the findings show that TMS ($\gamma_{11} = 0.82$; $p < 0.001$) is related to and affects TDCs, as predicted in *H1*. The model explains TDCs well ($R^2 = 0.67$). TMS affects the development of TDCs because human, conceptual, and technological competency are thought to be supported by managerial effectiveness (Benitez-Amado *et al.*, 2010). TMS also affects OL directly ($\beta_{21} = 0.42$; $p < 0.001$). Furthermore, we have shown an indirect effect (0.33; $p < 0.001$) of TMS on OL by TDCs (0.82×0.40; see Bollen (1989) for calculation rules). The global influence of TMS on OL is thus 0.75 ($p < 0.001$), supporting *H2*. TMS encourages development of OL processes, which enable generation of new technological abilities and knowledge (García-Morales *et al.*, 2006). TDCs affect OL ($\gamma_{21} = 0.42$; $p < 0.001$), supporting *H3*. TDCs also allow an organization to increase its capability to carry out actions that improve OL (Senge *et al.*, 1994). Comparing the

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

Effect from		To	Direct effects[a]	*t*-value	Indirect effects[a]	*t*-value	Total effects[a]	*t*-value
Top management support	→	Tech. dist. competencies	0.82****	16.34			0.82****	16.34
Top management support	→	Organizational learning	0.42****	4.35	0.33****	4.44	0.75****	16.73
Top management support	→	Corporate entrepreneurship			0.70****	16.59	0.70****	16.59
Top management support	→	Organizational performance			0.45****	14.44	0.45****	14.44
Tech. dist. competencies	→	Organizational learning	0.40****	4.27			0.40****	4.27
Tech. dist. competencies	→	Corporate entrepreneurship	0.43****	6.08	0.19****	3.72	0.62****	8.99
Tech. dist. competencies	→	Organizational performance			0.39****	8.64	0.39****	8.64
Organizational learning	→	Corporate entrepreneurship	0.47****	6.08			0.47****	6.08
Organizational learning	→	Organizational performance			0.30****	5.96	0.30****	5.96
Corporate entrepreneurship	→	Organizational performance	0.64****	16.81			0.64****	16.81
Goodness of fit statistics		$\chi^2_{224} = 574.86$ ($p > 0.01$); GFI = 0.99; AGFI = 0.99; ECVI = 3.39; AIC = 678.86; CAIC = 902.63; NFI = 0.99; NNFI = 0.99; IFI = 0.99; PGFI = 0.80; NCP = 350.86; RFI = 0.98; CFI = 0.99; RMSEA = 0.088						

Notes: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$ and ****$p < 0.10$; [a]standardized structural coefficients

magnitudes of these effects indicates that the effect of TMS on OL is larger than the effect of TDCs on OL. Globally, OL is explained well by the model ($R^2 = 0.61$).

Corporate entrepreneurship is influenced by TDCs ($\beta_{31} = 0.43$; $p < 0.001$) and OL ($\beta_{32} = 0.47$; $p < 0.001$), supporting *H4* and *H5*, respectively. Furthermore, we have shown an indirect effect (0.19; $p < 0.001$) of TDCs on corporate entrepreneurship by OL (0.40×0.47). The global influence of TDCs on corporate entrepreneurship is thus 0.62 ($p < 0.001$). Comparing the magnitudes of these effects indicates that the total effect of TDCs on corporate entrepreneurship is larger than the total effect of OL on corporate entrepreneurship. Globally, corporate entrepreneurship is explained well by the model ($R^2 = 0.71$).

TDCs and OL enhance the capacity and knowledge needed to discover and exploit entrepreneurial opportunities (Omerzel and Antoncic, 2008). Finally, we find a significant relationship of organizational performance with corporate entrepreneurship ($\beta_{43} = 0.64$; $p < 0.001$), supporting *H6*. Corporate entrepreneurship can increase companies' profits (Andreu and Ciborra, 1996; Shane and Venkataraman, 2000). Globally, the model explains organizational performance well ($R^2 = 0.41$). Other indirect effects are shown in Table V.

In testing the theoretical framework, we fit several nested models, each incorporating different assumptions about parameters. Comparisons with reasonable alternative models are recommended as a means of showing that a hypothesized model is the best representation of the data. Comparison is an important part of assessing model fit (Bollen and Long, 1993). The summary statistics in Table VI indicate that model 1 is preferred to the others, supporting the inclusion of a model with these relationships among the analyzed constructs. For example, if we compare the theoretical model (model 1) to a model that does not consider the relationship between corporate entrepreneurship and organizational performance (model 6), we see that the latter has a worse root mean square error of approximation ($>$RMSEA $= 0.008$), expected cross-validation index ($>$ECVI $= 0.30$), Akaike information criterion ($>$AIC $= 58.92$), consistent Akaike information criterion ($>$CAIC $= 58.92$) and estimated non-centrality parameter ($>$NCP $= 58.92$). Hence, the results show that corporate entrepreneurship affects organizational performance and that model 1 is preferred to model 6 ($\Delta\chi^2 = 58.92$; Δdf $= 1$). The theoretical model is also preferable to the other models formulated (Table VI). Length restrictions prevent detailed discussion of each model and of other

Description	χ^2	*df*	$\Delta\chi^2$	RMSEA	ECVI	AIC	NCP	CAIC
Theoretical	574.86	224		0.088	3.39	678.86	350.86	902.63
W.R. top man. support → org. learning	599.64	225	24.78	0.091	3.51	701.64	374.64	921.10
W.R. tech. dist. competencies → org. learning	590.80	225	15.94	0.090	3.46	692.89	365.89	912.36
W.R. tech. dist. competencies → corp. entrepreneurship	606.92	225	32.06	0.092	3.54	708.69	381.69	928.16
W.R. org. learning → corp. entrepreneurship	627.01	225	52.15	0.095	3.65	729.01	402.01	948.48
W.R. corp. entrepreneurship → org. performance	633.78	225	58.92	0.096	3.69	737.78	409.78	961.55

Notes: $n = 201$; W.R., without relationship

Table VI.
Model statistics against theoretical model

models (a full report is available from the authors). In sum, the proposed theoretical model represents (Figure 2) the preferred, i.e. the most acceptable and parsimonious, model.

5. Conclusions and future research

5.1 Discussion

The research results support the existence of a positive significant relationship between TMS and TDC. TDC development becomes possible if top managers obtain some funding and support their development. This support is not only financial (Petroni and Panciroli, 2002); it must include educational support, as all employees in the company should be trained to understand and achieve the distinctive competencies in technology (Andreu and Ciborra, 1996; Haro-Domínguez *et al.*, 2010; Leonard-Barton and Deschamps, 1988; Torkkeli and Tuominen, 2001). TMS is also significantly and positively related to OL. Top managers should motivate learning processes and promote courses for employees and lower managers to learn all of the knowledge generated by technological competencies to make their organization an intelligent organization that is difficult to imitate (Leonard-Barton, 1992; Lloréns-Montes *et al.*, 2005). The results of the research also support the conclusion that TDC encourages OL. Such learning must occur on all organizational levels to achieve excellent technological skills and specific technological knowledge (Lee *et al.*, 2001).

When TDCs and OL are promoted in the firm, opportunities emerge for entrepreneurs in the firm (Woolley, 2010). If technological organizations use their capacity to absorb new technology or to generate new advanced technological processes, they will exploit their TDCs and may obtain an outstanding advantage over other firms (Real *et al.*, 2006). The results also show that corporate entrepreneurship is promoted by OL, since the higher new knowledge acquired in the organization will increase the autonomy of different parts of the firm, allowing it to adopt more flexible structures to increase corporate entrepreneurship and enabling employees to be more creative (Antoncic and Hisrich, 2001; García-Morales *et al.*, 2006; Knight, 1997). Finally, the results show that corporate entrepreneurship will increase profits in the firm, whether sales or market share (Antoncic and Prodan, 2008; Lengnick-Hall, 1992; Murray and Kotabe, 1999). Corporate entrepreneurship is beneficial to the revitalization and performance of large corporations, as well as that of small and medium enterprises (Antoncic and Hisrich, 2001). Organizations that engage in entrepreneurial activities achieve higher levels of growth and profitability than organizations that do not (Antoncic and Hisrich, 2001), thereby obtaining higher performance (Antoncic and Prodan, 2008; Zahra, 1993).

5.2 Limitations and future research

Our investigation exhibits several limitations. 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 are related 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, using CEOs as respondents to questions on TMS or corporate entrepreneurship can provide valid measures (García-Morales *et al.*, 2008). However, it would have been preferable to interview questionnaires to other organizational

members to verify these variables. To confirm the validity of the CEOs' responses in the research, we sent the same questions to members of selected firms. The results were contrasted with those obtained in the main research survey using various tests to confirm that there were no significant differences between the research variables.

Third, 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) has argued that it is incorrect to assume that the use of a single method automatically introduces systematic bias, we recommend that future research gather measures of independent and dependent variables from different data sources to minimize the effects of any response bias (Podsakoff *et al.*, 2003).

Fourth, our data were cross-sectional, making it difficult to examine the evolution of the different variables in our study. This issue is of particular interest when 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 relationships and to detect possible reciprocal processes. We have tried to temper this limitation through attention to theoretical arguments by rationalizing the relationships analyzed and integrating temporal considerations into measurement of the variables (Hair *et al.*, 1999). Fifth, future studies should be based on a larger sample, preferably in more than one country. As this study focuses only on Spanish firms, a similar empirical research paper study in Europe could generalize the results throughout the European economy, and subsequently throughout the world.

Finally, the model only analyzes the relation of TDCs (influenced by TMS), TMS and OL on organizational performance through corporate entrepreneurship. The variables selected explain an acceptable amount of the variance in organizational performance. However, other constructs could be analyzed, such as absorptive capacity or knowledge management (García-Morales *et al.*, 2006; Nonaka and Takeuchi, 1995).

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Appendix

TMS

1. Top management cultivates technology project champions.
2. Top management ensures adequate funding of technology research and development.
3. Top management restructures work processes to leverage technology opportunities in the organization.
4. Top management facilitates technology transfer throughout the organization.

TDCs

The organization has:

1. Capability to obtain information about the status and progress of science and relevant technologies.
2. Capability to generate advanced technological processes.
3. Capability to assimilate new technologies and useful innovations.
4. Capability to attract and retain qualified scientific-technical staff.
5. Capability to dominate, generate or absorb basic and key business technologies.
6. Capability to establish efficient programs to develop technology from R&D units, providers and clients.

OL

In the last three years:

1. The organization has acquired and shared much new and relevant knowledge that provided competitive advantage.
2. The organization's members have acquired some critical capacities and skills that provided competitive advantage.
3. Organizational improvements have been influenced fundamentally by new knowledge entering the organization (knowledge used).
4. The organization is a learning organization.

Corporate entrepreneurship

In the last three years:

1. Proactiveness.
   - 1.1 In dealing with competitors, the organization is very often the first business to introduce new products/services, administrative techniques, operating technologies, etc.

1.2 In dealing with competitors, our organization typically adopts a very competitive, undo-the-competitors posture.

1.3 In general, top managers at our firm have a strong propensity for high risk projects (with chances of very high returns).

1.4 In general, top managers at our firm believe that, owing to the nature of the environment, bold, wide-ranging acts are necessary to achieve the firm's objectives.

1.5 When confronted with decision-making situations involving uncertainty, our organization typically adopts a bold, aggressive posture to maximize the probability of exploiting potential opportunities.

2. New business venturing.

2.1 The organization has stimulated new demands for existing products/services in current markets through aggressive advertising and marketing.

2.2 The organization has broadened the business lines in current industries.

2.3 The organization has pursued new business in new industries that are related to its current business.

2.4 The organization has found new niches for its products/services in current markets.

2.5 The organization has entered new businesses by offering new lines and products/services.

3. Self-renewal.

3.1 The organization has revised its business concept.

3.2 The organization has redefined the industries in which the company will compete.

3.3 The organization has reorganized units and divisions to increase organizational innovation.

3.4 The organization has coordinated activities among units to enhance organizational innovation.

3.5 The organization has increased the autonomy (independence) of different units to enhance their innovation.

3.6 The organization has adopted flexible organizational structures to increase innovation.

3.7 The organization has rewarded employees for creativity and innovation.

3.8 The organization has trained and encouraged employees to be creative and innovative.

4. Organizational innovation.

The organization has significantly increased:

4.1 Emphasis on developing new products/services.

4.2 Rate of new product/service introduction into the market.

4.3 Spending on new product/service development activities.

4.4 The number of products/services added by the organization and already existing in the market.

4.5 The number of new products/services introduced for first time in the market by the organization.

4.6 Percentage of revenue generated from new businesses/services that did not exist three years ago.

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

1. Organizational performance measured by ROA.
2. Organizational performance measured by ROE.
3. Organizational performance measured by return on sales.
4. Organization's market share in its main products and markets.
5. Growth of sales in its main products and markets.

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