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Technological variables and absorptive capacity's influence on performance through corporate entrepreneurship ☆

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ABSTRACT

Technology and corporate entrepreneurship constitute an important source of competitive advantage for organizations, as they enable the development and exploitation of new opportunities. This study proposes a model to analyze the effects of top management support for technology on the promotion of technological skills, absorptive capacity, and technological distinctive competencies. The research also considers the impact of technological skills and absorptive capacity on the development of technological distinctive competencies, analyzing the influence of these variables on organizational performance through corporate entrepreneurship. The study tests these relationships empirically using 160 European technology firms. The paper ends with discussion of the findings and provides several theoretical and practical implications for future research.

1. Introduction

Nowadays, technology constitutes one of the most valuable assets organizations possess, as technology facilitates growth and profitability (Zahra & Kirchhoff, 2005). Thus, understanding how organizations deploy their technological resources to achieve competitive advantage has become an important subject in current research (Huang, 2011).

Prior literature highlights the role that certain skills, capabilities, and competencies related to technology, as well as the acquisition and exploitation of knowledge (i.e., absorptive capacity), play in enabling business performance (Lee, Lee, & Pennings, 2001; Martín Rojas, García Morales, & García Sánchez, 2011). Yet, few studies analyze (1) how the role of top management support (TMS) of technology affects the promotion of these technological skills, competencies, and capabilities; and (2) the impact of developing such technological expertise and absorptive capacity on critical organizational variables such as corporate entrepreneurship, which is crucial for exploiting new business opportunities and may affect organizational performance (Antoncic & Hisrich, 2001; Hayton, 2005). The research also analyzes whether organizations can achieve higher levels of corporate entrepreneurship and organizational performance by fostering an advanced technological position and intense absorptive capacity, led by TMS of technology.

All technological variables need committed TMS to guide initiatives aimed at improving the development of technology within organizations (Ghosh, Tan, Tan, & Chan, 2001). Top management refers to the CEO (Chief Executive Officer) and his or her immediate subordinates, who are responsible for corporate policy (Bolívar Ramos, García Morales, & García Sánchez, 2012). In the resource-based view, top management represents one specific human capital resource that may differentiate pioneering firms. In fact, top management defines the technological strategy, which should aim to lead the organization to recognize, acquire, develop, and use technology to gain a competitive advantage (Lanctot & Swan, 2000).

As Liang, Saraf, Hu, and Xue (2007) show top managers' positive perceptions concerning the usefulness of technology result in specific managerial actions intended to assimilate technology. Thus, in a technological context, TMS represents the degree to which top management understands the importance of the technology function and the extent to which TMS is involved in technology activities that relate to technological success.

How TMS influences the development of technological skills, technological distinctive competencies (TDCs) and absorptive capacity is a critical issue for organizations, since companies are constantly under pressure to develop new skills and competencies and need to benefit from acquiring and exploiting knowledge flows as a means to remaining competitive (García Morales, Lloréns Montes, & Verdú Jover, 2007;

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Huang, 2011). This study defines technological skills as firm-specific techniques and scientific understanding (Leonard-Barton, 1992) embedded in individual employees, whereas TDCs represent the ability or expertise of the organization to apply scientific and technical knowledge through a series of routines and procedures to develop and improve products and processes (Real, Leal, & Roldán, 2006). The study in turn conceptualizes absorptive capacity as the ability of a firm to recognize the value of new, external information, assimilate it, and apply it to commercial ends (Cohen & Levinthal, 1990).

TMS may be a determinant in increasing the level of technological skills, as TMS is responsible for providing enough funds and commitment for technology training programs oriented toward improving employees' expertise in a given technological field (Bolívar Ramos et al., 2012). In addition, TMS influences the development of TDCs, since top management performs a leadership role in supporting innovation and technological development in dynamic and competitive environments (Huang, 2011).

TMS may be necessary to make companies more capable of accessing, assimilating, and applying knowledge to commercial ends. For example, TMS can influence information technology implementation and, in turn, promoting knowledge databases and other telecommunications, which may facilitate knowledge sharing and exploitation (Alavi & Leidner, 2001). This increase in the company's absorptive capacity may in turn affect the creation of TDCs, since these competencies have their roots in the knowledge base of the firm (Real et al., 2006).

The impact of technological skills, TDCs, and absorptive capacity on corporate entrepreneurship are additional issues the present investigation analyzes. Corporate entrepreneurship is defined as a process by which individuals inside organizations undertake new activities and are willing to depart from routines to pursue new opportunities (Zampetakis & Moustakis, 2010). Corporate entrepreneurship includes new business venturing, product/service/process innovation, self-renewal and proactiveness (Antoncic & Hisrich, 2001). Technological skills and TDCs positively influence corporate entrepreneurship because, as a platform of knowledge, they enable the development of new systems and processes and revision of the scope of the firm's operations to improve its responsiveness to its markets (Zahra, Nielsen, & Bogner, 1999). Moreover, absorptive capacity impacts corporate entrepreneurship, since it can considerably improve the ability to identify new opportunities (Zahra, Filatotchev, & Wright, 2009).

The research also responds to the need for fuller empirical exploration of corporate entrepreneurship's effects on organizational performance in the field of technology organizations (Bojica & Fuentes Fuentes, 2011; Martín Rojas et al., 2011). By adopting a risk-taking, innovative and proactive attitude, firms can take advantage of entrepreneurial opportunities and increase their financial and market performance (Antoncic & Hisrich, 2001; Hayton, 2005).

To achieve these objectives, this paper follows the following organization: Section 2 proposes and develops a number of empirically testable hypotheses. Section 3 presents the data and methodology used in this research. Section 4 explains the results. Finally, Section 5 discusses the implications of this study, presents some limitations, and establishes various lines for future research.

2. Theoretical framework and hypotheses

2.1. The influence of TMS on technological skills, absorptive capacity, and TDCs

TMS plays a critical role in enhancing employees' unique technological skills, which is crucial for organizational success (Martín Rojas et al., 2011).

One example of this importance occurs when a firm chooses to implement information technologies (IT). Lack of management support, measurable by the level of financing offered for IT, as well as the ease of technology transfer within the firm (Byrd & Davidson, 2003), dooms many IT processes to failure. Under these conditions, IT managerial abilities that cover the effective management of information systems—identification of and support for the appropriate IT projects, organization of adequate resources, leadership and motivation of teams, restructuring of work processes to take advantage offered, and collaboration with business units—can enable the development of IT technological skills. This capability stems from understanding, experience, and strategic planning, which render the firm capable of "adapt [ing] its hardware, software, networks and IT skills to ensure that IT can continue to support the firm's business strategy" (Tallon, 2008, p. 24).

Top management is the agent responsible for establishing changes in the values, norms, and organizational culture that eventually enable other organizational members to adapt to new technologies (Liang et al., 2007). The capabilities of promoting a technological proactive posture, developing a strategy that supports technology, and funding technology training programs demonstrate how TMS encourages the creation of stimulating work environments for technical employees to develop their skills (Byrd & Davidson, 2003; García-Morales, Ruiz-Moreno, & Lloréns-Montes, 2007). Thus:

H1. Higher levels of TMS lead to higher levels of technological skills in technology organizations.

TMS drives the company to improve its absorptive capacity and to be more innovative and proactive. TMS for technology facilitates access to external sources of knowledge and the creation of new communication channels with partner organizations, promoting the existence of strong absorptive capacity that stimulates the organization's innovative ability, flexibility, and responsiveness (Corso, Martini, Pellegrini, & Paoluci, 2003). In addition, TMS encourages an organizational culture based on knowledge that permits organizations to recognize the value of new information, assimilates what is relevant, and applies this information to commercial ends (Harrington & Guimaraes, 2005). Managers must support technology to search beyond current competencies and routines, nurturing absorptive capacity to detect trends, competitors, and relevant developments to obtain competitive advantage for the firm (Daft & Weick, 1984).

Internal processes of technological learning from past experience and current actions often enhance absorptive capacity. TMS develops organizational learning processes to obtain strategic knowledge which, through flexibility and adaptability, encourages absorptive capacity, and the increasing importance of strategic resources, what becomes one of the most significant concepts for strategic advantage (Camisón & Forés, 2010). Thus:

H2. Higher levels of TMS leads to higher levels of absorptive capacity in technology organizations.

Scholars have long recognized TMS as one of the most decisive factors ensuring successful implementation of distinctive competencies and technology (Ghosh et al., 2001; Leonard-Barton & Deschamps, 1988). Among these competencies, and linked to the field of technology, there are critical and core competencies called TDCs, which strengthen the firm's competitiveness on the global market (Lee et al., 2001).

The technological innovation literature views management support as an important power-tool to promote TDCs (Martín Rojas et al., 2011). This view stems from the fact that technological innovation opportunities derive from scientific discoveries, and top managers are the main granters of such scientific opportunities (Fontes, 2001). Support from top managers helps the firm to obtain more TDCs and competitive advantage by providing access to potential entrepreneurs (Byrd & Davidson, 2003; Fontes, 2001). In addition, TMS opens an opportunity for developing and exploiting nascent technology to generate new TDCs in a company (Giarratana & Torrisi, 2010).

Greater involvement of top management as suppliers of technology permits the identification of new complex technological projects by incorporating new knowledge and capabilities in the firm. These projects expand TDCs (Leonard-Barton & Deschamps, 1988), which help organizations to understand customers' needs better, improving competitiveness and enabling sustainable competitive advantage, since TDCs are truly difficult to replace and imitate (Huang, 2011; Lee et al., 2001). Consequently, TMS is vital to promoting and obtaining TDCs. Thus:

H3. Higher levels of TMS lead to higher levels of TDCs in technology organizations.

2.2. The influence of technological skills and absorptive capacity on TDCs

The literature shows technological skills to be important to the development of TDCs in all areas of an organization (Danneels, 2007). A reservoir of complementary skills and interests outside specific projects creates distinctive competencies (Prahalad & Hamel, 1990). The possession of certain skills is a necessary condition for exploiting competitive advantages and introducing new features in the development of the firm and its competences (Leonard-Barton, 1992). The best managers in technology companies earn their status by demonstrating remarkable skills that enable them to obtain TDCs (Leonard-Barton, 1992), which represent a significant advantage over competitors trying to enter the same market without access to such technologically sophisticated personnel (Danneels, 2007).

Among other technological variables in technology research, the personnel's technological skills promote TDCs in a company (Martín Rojas et al., 2011). Further, an innovation-supportive culture from top managers, which provides innovative technological skills, can generate business value, which translates into higher TDCs in the firm (Benitez Amado, Lloréns Montes, & Perez Arostegui, 2010).

In sum, if organizations train employees to obtain technological skills that are complex, tacit, and difficult to copy, organizations may benefit from TDCs (Leonard-Barton, 1992). Organizations that possess technological skills will improve their TDCs through the development of technological knowledge, which disseminates new technology in the company so as to achieve competitive advantage (Byrd & Turner, 2000). Thus:

H4. Higher levels of technological skills lead to higher levels of TDCs in technology organizations.

Absorptive capacity is a set of organizational practices and procedures by which firms acquire, assimilate, transform, and exploit external knowledge flows (Zahra & George, 2002). In the technology field, the combination of new acquired knowledge and technology helps organizations to develop TDCs and generates competitive advantage (Real et al., 2006).

The higher the absorptive capacity, the more effective the building of TDCs; this process keeps the firm competitive through innovations in its markets (Park & Rhee, 2012). In fact, the ability to take advantage of the TDCs in an organization will depend on the capacity to absorb prior relevant technological knowledge and the intensity of the effort applied to understand and learn about this knowledge (Cohen & Levinthal, 1990; García-Morales et al., 2007). As Wood and Weigel (2011) stress, the absorption of previous technological knowledge allows the construction of new TDCs, as the firm applies this knowledge in new scenarios where companies must absorb learning from outside the organization in order to obtain new TDCs. Further, companies build TDCs more successfully when they work with more technical advanced partners, absorbing more technological knowledge from them.

Absorptive capacity often results in technological innovations, operational and efficiency improvements, increased reliability and corporate adaptability, which lead to higher levels of organizational technological capabilities and competitiveness (Gupta & Thomas, 2001). Conversely, research confirms that the lack of local firms' absorptive capacity generally explains the absence of TDCs (Wood & Weigel, 2011). Thus:

H5. Higher levels of absorptive capacity lead to higher levels of TDCs in technology organizations.

2.3. The influence of technological skills, TDCs, and absorptive capacity on corporate entrepreneurship

Individual employees' skills specific to the pursuit of corporate entrepreneurship are fundamental to companies' ability to nurture and sustain innovation and new venture creation (Hayton & Kelley, 2006).

A positive association should thus exist between the high-technology firm's stock of intellectual capital—which includes skills such as technological skills—and its level of corporate entrepreneurship (Hayton, 2005).

Within the corporate entrepreneurship framework, organizations that wish to produce breakthrough ideas must emphasize domain-relevant skills and knowledge and a high degree of motivation in goal setting and response to challenges. Companies that do not possess the technological skills required to face continuous scientific and technological advances risk becoming trapped in established routines and practices, which limit their ability to adapt to market changes, develop new innovative solutions, and capture new opportunities (Savino & Messeni-Petruzzelli, 2012).

For companies that compete primarily in technologically advanced and sophisticated markets, science and technology provide a significant foundation for discovering new opportunities, which arise from market conditions and the firm's resources and skills (Zahra, 2008). This scenario accentuates the importance of technological skills to enable the mastery of technology, since employees seeking to promote corporate entrepreneurship need all of these skills to integrate existing and new knowledge and to recognize, evaluate, and capture entrepreneurial opportunities (Hayton & Kelley, 2006). Thus:

H6. Higher levels of technological skills lead to higher levels of corporate entrepreneurship in technology organizations.

Technologically competent firms develop systems and processes that allow them to implement new technical processes and tools, develop prototypes, and import technological knowledge from outside the firm. Using technological competencies to drive innovation promotes corporate entrepreneurship, since this process involves various forms of newness, such as sustained regeneration and organizational rejuvenation (Dess et al., 2003).

Companies that renew and develop TDCs through implementation of the appropriate technology strategy benefit from an ownership advantage that helps entrepreneurs to pursue new opportunities (Giarratana & Torrisi, 2010). Therefore, the generation of new competencies (such as TDCs) enlarges a firm's strategic options and enables the redefinition of its competitive arenas, while helping the company to pursue new markets (Zahra et al., 1999).

As Ahuja and Lampert (2001) show, firms must find a balance between undertaking activities that use what they already know and embarking on new activities to renew themselves and pursue corporate entrepreneurship. To achieve this objective, companies must renew their technological competencies; whose accumulation facilitates organizations' ability to respond effectively to new technological opportunities (Huang, 2011), thus improving their tendency to engage in corporate entrepreneurship (Antoncic & Prodan, 2008).

To sum up, the current business context, characterized by rapid technological change, requires a certain degree of technological diversification to keep up with rapid technological developments. In this scenario, firms may use different technological competencies to understand emerging opportunities and capitalize on promising new trends, stimulating corporate entrepreneurship (Hussinger, 2010). Thus:

H7. Higher levels of TDCs lead to higher levels of corporate entrepreneurship in technology organizations.

Absorptive capacity improves the company's existing knowledge base and encourages new knowledge creation activities that, in turn, influence entrepreneurial success (Bojica & Fuentes Fuentes, 2011).

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Moreover, absorptive capacity enables the exploitation and integration of external knowledge, which increases the likelihood of achieving better understanding of corporate entrepreneurship (Zahra et al., 1999).

Absorptive capacity affects competitive advantage through development of new products, processes, systems, and organizational forms, related to corporate entrepreneurship activities. The continuous pursuit and exploitation of new business opportunities—foundation of corporate entrepreneurship (Hayton & Kelley, 2006)—require the infusion of resources and new knowledge into the firms' operations from multiple external sources (Zahra et al., 2009). Therefore, firms which develop its absorptive capacity acquire and exploit knowledge from a variety of external sources (e.g., alliances) and exploit important resources and deploy them to support corporate entrepreneurship outcomes (Bojica & Fuentes Fuentes, 2011).

Technology ventures exploit breakthrough advancements in science and engineering to remain competitive (Antoncic & Prodan, 2008). In this scenario, high absorptive capacity fosters the recognition of opportunities to grow and create wealth through corporate entrepreneurship activities (Zahra et al., 2009). Thus:

H8. Higher levels of absorptive capacity lead to higher levels of corporate entrepreneurship in technology organizations.

2.4. The influence of corporate entrepreneurship on organizational performance

Organizations that engage in entrepreneurial activities tend to be more profitable than organizations that do not (Antoncic & Hisrich, 2001; Bojica & Fuentes Fuentes, 2011). Pearce, Fritz, and Davis (2010) assert that corporate entrepreneurship leads to a beneficial first-mover advantage. Consequently, the stronger the corporate entrepreneurship the company develops, the better its organizational performance. Similarly, firms that engage in corporate entrepreneurship can obtain significant financial benefits from their innovation, risk taking, and new business creation. This finding supports that entrepreneurial attitudes and behavior are necessary for firms of all sizes to prosper and flourish in competitive environments (Barringer & Bluedorn, 1999).

In industries with technological opportunities, engaging in corporate entrepreneurship and taking risks play an important role in a firm's success, as does simultaneously investing in the development of products and technologies (Antoncic & Prodan, 2008; Zahra & Covin, 1995). For technology organizations, recent studies indicate a positive relationship between corporate entrepreneurship and organizational performance (Bojica & Fuentes Fuentes, 2011). Zahra (1993) asserts that engaging in corporate entrepreneurship activities is a key factor to enhance the firm's growth and profitability. Thus:

H9. Higher levels of corporate entrepreneurship lead to higher levels of organizational performance in technology organizations.

3. Method

3.1. Sample and procedure

The population for this study consists of technology organizations within the European Union. The study focuses on manufacturing firms due to the interest inherent in carrying out a technological and entrepreneurship study on sectors with a large technological component. The sample (900 firms) comes from the Amadeus database. Drawing on the knowledge of dimensions of this investigation, previous contacts, and new interviews with managers and academics, the study developed a structured questionnaire to investigate how organizations face these issues.

This study uses CEOs as the key informants because they receive information from a wide range of departments and may evaluate the different variables of the organization (Bolívar Ramos et al., 2012). Likewise, the CEO is ultimately responsible for plotting the organization's direction and plans (Westphal & Fredickson, 2001).

First, the study uses stratified random sampling by country dividing the population into strata (based on the 10 EU countries analyzed: Austria, Belgium, Denmark, France, Germany, Italy, Poland, Spain, the Netherlands, and the United Kingdom). The research uses a random sampling procedure within each stratum. Systematic sampling in each stratum obtained 16 firms for each target country in the study (160 firms). The researchers put out a call to the CEOs and explained that the data obtained would be confidential and treated in aggregate form. Each CEO received a comparative study specific to his/her firm of the variables analyzed. This approach produced an approximate response rate of 17.7% (Table 1).

Technologies have played an important role in market globalization. For this reason, the literature advises performing the study within the framework of the EU countries. Comparing characteristics of responding businesses to those of non-responding businesses reduces the possibility of nonresponse bias. The results for return on assets, return on equity, return on sales, and number of employees indicate that there is no significant difference among respondents and non-respondents. Likewise, a series of chi-square and t-tests reveal no significant differences due to geographical location in the variables studied. Since the study collected all measures with the same survey instrument, the authors tested for the possibility of common method bias using Harman's one-factor test (see Konrad & Linnehan, 1995). A principal components factor analysis of the questionnaire measurement items yielded seven factors with eigenvalues greater than 1.0, which accounted for 67% of the total variance. Since the test identified several factors, not just a single factor, and since the first factor did not account for the majority of the variance, a substantial amount of common method variance does not appear to be present (Konrad & Linnehan, 1995).

3.2. Measures

3.2.1. Top management support

The study established a four-item scale from Byrd and Davidson (2003) and Ray, Muhanna, and Barney (2005). A confirmatory factor analysis validated the scale ($\chi^2{}_2 = 1.19$; Normed Fit Index, NFI = .99; Non-Normed Fit Index, NNFI = .99; Goodness of Fit Index, GFI = .99; Comparative Fit Index, CFI = .99). The scale was unidimensional and showed high reliability ($\alpha = .80$).

3.2.2. Technological skills

The study established a scale of four items from Ray et al. (2005) and Byrd and Davidson (2003). A confirmatory factor analysis ($\chi^2{}_2 = 3.11$; NFI = .99; NNFI = .99; GFI = .99; CFI = .99) validated and then verified each scale's unidimensionality and its high validity and reliability ($\alpha = .82$).

3.2.3. Absorptive capacity

The research used three items to measure knowledge acquisition, two items to measure knowledge assimilation, four items to measure knowledge transformation, and two items to measure knowledge exploitation and adapted the items, developed by Jiménez Barrionuevo, García Morales, and Molina (2011), to the present study. The researchers calculated the arithmetical mean of these items (a high score indicates good level of knowledge acquisition, knowledge assimilation, knowledge transformation, and knowledge exploitation) and obtained a four-item scale for absorptive capacity. A confirmatory factor analysis then validated this scale ($\chi^2{}_2 = 1.91$; NFI = .99; NNFI = .99; GFI = .99; CFI = .99) and showed that it is one-dimensional and has adequate validity and reliability ($\alpha = .79$).

3.2.4. Technological distinctive competencies

The research drew up a six-item scale to reflect TDCs from Real et al. (2006), and used a confirmatory factor analysis to validate the scale

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Table 1
Technical details of the research.

Country	Austria	Belgium	Denmark	France	Germany	Italy	Poland	Spain	The Netherlands	United Kingdom	Total
Sample size (% response)	125 (12.80%)	105 (15.23%)	118 (13.55%)	96 (16.66%)	72 (22.22%)	84 (19.04%)	87 (18.39%)	75 (21.33%)	70 (22.85%)	68 (23.52%)	900 (17.7%)
Op. revenue	158,468,892€	174,995,941€	227,957,257€	173,026,527€	336,097,975€	127,836,965€	53,343,738€	183,813,995€	388,588,275€	343,195,409€	216,732,497€
Assets	158,718,963€	270,510,461€	207,372,794€	211,912,824€	345,232,318€	146,907,477€	42,869,362€	275,075,014€	422,027,487€	350,885,241€	243,151,194€
Net incomes	8,288,139€	16,910,688€	5,582,612€	5,834,306€	9,631,181€	4,568,700€	1,863,353€	13,901,301€	24,521,259€	20,807,065€	11,190,860€
Cash flow	16,500,933€	23,135,747€	17,568,782€	13,046,066€	28,664,982€	11,797,118€	4,466,118€	24,778,907€	56,002,029€	38,013,436€	23,397,411€
Own funds	117,854,931€	242,044,196€	147,589,537€	121,995,552€	216,388,135€	97,777,509€	41,365,365€	164,166,752€	284,084,600€	247,120,624€	168,038,720€
Sectors	High-tech manufacturing (pharmaceutical industry, hardware and other computer science equipment, automotive industry, space, and aeronautics products)										
Methodology	Structured questionnaire										
Universe of population	5441 firms										
Sample error	7.7%										
Confidence level	95%, p–q = 0.50; Z = 1.96										
Data collection Period	From May 2010 to September 2010										

($\chi^2_9 = 22.23$; NFI = .94; NNFI = .94; GFI = .98; CFI = .96). The scale was one-dimensional and showed high reliability ($\alpha = .86$).

3.2.5. Corporate entrepreneurship

The research used four items developed by Knight (1997) to measure proactiveness, four items developed by Zahra (1993) to measure new business venturing, four items developed by Zahra (1993) to measure self-renewal, and four items developed by Zahra (1993) to measure organizational innovation. The present study adapted these items. The researchers calculated the arithmetical mean of these items (a high score indicates good level of proactiveness, new business venturing, self-renewal, and organizational innovation) and obtained a four-item scale of corporate entrepreneurship. They then developed a confirmatory factor analysis to validate this scale ($\chi^2_2 = 3.82$; NFI = .99; NNFI = .99; GFI = .99; CFI = .99) and showed that the scale was one-dimensional and had good validity and reliability ($\alpha = .83$).

3.2.6. Organizational performance

The investigation used a 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. The literature has established widely that a high correlation and concurrent validity exist between objective and subjective data on performance, which implies that both are valid when calculating a firm's performance (Venkatraman & Ramanujam, 1986). The research 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, the investigation calculated the correlations between objective and subjective data, and these were high and significant. A confirmatory factor analysis to validate the scale ($\chi^2_5 = 20.86$; NFI = .94; NNFI = .91; GFI = .98; CFI = .96) showed that the scale was unidimensional and had high reliability ($\alpha = .84$). Items are described in Table 2.

3.3. Model and analysis

The research used LISREL's 8.80 program to test the theoretical model postulated in Fig. 1. The study involved one exogenous latent variable (TMS [ξ_1]), first-grade endogenous latent variables (technological skills [η_1] and absorptive capacity [η_2]), and second-grade endogenous latent variables (TDCs [η_3], corporate entrepreneurship [η_4] and organizational performance [η_5]).

4. Results

This section presents the main research results. Consistent with the two-step approach advocated by Anderson and Gerbing (1988), the paper estimates a measurement model before examining structural model relationships. First, the investigation assesses the quality of the measurement models for the full sample to establish valid constructs. Table 3 indicates the standardized structural coefficients, Cronbach's alpha, composite reliability, and average variance extracted. The Cronbach's alpha values are above the minimum recommended value of 0.7 and the constructs display satisfactory levels of reliability, as indicated by composite reliabilities ranging from 0.817 to 0.864 (composite reliabilities > 0.7, Fornell & Larcker, 1981) and average variance extracted ranging from 0.51 to 0.61. Examining both the significance of the factor loadings and the average variance extracted determines convergent validity, the extent to which maximally different attempts to measure the same concept agree. The amount of variance shared or captured by a construct should be greater than the amount of measurement error (average variance extracted > 0.5, Fornell & Larcker, 1981). All of the multi-item constructs meet this criterion, and each loading (λ), relates significantly to its underlying factor (t-values greater than 6.54) in support of convergent validity. The items in each scale

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Table 2
Measures.

Top management support (1 "Completely disagree", 7 "Completely agree").
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.

Technological skills (1 "Completely disagree", 7 "Completely agree"). The skills of the people in the department/unit of technology are very superior to:
1. Closest competitors in hardware and operating systems performance.
2. Closest competitors in business applications software performance.
3. Closest competitors in communications services efficiency.
4. Closest competitors in the generation of programming languages.

Absorptive capacity (1 "Completely disagree", 7 "Completely agree"). Think of an organization that has had frequent contact with your organization over the past three years, or with which you would like to have had contact in order to obtain or exchange new information or useful knowledge to perform the business of the organization.
1. Knowledge acquisition.
 1.1. Close personal interaction exists between the two organizations.
 1.2. The relationship between the two organizations is characterized by mutual trust.
 1.3. The relationship between the two organizations is characterized by a high level of reciprocity.
2. Knowledge assimilation.
 2.1. The organizational cultures of the two organizations are compatible.
 2.2. The operating and management styles of the two organizations are compatible.
3. Knowledge transformation.
 3.1. Interdepartmental meetings are organized to discuss the development and tendencies of the organization.
 3.2. Important data are transmitted regularly to all units.
 3.3. When something important occurs, all units are informed within a short time.
 3.4. The organization has the capabilities or abilities necessary to ensure that knowledge flows within the organization and is shared among the different units.
4. Knowledge exploitation.
 4.1. The division of functions and responsibilities regarding use of information and knowledge obtained from the outside is clear.
 4.2. The organization has the capabilities and abilities needed to exploit the information and knowledge obtained from the outside.

Technological distinctive competencies (1 "Completely disagree", 7 "Completely agree"). The organization has:
1. Capability to obtain information about the status and the 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 its qualified scientific-technical staff.
5. Capability to dominate, generate, or absorb basic and key technologies of business.
6. Effectiveness in setting up programs oriented to internal development of technological or technology absorption competencies, from either R&D centers or suppliers and customers.

Corporate entrepreneurship (1 "Completely disagree", 7 "Completely agree"). In the last three years:
1. New business venturing.
 1.1. The organization has stimulated new demands on the existing products/services in current markets through aggressive advertising and marketing.
 1.2. The organization has broadened the business lines in current industries.
 1.3. The organization has pursued new businesses in new industries related to current business.
 1.4. The organization has entered new businesses by offering new lines and products/services.
2. Organizational innovation. The organization has significantly increased:
 2.1. The spending on new product/service development activities.
 2.2. The number of products/services added by the organization and already existing in the market.
 2.3. The number of new products/services that the organization introduces for first time in the market.
 2.4. The emphasis on R&D, technological leadership, and innovations.
3. Proactiveness.
 3.1. In dealing with competitors, the organization is very often the first business to introduce new products/services, administrative techniques, operating technologies, etc.
 3.2. In general, the top managers at this firm have a strong inclination toward high risk projects (with chances of very high returns).
 3.3. In general, the top managers at this firm believe that, owing to the nature of the environment, bold wide-ranging acts are necessary to achieve the firm's objectives.

Table 2 (*continued*)

Corporate entrepreneurship (1 "Completely disagree", 7 "Completely agree"). In the last three years:
 3.4. When confronted with decision-making situations involving uncertainty, this organization typically adopts a bold, aggressive posture in order to maximize the probability of exploiting potential opportunities.
4. Self-renewal.
 4.1. The organization has reorganized units and divisions to increase organizational innovation.
 4.2. The organization has coordinated activities among units to enhance organizational innovation.
 4.3. The organization has adopted flexible organizational structures to increase innovation.
 4.4. The organization has trained and encouraged the employees to be creative and innovative.

Organizational performance (1 "Much worse than my competitors", 7 "Much better than my competitors"). 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 return on assets (ROA).
2. Organizational performance measured by return on equity (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.

contain less than 50% error variance and converge on one construct (Anderson & Gerbing, 1988).

The measurements also achieve discriminant validity, the degree to which a construct differs from others, among all constructs. The squared correlation between each pair of constructs is lower than the levels of average variance extracted (Table 4). Further, no confidence interval in the estimation of the correlation between each pair of factors contains the value 1 (Anderson & Gerbing, 1988; Fornell & Larcker, 1981). The measurement model's fit is good (χ^2 Sat. B. (309 d.f.) = 356.12 ($p > 0.01$); NFI = 0.94; NNFI = 0.99; IFI = 0.99; PGFI = 0.66; NCP = 47.71; RFI = 0.93; CFI = 0.99; RMSEA = 0.031).

Second, this section presents the results for the structural model in Fig. 2 and Table 5. Structural equation modeling estimates the direct and indirect effects. Fig. 2 shows the standardized structural coefficients. The analysis uses the robust maximum likelihood procedure (Satorra & Bentler, 1988). 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 fits the data well (χ^2 Sat. B. (315 d.f.) = 370.19 ($p > 0.01$); NFI = 0.93; NNFI = 0.99; IFI = 0.99; PGFI = 0.67; NCP = 55.19; RFI = 0.93; CFI = 0.99; RMSEA = 0.033).

Examination of the standardized parameter estimates (Table 6) shows that TMS is closely related to and affects technological skills ($\gamma_{11} = .67$, $p < .001$, $R^2 = .45$), absorptive capacity ($\gamma_{21} = .22$, $p < .05$, $R^2 = .22$), and TDCs ($\gamma_{31} = .45$, $p < .01$), as predicted in H1, H2 and H3, respectively. The research also shows an indirect effect (.26, $p < .01$) of TMS on TDCs through technological skills (.67 × .31; see, for instance, Bollen, 1989 for calculation rules) and absorptive capacity (.22 × .24). The global influence of TMS on TDCs is thus 0.71 ($p < .001$). Comparing the magnitudes of these effects indicates that the influence of TMS on TDCs is larger than the total effect of TMS on technological skills or absorptive capacity. Technological skills ($\beta_{31} = .31$, $p < .05$) and absorptive capacity ($\beta_{32} = .22$, $p < .01$) also influence TDCs, supporting H4 and H5, respectively. Comparing the magnitudes of these effects indicates that the total influence of TMS on TDCs is larger than the effect of technological skills or absorptive capacity on TDCs. Globally, the model explains TDCs well ($R^2 = .58$).

Technological skills ($\beta_{41} = .29$, $p < .01$), TDCs ($\beta_{43} = .36$, $p < .05$) and absorptive capacity ($\beta_{42} = .36$, $p < .01$) influence corporate entrepreneurship, supporting Hypotheses 6, 7, and 8, respectively. Further, the research shows an indirect effect (.11, $p < .10$) of technological skills on corporate entrepreneurship through TDCs (.31 × .36) and an indirect effect (.08, $p < .05$) of absorptive capacity on corporate

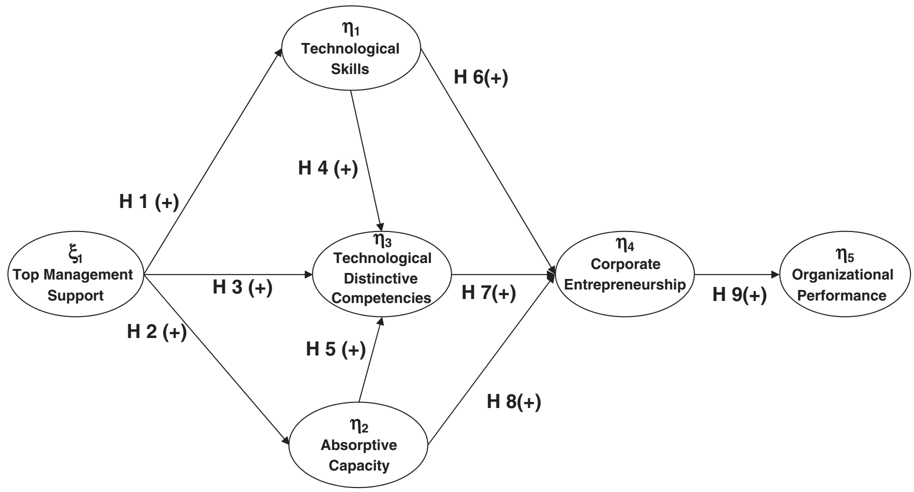

Fig. 1. Hypothesized model.

entrepreneurship through TDCs (.24 × .36). The global influence of technological skills on corporate entrepreneurship is thus 0.40 ($p < .001$), and of absorptive capacity on corporate entrepreneurship, 0.44 ($p < .001$).

Comparing the magnitudes of these effects indicates that the total effect of absorptive capacity on corporate entrepreneurship is greater than the effect of technological skills or TDCs on corporate entrepreneurship. Globally, the model explains corporate entrepreneurship well ($R^2 = .61$). Finally, organizational performance shows a significant relationship to corporate entrepreneurship ($\beta_{54} = .42$, $p < .001$, $R^2 = .18$), supporting H9. In addition to these effects, the research demonstrates other indirect effects (Table 5).

In testing the theoretical framework, the investigation fits several nested models, each incorporating different assumptions about parameters. Comparisons to reasonable alternative models can show that a hypothesized model is the best representation of the data. Comparison is an important part of assessing model fit. The summary statistics in Table 6 indicate the preference of Model 1 over the others, supporting the inclusion of a model with these relationships among the constructs analyzed. For example, comparison of a theoretical model (Model 1) to a model that does not consider the relationship between technological skills and corporate entrepreneurship (Model 5) shows that the latter yields a worse expected cross-validation index (>ECVI = .03), Akaike information criterion (>AIC = 4.95), and estimated non-centrality parameter (>NCP = 5.95). Hence, the results show that technological skills affect corporate entrepreneurship and that Model 1 is preferable to Model 5 ($\Delta\chi^2 = 6.95$, Δd.f. = 1, $p = 0.04$). The theoretical model is also preferable to the other models formulated (Table 6). The proposed theoretical model represents (Fig. 2) the preferred and the most acceptable and parsimonious, model.

Table 3
Measurement model results.

Variable	Item	Mean (S.D.)	λ* (t-values)	α	C.R.	A.V.E.	Goodness of fit statistics
Top management support (TMS)	MANSUP1	5.25 (1.22)	0.77***(10.72)	0.80	C.R. = 0.85	A.V.E. = 0.58	χ^2_{309} Sat. B. = 356.12
	MANSUP2		0.80***(9.43)				($p > 0.01$)
	MANSUP3		0.75***(7.70)				ECVI = 3.11
	MANSUP4		0.75***(7.48)				AIC = 494.71
Technological skills (TS)	TECSK1	4.90 (1.30)	0.73***(7.75)	0.82	C.R. = 0.83	A.V.E. = 0.55	CAIC = 775.90
	TECSK2		0.76***(9.98)				NFI = 0.94
	TECSK3		0.80***(11.92)				NNFI = 0.99
	TECSK4		0.68***(9.69)				IFI = 0.99
Absorptive capacity (AC)	KACQUI1	5.10 (1.26)	0.62***(6.70)	0.79	C.R. = 0.81	A.V.E. = 0.53	PGFI = 0.66
	KASSIM2		0.69***(7.48)				NCP = 47.71
	KTRANSF3		0.77***(8.43)				RFI = 0.93
	KEXPLOI4		0.82***(8.85)				CFI = 0.99
Technological distinctive competencies (TDCs)	TECCO1	5.18 (1.15)	0.66***(8.70)	0.86	C.R. = 0.86	A.V.E. = 0.51	RMSEA = 0.03
	TECCO2		0.69***(9.05)				
	TECCO3		0.77***(8.99)				
	TECCO4		0.66***(8.51)				
	TECCO5		0.77***(11.02)				
	TECCO6		0.75***(9.64)				
Corporate entrepreneurship (CE)	NBVEN1	4.72 (1.24)	0.78***(8.21)	0.83	C.R. = 0.86	A.V.E. = 0.61	
	INNOV2		0.82***(10.95)				
	PROAC3		0.68***(7.96)				
	SELFR4		0.84***(12.02)				
Organizational performance (OP)	PERF1	4.68 (1.22)	0.67***(7.78)	0.84	C.R. = 0.85	A.V.E. = 0.54	
	PERF2		0.77***(6.54)				
	PERF3		0.74***(9.52)				
	PERF4		0.81***(10.68)				
	PERF5		0.68***(7.29)				

Note: S.D. = standard deviation; λ* = standardized structural coefficient; C.R. = compound reliability; A.V.E. = average variance extracted; *$p < .05$; **$p < .01$; ***$p < .001$ (two-tailed).

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Table 4
Discriminant validity assessment.

Variable	1	2	3	4	5	6
1. TMS	0.58	0.47–0.84	0.01–0.39	0.52–0.85	0.54–0.83	0.25–0.65
2. Technological skills	0.43	0.55	(−0.08)–0.28	0.49–0.77	0.36–0.70	0.12–0.55
3. Absorptive capacity	0.04	0.01	0.53	0.17–0.53	0.33–0.72	0.03–0.41
4. TDCs	0.46	0.39	0.12	0.51	0.51–0.78	0.21–0.59
5. Corporate entrepreneurship	0.47	0.28	0.27	0.40	0.61	0.20–0.59
6. Organizational performance	0.20	0.10	0.04	0.16	0.16	0.54

Note: Numbers on the diagonal show the AVE. Numbers below the diagonal represent the squared correlation between the constructs. Numbers above the diagonal represent the confidence interval between each pair of constructs (95%).

5. Discussion, limitations, and future research

5.1. Discussion

The results of this research stress that exploiting technologically skilled people and the development of technological distinctive competencies increase corporate entrepreneurship (Berry, 1996). In this regard, managers play a key role in the firm, as they weigh important strategic decisions and a firm's ability to acquire, assimilate, and generate commercializable outputs from new external knowledge. They must develop the firm's absorptive capacity (Zahra & George, 2002), which impacts access to the technology in the firm (Cohen & Levinthal, 1990; Leonard-Barton, 1992).

TMS is thus absolutely essential in the era of global scale and knowledge-based economy. Firms benefiting from the more technology-based knowledge provided by TMS may increase their potential for the creation and shaping of cooperative structures and new developments (Gallego, Rubalcaba, & Suárez, 2013) oriented to generating new combined absorptive capacity between different innovators that permit the development of TDCs and corporate entrepreneurship.

Despite studies in this area, the literature still lacks an empirical understanding of the theoretical assertions concerning technological skills, absorptive capacity, TDCs, and corporate entrepreneurship. This paper studies the importance of support, both financial and strategic, provided by top managers to develop the firm's technological skills (Baptista, Karaöz, & Mendoça, 2007; Leonard-Barton, 1992), enrich its knowledge base and improve its ability to assimilate and exploit (related and diverse) external knowledge through absorptive capacity and strength. Managers apprehend TDCs through intuitive understanding and give them robust shape as indicators of competencies and dynamism (Banerjee, 2003).

All of these findings jointly engage entrepreneurial acts. Those variables impact corporate entrepreneurship, increasing variety and expanding the search for technological opportunities (Rerup, 2005). The use of technological skills, which promote a technologically proactive attitude in the firm's employees (García-Morales et al., 2007), thus strengthens corporate entrepreneurship. The firm's absorptive capacity also shapes this entrepreneurial behavior, which permits the company to develop learning processes that may achieve a complex knowledge structure affected by both the nature of initial experience and the cognitive attributes of entrepreneurs (Camisón & Forés, 2010; García Morales, Jiménez Barrionuevo, & Gutiérrez Gutiérrez, 2012).

Recently, TDCs that encourage and enable the firm's entrepreneurs to identify potential market opportunities and determine how to act on them to obtain an outstanding advantage have motivated corporate entrepreneurship (Martín Rojas et al., 2011). TDCs open a space of opportunity to develop and exploit nascent technology that is truly difficult to imitate (Alvarez & Barney, 2007) and may differentiate the firm from others in the market (Lee et al., 2001). In addition, the

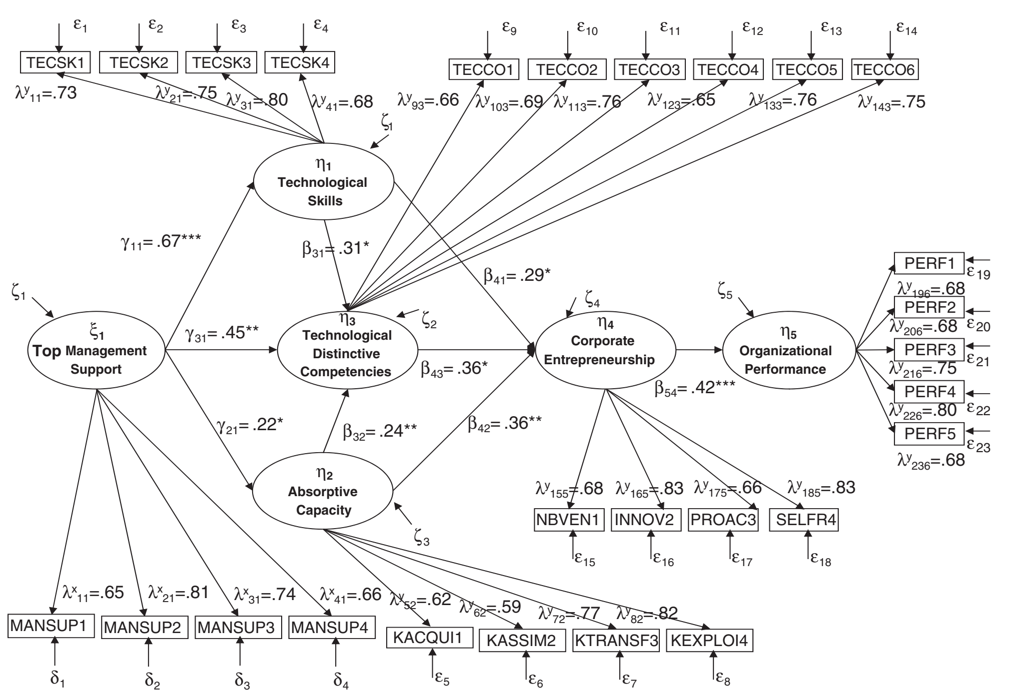

Fig. 2. Results of structural equation model.

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Table 5
Structural model result (direct, indirect, and total effects).

Effect from	To	Direct effects	t	Indirect effects	t	Total effects	t	Hypotheses
TMS	→ Technological skills	0.67^{***}	4.47	0.67^{***}			4.47	Hypothesis 1
TMS	→ Absorptive capacity	0.22^{*}	2.23			0.22^{*}	2.23	Hypothesis 2
TMS	→ TDCs	0.45^{**}	2.60	0.26^{**}	2.98	0.71^{***}	4.69	Hypothesis 3
TMS	→ Corporate entrepreneurship			0.53^{***}	4.81	0.53^{***}	4.81	
TMS	→ Organizational performance			0.22^{**}	2.97	0.22^{**}	2.97	
Technological skills	→ TDCs	0.31^{*}	2.07			0.31^{*}	2.07	Hypothesis 4
Technological skills	→ Corporate entrepreneurship	0.29^{*}	2.22	0.11	1.62	0.40^{***}	3.54	Hypothesis 6
Technological skills	→ Organizational performance			0.17^{**}	2.99	0.17^{**}	2.99	
Absorptive capacity	→ TDCs	0.22^{**}	2.94			0.22^{**}	2.94	Hypothesis 5
Absorptive capacity	→ Corporate entrepreneurship	0.36^{**}	3.27	0.08^{*}	2.38	0.44^{***}	4.35	Hypothesis 8
Absorptive capacity	→ Organizational performance			0.19^{***}	3.45	0.19^{***}	3.45	
TDCs	→ Corporate entrepreneurship	0.36^{*}	2.22			0.36^{*}	2.88	Hypothesis 7
TDCs	→ Organizational performance			0.15^{*}	2.14	0.15^{*}	2.14	
Corporate entrepreneurship	→ Organizational performance	0.42^{***}	3.53			0.42^{***}	3.53	Hypothesis 9
Goodness of fit statistics	χ^2_{315} Sat. B. = 370.19 (p > 0.01) ECVI = 3.12 AIC = 496.19 CAIC = 752.92 NFI = 0.93 NNFI = 0.99 IFI = 0.99 PGFI = 0.67 NCP = 55.19 RFI = 0.93 CFI = 0.99 RMSEA = 0.03							

Note: n = 160.
* $p < .05$ (two-tailed).
** $p < .01$ (two-tailed).
*** $p < .001$ (two-tailed).

corporation's entrepreneurial capacity emphasizes the importance of innovating and adopting a long-term view in determining a new firm's performance with a sustainable competitive advantage (Zahra, 1993).

5.2. Limitations and future research

This investigation has several limitations. A first limitation involves the cross-sectional nature of the research. Cross-sectional research into a series of dynamic concepts (e.g., corporate entrepreneurship, absorptive capacity) allows analysis only of a specific situation in time of the organizations studied, not their overall conduct through time. This study's approach reduces the magnitude of this problem by enabling dynamic characteristics and causal affirmations when the relationships are based on theoretical rationales. For this reason, the study begins with a theoretical effort that allows identification and confirmation of the formal existence of the different cause–effect relationships. Nonetheless, future research should focus on longitudinal study.

Second, the cross-sectional nature of the research introduces another potential limitation—common method bias. The authors were aware of this possibility, however, and took steps to guard against this bias. Podsakoff, MacKenzie, Lee, and Podsakoff (2003) provide guidance to reduce common-source bias in this regard, stressing two key goals: 1) to ensure anonymity in survey administration; and 2) to improve items used to measure constructs. The study followed both recommendations. By clearly communicating study goals and assuring respondents of the survey's anonymity, the investigation meets a key recommendation of Podsakoff et al. (2003), that well-tested and -validated scales reduce item ambiguity. In measuring study constructs, the research also relies on previously tested scales. Finally, the research randomized the order of presentation of the survey items across the subjects. These steps together minimize common method bias (Pandey, Wright, & Moynihan, 2008). The investigation also tested the possibility of common method bias using Harman's one-factor test and other methods, and this bias does not appear to be present (Konrad & Linnehan, 1995).

Third, the absence of objective measures is a limitation. Anonymity plays an important role in increasing the value of these subjective measures and reducing social desirability bias for responses related to sensitive topics. The low risk of social desirability bias in this study became clear from several managers who commented that going beyond regulatory compliance made no sense at all for their companies. Other studies indicate that external validation of these variables from the archival data of a subset of respondents increases confidence in self-reports and reduces the risk of common method variance (Konrad & Linnehan, 1995).

Thus, to confirm the validity of the information provided by the CEO in this research, members of several selected firms provided additional information. The research used various tests to contrast the results with those obtained in the main research survey to confirm that no significant differences existed between the research variables. Where possible, the authors calculated the correlations between objective and subjective data for some variables (e.g., organizational performance), and these were high and significant. Other studies show that using CEOs as respondents to questions on TMS or corporate entrepreneurship can provide valid measures (Bolívar Ramos et al., 2012; Martín Rojas et al., 2011). Future studies could analyze a larger sample and use firms from other sectors, as well as integrating the influence of external factors explicitly.

Table 6
Model statistics against theoretical model.

Model	Description	χ^2 Sat. B.	d.f.	$\Delta\chi^2$	ECVI	AIC	NCP
1	Theoretical	370.19	315		3.12	496.19	55.19
2	W.R. TMS → TDCs	375.76	316	5.57	3.14	499.66	59.66
3	W.R. Tech. Skills → TDCs	376.27	316	6.08	3.15	500.27	60.27
4	W.R. Absorp. Capacity → TDCs	375.77	316	5.58	3.14	499.77	59.77
5	W.R. Tech. Skills → Corp. Entrepreneurship	377.14	316	6.95	3.15	501.14	61.14
6	W.R. Absorp. Capacity → Corp. Entrepreneurship	382.85	316	12.66	3.19	506.85	66.85
7	W.R. TDCs → Corp. Entrepreneurship	375.23	316	5.04	3.14	499.23	59.23

Note: W.R. = Without Relationship; n = 160.

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