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Influence of technological support, skills and competencies, and learning on corporate entrepreneurship in European technology firms

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ABSTRACT

In the today's changing environment, firms are hardly competing with each other to achieve a competitive advantage that can differentiate them from others and improve their organizational performance. In this sense, it is crucial to develop corporate entrepreneurship and promote strategic variables that foster it.

The aim of this paper is to highlight the importance of different technological variables (top management support to technology, technological skills and technological distinctive competencies) and organizational learning on corporate entrepreneurship, and thus analyze the influence of corporate entrepreneurship on organizational performance in the context of technology firms.

A sample of 160 European technology firms was selected from the database Amadeus in 2009 with CEOs as our main informants. The hypotheses studied are empirically confirmed by using a hierarchical regression model.

1. Introduction

In current competitive environments, characterized by rapid technological change and the increased importance of timing in innovation, acquiring external knowledge and technologies as well as undertaking in-house developments have become critical factors for firms (Berchicci, 2013; Hussinger, 2010). Companies thus emphasize the role of technology for good reasons, such as increased firm performance and achievement of competitive advantage (Bitondo and Frohman, 1981; Drejer and Riis, 1999; Huang, 2011). In this scenario, technology firms drive economic growth and productivity gains and have created new industries and innovative products and processes (Grinstein and Goldman, 2006; Newbert et al., 2008). However, to make the most of this situation and to achieve such organizational goals, these firms must have top management support for technology (Fernandes et al., 2006), build programs to improve technological skills (Bolívar Ramos et al., 2012), develop new technological competencies (Newbert et al., 2007; Prahalad and Hamel, 1990; Walsh and Linton, 2002), strengthen organizational learning (García Morales et al., 2007) and achieve intensive participation of entrepreneurs in the firm (Tomczyk et al., 2013).

Previous studies have analyzed the influence of different technological variables in organizations. These include top management support for technology (TMS) (Byrd and Davidson, 2003; Fernandes et al., 2006), technological skills (Bolívar Ramos et al., 2012; Teece et al., 1990), technological competencies (Bitondo and Frohman, 1981; Danneels, 2008; López Sáez et al., 2005; Marino, 1996; Martín Rojas et al., 2011a, 2011b; Newbert et al., 2007; Real et al., 2006), technological infrastructure (Hu et al., 2005), technology leadership position (Cantwell and Janne, 1999) and technology investment (Voudouris et al., 2012), among others. Our investigation focuses specifically on TMS, technological skills and technological distinctive competencies (TDCs) because, as previous studies have highlighted, these factors play a critical role in companies' ability to achieve competitive advantages associated with technology (Huang, 2011; Newbert et al., 2007; Walsh and Linton, 2002). Further, these technological variables have been shown to have positive effects on the way organizations seek and exploit new opportunities and therefore on the way companies develop corporate entrepreneurship activities (Martín Rojas et al., 2011a, 2011b).

A firm's entrepreneurial orientation results from the values, decisions and practices of its top managers, who are in the strongest position to influence and shape the firm (Simsek et al., 2010). To ensure that organizations take advantage of the opportunities they encounter, top managers must implement a culture that supports technology and achieve the involvement of everyone

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in the firm (Martín Rojas et al., 2011a, 2011b). Thus, top management's attention to allocation processes becomes critical in shaping the firm's strategic actions to new technological paradigms (Maula et al., 2013). In addition, to obtain the maximum benefits new technologies offer, employees' technological skills must constantly be renewed and improved. If they are not, even organizations that access the best technological advances in the field may not be ready to exploit their potential advantages (Štemberger et al., 2011). Moreover, fuelling the company with new technological competencies is required to increase the firm's strategic choices (Snow and Hrebiniak, 1980) and to create and spread new knowledge within the firm. This is a process also supported by organizational learning (Linton and Walsh, 2013; Real et al., 2006) and that contributes to the ability to enable entrepreneurship (Carayannis et al., 2006). Thus, the combination of TMS to guarantee the performance of technology, technological skills to make employees able to use and exploit such technology and TDCs to help organizations remain in the technological vanguard of their sectors, when linked to organizational learning (OL), affects the ability of organizations to capture opportunities and achieve competitive success (Banerjee, 2003; Fontes, 2005; Newbert et al., 2008).

In line with previous arguments, technology constitutes a strategic issue for firms (Jones and Smith, 1997), and the introduction of cutting edge technologies in technology industries may enable companies to gain the reputation of leaders (Simon et al., 2002). Under these circumstances, TMS for technology is central to achieving an advanced technological position that seeks competitive advantage, since the organization's strategies and decisions are guided by top management (Liang et al., 2007). Moreover, organizations need entrepreneurial management that enable them to anticipate disruptive technological changes and developing business plans to cope with such changes (Bitondo and Frohman, 1981; Newbert et al., 2008). To this end, and in order to introduce an innovative technology successfully, firms must be able to integrate various resources and competencies (Gredel et al., 2012). Taking this issue into account has important consequences, since technological skills, TDCs and OL permit the exploitation of technological opportunities for the development of corporate entrepreneurship (CE), the reduction of costs and the generation of organizational competitive advantage (Martín Rojas et al., 2011a, 2011b). As Zahra et al. (1999) suggest, achieving corporate entrepreneurship and profitability requires the generation and deployment of unique resources and skills. Hence, technological firms that aim to become leaders in their industries must differentiate themselves by showing outstanding technological expertise driven by their unique knowledge and resources related to technology (García Morales et al., 2007; Ju et al., 2013).

Based on the foregoing premises, our study aims to explore the effects of TMS, technological skills and TDC, and OL on corporate entrepreneurship (CE), while also explaining their repercussions for organizational performance in the context of technology firms. The purpose of this investigation is thus to contribute to the existing literature that stresses the importance of technology and learning for firms competing in hyper-competitive environments to achieve competitive advantage (Drejer and Riis, 1999). We contribute by showing how these technological variables and OL constitute critical factors in technology firms to enhance CE – that is, entrepreneurship within an existing organization – and are essential to improve organizational performance (Antoncic and Prodan, 2008). In this investigation, CE must be analyzed as a means for renewing established technology firms so that they can innovate and increase their ability to compete in global markets. Covin and Slevin (1991), p. 19 suggest that "the growing interest in the study of entrepreneurship is a response to the belief that such activity can lead to improved performance in established organizations". Along the same lines, and applied specifically to a technological context, Antoncic and Prodan (2008) stress that corporate entrepreneurship-related activities are necessary to organizational survival, profitability and growth and play an important role in the performance and revitalization of current economies.

To develop of all these constructs, we structure the paper in the following sections. The theoretical background section explains all of the concepts and hypotheses. The research methodology and results section discusses the main results. Finally, the implications, limitations and future research are explained in the sections on discussion and conclusions.

2. Theoretical background

Top Management's support from and commitment to technology is one important factor to be considered and "reflects, in many ways, the importance that top management executives place on technology" (Byrd and Davidson, 2003, p. 246). It leads to securing the assistance of human, capital and other resources that determine technology implementation (Fernandes et al., 2006). In addition to TMS, technological skills and TDCs are technological strategic variables. Bolívar Ramos et al. (2012) define technological skills as specific techniques and scientific understanding. These technological skills relate to the concepts of TDCs, since competencies are based on a technology or knowledge-based component and usually result from a blending of technology and skills (Marino, 1996; Prahalad and Hamel, 1990). Specifically, TDCs can be conceptualized as 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 (Newbert et al., 2007; Real et al., 2006). Reinforcing these aspects is critical, since the real sources of advantage are to be found in management's ability to consolidate technologies and skills into competencies that empower individual businesses to adapt quickly to new opportunities (Prahalad and Hamel, 1990), thereby fostering CE processes.

CE also requires specialized knowledge to be obtained through OL, defined here as "a constant process that extends across time, allowing new abilities and knowledge to be developed to achieve improved organizational performance" (Wild et al., 2002, p. 372), increasing the firm's effectiveness and potential to create and use knowledge to achieve competitive advantage (Martín Rojas et al., 2011a, 2011b). As Zahra (2008) suggests, learning fosters entrepreneurial activities by enabling firms to innovate, create new businesses and strategically renew their operations.

Finally, CE refers to the "pursuit of entrepreneurial actions and initiatives that transform the established organization through strategic renewal processes and/or extend the firm's scope of operations into new domains, that is, new product-market segments or technological arenas" (Goodale et al., 2011, p. 116). It is "a vision-directed, organization-wide reliance on entrepreneurial behaviour that purposefully and continuously rejuvenates the organization and shapes the scope of its operations through the recognition and exploitation of entrepreneurial opportunity" (Ireland et al., 2009, p. 21). CE thus includes innovation, risk taking and proactiveness, but also business venturing and strategic renewal (Zahra, 1996). CE is linked to obtaining higher organizational performance (Antoncic and Prodan, 2008; Miles and Covin, 2002), which will be conceptualized in this study as strategic market performance and financial market performance (Murray and Kotabe, 1999).

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

Working in Silicon Valley with technological organizations, Dean and Giglierano (1990) found that most research focusing

on the financing of new ventures shows that initial funding is important. Once the new venture has been created, however, key top executives must focus their efforts on managing and supporting the growth of technology in the firm, and entrepreneurs must discover opportunities to use that technology by promoting innovations (Newbert et al., 2007). Most innovations involve changes in more than one product, market or technology and thus require support beyond the divisional level, for reasons of financing or of the strategic direction of the firm (Knight, 1987). In this sense, top management sponsorship is especially necessary for technological ideas that arise far down in the level of the organization (Knight, 1987). Such support and funding will allow entrepreneurs to develop new technological products or processes, obtain a better strategy focused on technological issues and improve decision making in technological matters so as to achieve a sustainable competitive advantage in the firm (Knight, 1987; Luo et al., 2012). In both strategic and funding support, TMS is critical in helping the members of technological organizations to understand and apply the strategy chosen and to increase CE.

Since entrepreneurial technological firms pursue opportunities to obtain new resources so as to outperform their competitors (Newbert et al., 2008), top managers should bear in mind that the search for technology support, through collaboration as a means of complementing and leveraging their internal capabilities, enables entrepreneurial development. Mechanisms promoting the creation of technological support from top managers are necessary to increase CE and boost industry competitiveness (Newbert et al., 2008; Tsai and Wang, 2009). Berry (1996) finds that companies that were able to improve their entrepreneurial capabilities by adapting and enhancing them achieved greater commitment from top management and a higher level of credibility across the broader organization. These firms with TMS became more receptive to CE over time. Indeed, TMS enhances strategies that guide the organization′s entrepreneurial efforts. CE is enabled by TMS (Knight, 1987). In companies belonging to technology-based industries, such as biotechnology and computer software, firm managers play a central role in attracting and motivating expert staff to promote innovation activities (Casper and Whitley, 2004), one of the dimensions of CE.

Focusing on Micro-Electro Mechanical Systems (MEMS) and nanotechnology in the pharmaceutical technology landscape, Tierney et al. (2013) find that managerial support for technology influences and stimulates technological innovations, and consequently CE. Similarly, in studying nanotechnology, Allarakhia and Walsh (2012) find that top managers promote corporate entrepreneurship in the firm, since nanotechnology is being increasingly applied to a great variety of fields where entrepreneurial goals are becoming important. Other scholars, such as Shane and Venkataraman (2000), find that top managers with higher levels of technological education possess greater capabilities in technology, innovation and creativity, acquiring more investments and consequently more support for entrepreneurial projects. Based on these previous studies, we assert the following hypothesis:

H1a. TMS will be positively related to CE in technology firms.

A crisis often arises as a result of an unanticipated event in the firm′s external environment. These crises are direct consequences of the founding entrepreneur′s inability to adapt the management style to the changing needs of the organization and to use technology appropriately (Berry, 1996). Frequently, such use of technology becomes a prerequisite for success and the organizational business abilities and technological skills are truly necessary (Berry, 1996), since they drive and enable corporate entrepreneurship (Acur et al., 2010). As a result of this "critical event", the business must reorient its strategy which, in a technology firm, requires concurrent development in the technological skills, techniques and processes necessary to manage the enterprise effectively (Berry, 1996; Lucas et al., 2009). In a recent study performed on new technology-based firms – primarily ICT, environment and energy, and advanced materials industries – Fini et al. (2012) emphasize that the current tendency of technology companies to engage in corporate entrepreneurship activities is influenced by individuals' skills. In this scenario, technological skills are not an exception.

In numerous cases, seemingly intractable technological problems have been solved through an entrepreneur′s excellence (Leonard-Barton, 1987). Professional entrepreneurs in technology companies earn their status by discovering new opportunities for technological advance (D′Este et al., 2012). In this case, organizational technological skills have been studied as a key factor for entrepreneurs to discover different kinds of technological opportunities obtained by 'achieving the impossible' and inventing their way out of difficulties and (D′Este et al., 2012). Thus, the majority of successful new technology-based ventures and CE (Antoncic and Prodan, 2008) are founded and developed by a group of people (Cooper, 1973) whose experienced technological skills play a pivotal role in the organization to achieve an excellent command of CE (Fontes, 2005; Lucas et al., 2009; Omerzel and Antoncic, 2008).

Nevertheless, these technological skills must not be applied alone. They should be complemented by scientific knowledge, improving CE (Andreu and Ciborra, 1996; Fontes, 2005) to support the information required to produce a market-led organization with strategic planning systems and to identify new opportunities to develop new products or services in an autonomous way (Berry, 1996; Fontes, 2001, 2005; Newbert et al., 2008).

Zahra and Garvis (2000) emphasize the fact that U.S. companies have learned and utilized different technological skills closely linked to entrepreneurial activities. Given the current and changing conditions within and outside their organizations, these technological skills include strategic objectives to guide and support entrepreneurial activities and processes, which allow firms in technology-intensive industries to access complementary resources so as to develop a competitive advantage (Newbert et al., 2008). Thus, managers' possession of technological skills is a necessary condition for environmental development and may even be a sufficient condition for adequate development of to certain levels (Brio and Junquera, 2003). Furthermore, learning these technological skills will over time help the corporation to develop and advance its entrepreneurial activity, mainly in technological firms (Acur et al., 2010; Newbert et al., 2008).

Technological firms are usually more flexible than other firms in maintaining the ability to combine their technology with other complementary assets, such as managers' competencies in exploiting international growth opportunities to improve their technological skills and CE (Autio et al., 2000). Successful potential entrepreneurs identify such growth opportunities through technological assets, which require new technological skills (Alvarez and Barney, 2007; Lucas et al., 2009). Taking into account the previous studies, we formulate the following hypothesis:

H1b. Technological skills will be positively related to CE in technology firms.

Walsh and Linton (2002) suggest that core or distinctive competencies are relevant to a specific industry and may be seen as strategic in the firm. Within these core competencies, the firm′s technological competencies have been accepted as one important element of the organizational core competency (Banerjee, 2003). Technological competencies are extremely important to achieving a competitive advantage in the industry by adapting quickly to changing opportunities (Prahalad and Hamel, 1990; Walsh and Linton, 2001). Consistent with the dynamic capabilities theory,

TDCs may be viewed as a bundle of intangible and valuable resources that accumulate over time (Drejer, 2001).

Entrepreneurial climate is based on nurturing the organization′s TDCs, as this enhances the creation and dissemination of new knowledge that enables entrepreneurship (Marino, 1996). TDCs promote engineering and the construction of know-how (Panda and Ramanathan, 1997), manufacturing facilities and patents, which improve CE (Danneels, 2008). TDCs are not "simple" assets, but an assessment framework which is built by acquiring and supporting capabilities over time, ranging from simple to complex (Drejer, 2001; Panda and Ramanathan, 1997), that increases CE (Danneels, 2008). Likewise, TDCs provide an ownership advantage that enables entrepreneurs to increase the firm′s likelihood of survival (Giarratana and Torrisi, 2010; López Sáez et al., 2005).

In the field of technology, core competencies are suggested to lead to competitive advantage (Prahalad and Hamel, 1990; Walsh and Linton, 2001) and improve the entrepreneurs' strategic choices (e.g., technological strategies) (Snow and Hrebiniak, 1980; Zahra, 1996). Thus, technological choices and TDCs influence the ability of entrepreneurs to improve the firm′s position in the market (Fontes, 2005). TDCs may not only affect a specific industry but also frequently provide an advantage across multiple industries (Walsh and Linton, 2002) and are usually articulated in the technology firm′s strategy, which defines the desired competencies, their sources, timing and potential use (Banerjee, 2003; Drejer, 2001; Prahalad and Hamel, 1990). Today, there is a growing appreciation of technology′s impact on entrepreneurship′s strategic choices (Todorovic, et al., 2011; Zahra, 1996).

Technology firms with TDCs play a critical role in such a process by acting as disseminators of new technology, as in the case of micro-electro-mechanical systems (MEMS) (Kassicieh et al., 2002; Tierney et al., 2013), and by acting as translators of competencies to entrepreneurs (Fontes, 2001, 2005; Martín Rojas et al., 2011a, 2011b). This is the case because innovation opportunities in technology derive from scientific discovery, which provides access to potential entrepreneurs with a fundamental advantage (Fontes, 2001). In this regard, entrepreneurs must discover those innovative opportunities that are motivated by TDCs (Martín Rojas et al., 2011a, 2011b), for TDCs will increase CE in technological companies since successful entrepreneurs identify such innovative opportunities through technology. TDCs present an opportunity for CE (Alvarez and Barney, 2007; Martín Rojas et al., 2011a, 2011b), and without TDCs the identification of opportunities and CE are "fruitless" (Shane and Venkataraman, 2000).

In biopharmaceutical industries, technological competencies (e.g., the competency of new product development) act as catalysts to asset accumulation and contribute to both firm renewal and entrepreneurship in new markets (Wang and Lestari, 2013). The foregoing discussion allows us to formulate the following hypothesis:

H1c. TDCs will be positively related to CE in technology firms.

2.2. The influence of OL on CE

OL is an essential prerequisite for entrepreneurial strategic awareness and effective strategy development (Berry, 1996). Learning new knowledge makes future entrepreneurial initiatives more likely, and such initiatives constitute one of the main ways to drive technological change and catalyze and accelerate sustainable growth (Carayannis et al., 2006).

CE is built better when learning has been developed in the organization, in successful and unsuccessful situations (Burger-Helmchen, 2009; Carayannis and Samanta Roy, 2000; Kautt et al., 2007; Omerzel and Antoncic, 2008; Rerup, 2005; Rhee et al., 2010). Rerup (2005) indicates that entrepreneurs learn from success by repeating what they do well and learn from failure by changing or abandoning what they are doing poorly. Similarly, Carayannis et al. (2006) highlight that organizational learning has become a crucial factor for economic, social and especially entrepreneurial development; it empowers people and entrepreneurs across the world by taking advantage of opportunities and chances unknown and unexplored until recently. If an organization wishes to have well-constructed CE, entrepreneurs should discover these opportunities and exploit them profitably (Burger-Helmchen, 2009). Furthermore, new OL processes to satisfy new knowledge will be required so that entrepreneurs may exploit those opportunities (Burger-Helmchen, 2009). Such knowledge and learning constitute the factors with which entrepreneurs can distinguish themselves from their competitors. In so doing, they may be able to maintain a sustainable competitive advantage (Burger-Helmchen, 2009; Carayannis et al., 2006; Omerzel and Antoncic, 2008), which may in turn be associated with superior performance (Rhee et al., 2010). Entrepreneurs with more knowledge will be less uncertain about their effectiveness and will be quicker to notice and learn from changes on the market (Omerzel and Antoncic, 2008).

In the business context, OL is a prerequisite for the development of entrepreneurial attitudes and skills throughout the firm. Entrepreneurs must devote enormous discipline and effort to developing their learning mindset (Pitts, 2008; Polities, 2008). They typically need different kinds of knowledge and learning in different growth periods and must thus continuously develop their need for knowledge, so as to maintain CE (Carayannis et al., 2006; Omerzel and Antoncic, 2008).

Acquiring knowledge through OL is a specific requirement for high levels of CE (Lloréns Montes et al., 2005). By combining new tools, technologies, sources and opportunities acquired through learning, entrepreneurs can constantly create new added value (Burger-Helmchen, 2009; Omerzel and Antoncic, 2008). Once this knowledge has been acquired, it might well be recognized as a means by which the poorly organized business environment can become well organized (Burger-Helmchen, 2009; Omerzel and Antoncic, 2008).

OL also enables the development of CE in technological organizations by enhancing the development of technological variables throughout the firm as a coordinating management process. This is especially relevant in nanotechnology and micro-electromechanical systems (MEMS), where organizational learning enables communications, guidance and control to expand entrepreneurial behaviour and innovation in the firm (Carayannis and Samanta Roy, 2000; Carayannis et al., 2006; Kautt et al., 2007). In this way, the firm may be able to become a cognitive entity in which new abilities, competencies and knowledge develop (Berry, 1996; García Morales et al., 2006; Martín de Castro et al., 2013; Martín de Castro and López Sáez, 2008; Teece et al., 1990). In addition, 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 CE.

In a study conducted in the information and communication technology sector, Bojica and Fuentes-Fuentes (2011) show that companies that increase their market and technological knowledge base develop an important contingency for obtaining the outcomes associated with corporate entrepreneurship activities. Finally, different models of OL are usually used to study CE to determine the relationship between the two strategic variables (García Morales et al., 2006). Based on the previous arguments, the following relationship is proposed:

H2. OL will be positively related to CE in technology firms.

2.3. The influence of CE on organizational performance

CE is usually depicted as an antecedent of company performance or as an organizational process that contributes to firm

survival and performance (Covin and Slevin, 1991; Lengnick-Hall, 1992; Shan, 1990; Zahra, 1996, 2008). Current research suggests that CE is positively associated with financial and economic performance (Antoncic and Prodan, 2008; Luo et al., 2012; Simsek and Heavey, 2011). Previous studies have analyzed this relationship in the U.S. (Zahra, 1996) and in transition economies (Antoncic and Prodan, 2008). Our study aims to determine whether this relationship has the same effect in the European market.

Firms that engage in CE can gain important financial benefits from their innovation, risk taking and new business creation. This finding supports past results by leveraging performance in the firm (Clausen and Korneliussen, 2012; Miles et al., 2003; Simsek and Heavey, 2011; Zahra, 1996). Different authors argue that entrepreneurial attitudes and behaviours are necessary for firms of all sizes to prosper and flourish in competitive environments (Clausen and Korneliussen, 2012; Shan, 1990; Simsek and Heavey, 2011). Thus, organizations engage in corporate entrepreneurship to increase competitiveness through efforts aimed at the rejuvenation, renewal and redefinition of organizations and their markets or industries (Miles et al., 2003).

We currently live in what is seen as a hostile environment with a shortage of opportunities for CE (Covin and Slevin, 1991; Langerak et al., 2004; Zahra, 1996). In these conditions, new products and processes serve to accommodate the uncertainties a firm faces in its entrepreneurial environment (Langerak et al., 2004) by permitting originality in innovation, which produces a positive impact on productivity and growth (Therrien et al., 2011).

In the field of technology companies, competition in strategic elements of CE, such as innovation, are usually extremely intense (Clausen and Korneliussen, 2012; Martín de Castro et al., 2013; Shan, 1990). For example, there is a strong incentive to be the first innovator when the first-mover advantage is significant. Once an innovation is made, the entrepreneurial initiatives will create profit by harnessing innovation to reduce variable costs in production technologies in the shortest possible time, as the innovator's position in the market might otherwise be quickly eroded by imitators or by even better and superior innovations (Clausen and Korneliussen, 2012; Miles et al., 2003; Shan, 1990).

From a theoretical perspective, taking these CE activities into account is important because there are at least two reasons for expecting a positive and increasing relationship between CE activities and subsequent firm performance (Luo et al., 2012). First, CE can be a source of competitive advantage for a firm. Entrepreneurial companies frequently develop strong, positive market reputations that ensure customer loyalty. Second, since firms that pursue CE are proactive by definition, this often enables them to exploit an additional basis for competitive advantage (Zampetakis et al., 2009). These advantages may cause the magnitude of the organization's performance to increase as the effects of technology progress. Learning and obtaining knowledge of recent advances in technological society allow the firm continually to achieve better and better products and processes—that is, sustainable growth (Luo et al., 2012). Among such entrepreneurial firms, there is a willingness to increase learning from past entrepreneurial initiatives aimed at fostering potential knowledge and innovation and enabling economic development (Carayannis et al., 2006).

Further, in a study of 207 firms in Norway, Clausen and Korneliussen (2012) note that a quick response strategy in firms with an entrepreneurial orientation often translates into superior firm performance, since these companies improve the commercialization of new innovative products or processes faster than competitors. In a study of 126 firms in the Netherlands, Langerak et al. (2004) highlight that new product development (NPD) activities permit firms to achieve superior performance through proficiency in new product or process launch innovative activities. In this way, firms that exhibit CE are typically viewed as dynamic, flexible entities preparing or prepared to take advantage of new business opportunities when they arise (Goodale et al., 2011; Zampetakis et al., 2009).

Increased CE in technological companies may also lead to the development of key capabilities that improve a firm's performance (Luo et al., 2012), since CE in technological companies may generate products, goods, processes, services and systems that can capture an unique business opportunity, resulting in superior economic performance (Antoncic and Prodan, 2008; Langerak et al., 2004; Miles et al., 2003; Simsek and Heavey, 2011; Zahra, 1996). CE can thus improve the firm's profitability and fuel its growth (Zahra, 1996). In addition, for a firm to succeed in industries with technological opportunities, it is important that it engage in CE and take risks, while at the same time making investments in developing products and technologies (Antoncic and Prodan, 2008; Langerak et al., 2004). We must not forget, however, that only a cohesive choice of strategy configuration and approach to CE will enable a positive relationship to organizational performance and profitability for firms in which shared values and lean operations are dominant corporate characteristics (Lengnick-Hall, 1992).

To sum up, CE involves intentions and actions at all levels to promote value creation continuously in a company (Zampetakis et al., 2009). Therefore, CE might well be a vehicle of increased organizational growth and profitability, strategic renewal, organizational change and customer value-added services (Miles et al., 2003; Zahra, 1996). Such qualities enable the improvement of better organizational performance, not just at one specific moment, but over time (Zampetakis et al., 2009). In fact, research in the U.S. and Europe has found that CE is related to long-term sustainable and superior returns (Clausen and Korneliussen, 2012; Langerak et al., 2004; Miles et al., 2003). In this regard, organizations that engage in intrapreneurial activities – entrepreneurship within existing organizations – are expected to achieve higher levels of growth and profitability than organizations that do not engage in them (Philpott et al., 2011). Moreover, improved organizational results, usually in terms of growth and profitability, are thought to be a result of entrepreneurship in established organizations over time (Covin and Slevin, 1991; Zahra, 2008). Based on the literature discussed above, we formulate the following hypothesis:

H3. CE will be positively related to organizational performance in technology firms.

3. Methodology

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

3.1. Sample and procedure

The population for this study consisted of technology firms within the geographical area of the European Union. We chose high-tech firms due to the interest inherent in studying technology and entrepreneurship in sectors with a high technological element. Technological firms are potential vehicles for transferring knowledge from the academic environment to the production sector and are strategic for the economy (Fontes 2001, 2005; Martín de Castro and López Sáez, 2008). The Amadeus (2009) database was used. Drawing on our knowledge about key dimensions of this investigation, previous contacts with managers and

scholars and new interviews with managers and academics interested in these strategic variables, we developed a structured questionnaire to investigate how organizations face these issues. We then established a list of the CEOs of the organizations, with the help of partial funding from the Spanish Ministry of Science and Research and the Local Council for Economy, Innovation and Science of Andalusia's Regional Government.

CEOs were our main informants, since they manage a great deal of information on all departments in the company. Furthermore, 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. CEOs were also chosen as informants because they are ultimately responsible for plotting the organization's direction and plans, as well as for guiding the actions carried out to achieve them.

We used stratified random sampling by country to divide 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). We chose the countries based on their Gross Domestic Product, selecting the eight countries with the largest Gross Domestic Product in the European Union (Germany, the United Kingdom, France, Italy, Spain, Poland, the Netherlands, Belgium) plus two with lower levels (Austria and Denmark) to confirm whether there are significant differences between the first and second levels. Within each stratum, a random sampling procedure was used. Through systematic sampling in each stratum, we obtained 16 firms for each target country in the study. We put out a call to the CEOs and explained that the data obtained would be confidential and would be treated in aggregate form. We offered to send each CEO a comparative study specific to his/her firm on the variables analyzed. This approach enabled us to obtain an approximate response rate of 17.7% (Table 1). Technologies have played an important role in market globalization and, in turn, in globalizing business practices. It is thus advisable to perform the study within the framework of EU countries (Verdú Jover et al., 2006).

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, return on equity, return on sales and number of employees indicated that there was no significant difference among respondents and non-respondents (Armstrong and Overton, 1977). Likewise, a series of chi-square and *t*-tests revealed no significant differences among types of selected countries for the variables studied. Since all measures were collected with the same survey instrument, the possibility of common method bias was tested using Harman's one-factor test (see Konrad and Linnehan, 1995). A principal components factor analysis of the questionnaire measurement items yielded five factors with Eigen-values greater than 1.0, which accounted for 69% 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

The use of constructs has played an important role in designing survey instruments in management research. In any research concerning behavioural elements, no device using a single metric unit can measure precisely, and researchers usually employ two or more measures to gauge a construct or scale. 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 their validity and reliability.

3.2.1. Top management support

Using scales established by Byrd and Davidson (2003) and Ray et al. (2005), we developed a Likert-type seven-point scale (1 "totally disagree", 7 "totally agree") of four items (see Appendix) to reflect TMS. We developed a confirmatory factor analysis to validate our scales ($\chi^2_2=1.13$; 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 one dimensional and showed high reliability ($\alpha=.784$).

3.2.2. Technological skills

We used the scales designed by Ray et al. (2005) and Byrd and Davidson (2003) to establish a Likert-type seven-point scale (1 "totally disagree", 7 "totally agree") of four items (Appendix) to reflect technological skills. Using a confirmatory factor analysis ($\chi^2_2=1.68$, NFI=.99, NNFI=.99, GFI=.99, CFI=.99), we validated our scales and then verified each scale's one-dimensionality and its high validity and reliability ($\alpha=.866$).

3.2.3. Technological distinctive competencies

Using scales established by Real et al. (2006), we drew up a Likert-type seven-point scale (1 "totally disagree", 7 "totally agree") of six items (Appendix) to reflect TDCs in the organization. We developed a confirmatory factor analysis to validate our scales ($\chi^2_9=24.68$, NFI=.94, NNFI=.93, GFI=.98, CFI=.96). The scale was one-dimensional and showed high reliability ($\alpha=.957$).

3.2.4. Organizational learning

We used the Likert-type seven-point scale (1 "totally disagree", 7 "totally agree") of four items (Appendix) developed by Aragón et al. (2007) and García Morales et al. (2006) to measure OL. These items have been duly adapted to the present study. We developed a confirmatory factor analysis to validate the scales ($\chi^2_2=0.28$, NFI=.99, NNFI=.99, GFI=.99, CFI=.99), which required eliminating Item 4.

Table 1
Technical details of the research.

Country	Austria	Belgium	Denmark	France	Germany	Italy	Poland	Spain	The Netherlands	United Kingdom	Total
Sample Size	125	105	118	96	72	84	87	75	70	68	900
(% Response)	(12.80%)	(15.23%)	(13.55%)	(16.66%)	(22.22%)	(19.04%)	(18.39%)	(21.33%)	(22.85%)	(23.52%)	(17.77%)
Sectors	High-tech firms (pharmaceutical industry, hardware and other computer science equipment, automotive industry, space and aeronautics products, MEMS and nanotechological firms)										
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										

The scale was one-dimensional and had adequate validity and reliability (α=.778).

3.2.5. Corporate entrepreneurship

We used Likert-type seven-point scales (1 "totally disagree", 7 "totally agree") of 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. These items have been duly adapted to the present study (Appendix). We calculated the arithmetic mean of these items (a high score indicated a good level of proactiveness, new business venturing, self-renewal and organizational innovation) and obtained a 4-item scale to measure CE. We developed a confirmatory factor analysis to validate the scale of CE (χ^2_2=3.68, NFI=.99, NNFI=.98, GFI=.99, CFI=.99) and showed that the scale was one-dimensional and had adequate validity and reliability (α=.800).

3.2.6. Organizational performance

After reviewing how performance is measured in different works of strategic research, we used a Likert-type seven-point scale (1 "Much worse than my competitors," 7 "Much better than my competitors") of five items developed by Murray and Kotabe (1999) to ask about the organization's performance as compared with that of its most direct competitors (Appendix). 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; Douglas and Judge, 2001). Many researchers have used managers' subjective perceptions to measure beneficial outcomes for firms. Others have preferred objective data, such as return on assets. The literature has established widely that there is a 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 (χ^2_5=22.13, NFI=.94, NNFI=.90, GFI=.98, CFI=.95) and showed that the scale was one-dimensional and had high reliability (α=.833).

3.3. Control variables

The research adds control variables for several other factors that may influence the estimation results. In this case we take into account that firms may vary in size, industry or sector and country or nationality. The measurement of size is a difficult question, as multiple focuses may be adopted to be operational (Gupta and Govindarajan, 2000). Size could be measured by the number of employees, the volume of sales, activity or net assets (in millions of Euros), although all of these options would measure the size as an organizational factor (Damanpour, 1992). Items initially used were the volume of annual sales and the number of employees. Both items had a high significant correlation in our sample. We thus decided to use the number of employees in our models, because CEOs are more reluctant to give an accurate figure for sales. To avoid desirability bias due to the range of variance values throughout the sample, we measured size through a logarithmic transformation in the number of employees instead of gross data (Damanpour, 1992; Gupta and Govindarajan, 2000; Kimberly and Evanisko, 1981).

Industry type has been included, as in other similar studies on entrepreneurial activities or opportunities for innovation (Covin and Slevin, 1991; Zahra, 1993, 1996). The nationality variable was included as a nominal variable with ten categories. Loyalty and the way people act or work in a local firm reside mostly in the way of thinking in the country where these people work. This fact could determine the degree of investment in technology or the importance employees give to technology (Grinstein and Goldman, 2006; Van Gils, 2005).

4. Results

In this section we present the research results. First, Table 2 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, technological skills, OL, CE and organizational performance. Likewise, there is a positive correlation between sector and TDCs. Patel and Pavitt (1997) show that profiles of technological competency are mainly sector-specific. For example, there are dissimilarities between manufacturing firms and trade-only firms (Huang, 2011). Similarly, Bolívar Ramos et al. (2012) stress that technological firms are characterized by developing a higher level of technological distinctive competencies in order to stimulate the recognition and application of new knowledge in firms to create and distribute innovative products or services.

In addition, a positive correlation exists among size and TMS, technological skills, CE and organizational performance. Technological organizations require TMS to implement new technologies successfully and to foster a technological proactive attitude within the firm (Thong et al., 1996). Taking into account that the organizational structure in smaller firms is simpler, the role of TMS in the implementation of some new technologies tends to be less important than in larger organizations, where more political problems arise (Thong et al., 1996). Larger firms also usually take more advantage than small firms of a wider variety of knowledge

Table 2
Means, standard deviations and correlations.

Variable	Mean	S.D.	1	2	3	4	5	6	7	8	9
1. Sector	1.260	0.438	1.000								
2. Size	4.128	2.510	−.077	1.000							
3. Country	5.500	2.881	.037	−.133	1.000						
4. Top management support	5.231	1.231	.035	.186*	.011	1.000					
5. Technological skills	5.148	1.179	0.16	.264***	−.077	.690***	1.000				
6. Technological dist. compet.	4.806	1.391	.158*	.139	−.058	.644***	.528***	1.000			
7. Organizational learning	5.531	1.127	.022	.066	.020	.419***	.444***	.344***	1.000		
8. Corporate entrepreneurship	4.767	1.141	.077	.216**	.075	.668***	.626***	.547***	.437***	1.000	
9. Organizational performance	4.724	1.124	−.018	.208**	.182*	.382***	.354***	.272***	.430***	.390***	1.000

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

inputs that draw on a great diversity of scientific skills (Pavitt, 1991). Further, larger organizations benefit from having more funds to encourage technology training programs aimed to enhance the level of users' technological skills to employ technology applications (Bolívar Ramos et al., 2012).

We must also consider the influence of firm size on corporate entrepreneurship and organizational performance. As suggested before, large organizations have more resources, a characteristic fundamental to implementing new entrepreneurial ideas. Larger firms are thus in a better position to venture in domestic or international markets and have the possibility of obtaining higher levels of organizational performance (Zahra et al., 2000). Finally, the positive correlation between country and organizational performance must be pointed out. As Brouthers (2002) shows through a study related to foreign market entry mode choice and firm performance, organizations achieve higher financial performance if they take into account institutional and cultural context value-added criteria.

With respect to the quality of the scales used, the constructs display satisfactory levels of reliability, as indicated by composite reliabilities ranging from 0.81 to 0.89 and shared variance coefficients ranging from 0.54 to 0.59 (Table 3). Convergent validity, the extent to which maximally different attempts to measure the same concept agree, can be judged by looking at 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 greater than 10.37) in support of convergent validity. Likewise, a series of chi-square difference tests on the factor correlations showed that discriminant validity – the degree to which a construct differs from others – is achieved among all constructs (Anderson and Gerbing, 1988). In particular, discriminant validity was established between each pair of latent variables by constraining the estimated correlation parameter between them to 1.0 and then performing a chi-square difference test on the values obtained for the constrained and unconstrained models (see Anderson and Gerbing, 1988). The resulting significant differences in chi-square indicate that the constructs are not perfectly correlated and that discriminant validity is achieved.

Second, hypotheses H1a–H1c and H2 were tested using the hierarchical regression method (Cohen and Cohen, 1983). We have checked for the presence of multicolinearity in these regression analyses and have determined that they meet the requirements for measures of the tolerance value and variance inflation factor (Hair et al., 2010). In the first step, the dependent variable of interest (CE) was regressed on the control variables (Model 1). Next (Model 2), the technological independent variables (TMS, technological skills, TDCs) were entered. Finally (Model 3), OL was added (Table 4).

H1a–H1c suggest that TMS, technological skills and TDCs will be positively related to CE. As shown in Model 2, TMS ($\beta=0.343$, $p<.001$), technological skills ($\beta=0.284$, $p<.001$) and TDCs ($\beta=0.168$, $p<.05$) have a significant positive relationship to CE and together accounted for 45.7% of the variance in CE. Thus the data support hypotheses H1a–H1c. Managers must support the technological development and the technological skills and competencies in their firms, as well as streams of knowledge through which the firm will develop its specific technological dynamic capabilities and increase the firm's CE (Berry, 1996; Brio and Junquera, 2003; Lucas et al., 2009).

H2 suggests that OL will be positively related to CE. As shown in Model 3, OL ($\beta=0.126$; $p<.05$) had a significant positive relationship to CE and accounted for 6.2% of the variance in CE. Thus, the data support Hypothesis 2. OL processes achieve a knowledge structure that improves the CE in the firm (Omerzel

Table 3
Validity, reliability and internal consistency.

Variable	Item	Validity, reliability and internal consistency		
		λ^*	R^2	A. M.
Top management support	MANSUP1	0.65***(11.57)	0.53	$\alpha=0.784$C.R.$=0.823$
	MANSUP2	0.80***(17.38)	0.64	S.V.$=0.540$
	MANSUP3	0.74***(14.61)	0.54	
	MANSUP4	0.67***(12.01)	0.54	
Technological skills	TECSK1	0.71***(15.14)	0.50	$\alpha=0.866$C.R.$=0.852$
	TECSK2	0.79***(19.74)	0.62	S.V.$=0.593$
	TECSK3	0.87***(25.92)	0.75	
	TECSK4	0.70***(14.64)	0.50	
Technological distinctive competencies	TECCO1	0.66***(13.13)	0.54	$\alpha=0.857$C.R.$=0.894$
	TECCO2	0.75***(17.31)	0.56	S.V.$=0.587$
	TECCO3	0.77***(19.16)	0.59	
	TECCO4	0.75***(17.27)	0.56	
	TECCO5	0.85***(25.56)	0.72	
	TECCO6	0.77***(18.62)	0.59	
Organizational learning	ORLEAR1	0.65***(11.02)	0.52	$\alpha=0.778$C.R.$=0.813$
	ORLEAR2	0.90***(16.83)	0.82	S.V.$=0.597$
	ORLEAR4	0.69***(11.95)	0.51	
Corporate entrepreneurship	COREN1	0.63***(11.12)	0.50	$\alpha=0.800$C.R.$=0.834$
	COREN2	0.82***(19.35)	0.68	S.V.$=0.561$
	COREN3	0.61***(10.37)	0.51	
	COREN4	0.82***(18.96)	0.66	
Organizational performance	OPERF1	0.74***(16.12)	0.55	$\alpha=0.833$C.R.$=0.873$
	OPERF2	0.73***(15.23)	0.53	S.V.$=0.580$
	OPERF3	0.77***(18.92)	0.60	
	OPERF4	0.84***(23.00)	0.71	
	OPERF5	0.72***(15.41)	0.52	

Note: λ^*=Standardized Structural Coefficient; R^2=Reliability; α=Alpha Cronbach; C. R.=Compound. Reliability; S. V.=Shared Variance; f. p.=fixed parameter; A. M.=Adjustment Measurement; *$p<.05$; **$p<.01$; ***$p<.001$(two-tailed).

Table 4
Regression analysis.

Independent variables	Dependent variable		
	Model 1	Model 2	Model 3
Constant	3.783***	0.530	0.421
	(10.427)	(1.395)	(0.358)
Sector	0.098	0.038	0.039
	(1.257)	(0.662)	(0.682)
Size	0.098	0.110	0.105
	(1.251)	(1.926)	(1.856)
Country	0.237**	0.071	0.078
	(3.014)	(1.218)	(1.336)
Top management support		0.343***	0.324***
		(3.932)	(3.720)
Technological skills		0.284***	.247**
		(3.568)	(3.050)
Technological distinctive competencies		0.168*	.156*
		(2.215)	(2.064)
Organizational learning			.126*
			(2.002)
R^2	0.066	0.523	0.585
Adjusted R^2	0.048	0.504	0.564
Change in adjusted R^2		0.457***	0.062*
F	3.661	27.778	24.854
Std. error	1.108	0.800	0.792

Note: *$p < .05$; **$p < .01$; ***$p < .001$(two-tailed); T-Students are shown in parentheses below the variables.

Table 5
Regression analysis.

Independent variables	Dependent variable	
	Model 1	Model 2
Constant	0.356***	0.453***
	(10.833)	(5.826)
Sector	−0.008	−0.043
	(−0.106)	(−0.587)
Size	0.235**	0.152*
	(3.033)	(2.033)
Country	0.214**	0.179*
	(2.760)	(2.457)
Corporate entrepreneurship		0.351***
		(4.721)
R^2	0.088	0.203
Adjusted R^2	0.070	0.188
Change in adjusted R^2		0.115***
F	4.979	9.820
Std. error	1.108	0.800

Note: *$p < .05$; **$p < .01$; ***$p < .001$(two-tailed); T-Students are shown in parentheses below the variables.

and Antoncic, 2008). The *F*-tests on all adjusted R square changes are significant, indicating that successive factors added in the regression models significantly improve the prediction for CE. Sector, size and country are not significant variables in the models analyzed that relate to CE. Nevertheless, if we consider the level of significance to be approximately 10%, we would observe a positive influence of size on corporate entrepreneurship ($\beta = 0.110$; $p < .10$, Model 2; $\beta = 0.105$; $p < .10$, Model 3). Large organizations have more resources and empowerment to implement entrepreneurial ideas, despite the fact that corporate entrepreneurship is not only linked to big firms (Hornsby et al., 1993).

Third, Hypothesis 3 was tested using the hierarchical regression method and similarly checking for multicolinearity and the compliance of requirements of the tolerance value and variance inflation factor measures. In the first step (Model 1), the dependent variable of interest (organizational performance) was regressed on the control variables. Finally (Model 2), the independent variable (CE) was introduced (Table 5). H3 suggests that CE will be positively related to organizational performance. As shown in Model 2 of Table 5, CE ($\beta = 0.351$, $p < .001$) had a significant positive relationship to CE and accounted for 11.5% of the variance of organizational performance. The data therefore support hypothesis H3. The *F*-test on change in adjusted *R* square is significant, indicating that the factor CE added in the regression model significantly improved the prediction for organizational performance. CE drives the creation of new innovations, can increase investment in new business revenue and renovation and enables technological entrepreneurship (Jiménez Barrionuevo et al., 2011; Martín Rojas et al., 2011a, 2011b). Size and country are significant variables analyzed in relation to organizational performance. Larger companies usually obtain higher results (Bolívar Ramos et al., 2012; Zahra et al., 2000). Organizational performance will also be higher in the country that invests more in R&D than in a country that invests less (Brouthers, 2002). As to sector, no significant differences were found with respect to organizational performance.

5. Discussion

Today more than ever, economic growth is driven by the accumulation of knowledge and new technological developments, which creates technical platforms for further innovations and corporate entrepreneurship (Carayannis et al., 2006; Carayannis and Samanta Roy, 2000). Such growth, in turn, encourages better results in the firm (Goodale et al., 2011; Langerak et al., 2004). Our study opens this black box. It points to the importance of organized, specific, directed managerial action and the establishment of technology management to benefit from a high level of corporate entrepreneurship through organizational learning processes in order to increase the firm's organizational performance. The research findings have implications that are useful for both academics and practitioners.

5.1. Implications for theory

Identifying factors that facilitate resource exploitation provides a more dynamic understanding of how competitive advantage is attained, specifically by placing the responsibility of creating and sustaining a competitive advantage on the entrepreneur and the manager (Bolívar Ramos et al., 2012). By viewing entrepreneurs and managers as strategists entrusted with the task of utilizing potentially value-creating resources more effectively or innovatively than their competitors, this paper attempts to inform scholars of some of the capabilities in the entrepreneurial context that can facilitate the transformation of technological resources into competitive advantage.

TMS is thus essential to influencing the firm's strategies in order to strengthen its entrepreneurial orientation by promoting new products and processes (Bitondo and Frohman, 1981; Clausen and Korneliussen, 2012). Managers must also carry out actions to promote the presence of technologically skilled personnel in the firm. These personnel will have knowledge, specific capabilities and strategic behaviour, characteristics that are not easy for competitors to imitate. These characteristics will increase corporate entrepreneurship and the capacity to create and maintain businesses with features that seem difficult, sometimes even unfeasible to achieve (Banerjee, 2003; Brio and Junquera, 2003; Fontes, 2001, 2005; Leonard-Barton, 1987).

Once technological skills have been acquired and understood, it ought to be highlighted that TDCs are important ingredients for success in the technology transfer process (Banerjee, 2003; Drejer, 2001; López Sáez et al., 2005; Snow and Hrebiniak, 1980; Walsh and Linton, 2001, 2002), since these factors may well promote

innovation and corporate entrepreneurship (Martín Rojas et al., 2011a, 2011b) in biotechnology (Fontes, 2001, 2005) and nanotechnology and MEMS firms (Kassicieh et al., 2002; Tierney et al., 2013).

To promote these three strategic technological variables, managers of technological firms must employ a series of OL processes, which can provide both an opportunity and a challenge for entrepreneurs in catalyzing and accelerating economic development and leveraging organizational performance (Banerjee, 2003; Todorovic et al., 2011). This occurs primarily in technology based firms, through technological initiatives and OL, as for example in the micro-electro mechanical systems or nanotechnology sectors (Allarakhia and Walsh, 2012; Newbert et al., 2008).

We thus consider entrepreneurship to be a major resource of the firm to drive technological change and stimulate sustainable growth (Carayannis et al., 2006). Increased CE in technological companies may also lead to improvement in a firm′s performance (Luo et al., 2012; Teece et al., 1997), since CE in technological companies may embrace new resource combinations that generate products, goods, processes, services and systems that can capture a unique business opportunity (Clausen and Korneliussen, 2012; Goodale et al., 2011; Therrien et al., 2011), enabling innovation and resulting in superior economic performance (Antoncic and Prodan, 2008; Langerak et al., 2004; Zahra, 2008).

Finally, to conclude it is thus not surprising that market performance is driven largely by relationships that enable access to technological and human resources, such as technological strategic variables and OL processes, which provide incentives for corporate entrepreneurship (Newbert et al., 2008).

5.2. Implications for Practice

In today′s rapidly changing world, technological companies are compete intensely with each other to achieve a competitive advantage that can differentiate them from others and enable them to obtain a good position or higher performance (Langerak et al., 2004; Newbert et al., 2007). Our results prove useful for practitioners working in technology-intensive industries. They encourage the development of channels by which essential capabilities inside the firm may be developed. Such advice is not necessarily limited to those firms with the best existing resource endowments. Instead, firms must exploit their resources so that they can take proactive steps to improve their competitiveness and gain a sustainable competitive advantage (Newbert et al., 2008), specifically in the field of technology (López Sáez et al., 2005; Martín de Castro et al., 2013; Martín Rojas et al., 2011a, 2011b).

The access and exploitation of technological resources by top managers, as well as the access to capabilities that enable exploitation of the firm′s human resources, may enable firms in technologically intensive industries to attain an advantage over their competitors with respect to external indicators, such as marketing, growth in sales, profitability and market share (Langerak et al., 2004). This finding confirms previous research outcomes where entrepreneurial ability, coupled with technology and the ability to learn and assimilate new knowledge, was found to help firms to achieve more challenging goals in high-technology environments (e.g., Carayannis et al., 2006; Langerak et al., 2004; Newbert et al., 2008).

Managers must also act to promote the presence of technologically skilled personnel in the firm. The provision of training processes may assist employees in developing their social networking abilities within the industry and create organizational contexts that enable individuals and teams to obtain and assimilate new entrepreneurial information. These personnel must in turn be encouraged to share knowledge and expertise with each other, since it might well be appropriate to create communities of practice, internal or external to organizations, to enhance social networking practices that may foster better cooperation and information exchange (Wang et al., 2013).

Likewise, TDCs do a good job in promoting innovation and corporate entrepreneurship (Martín Rojas et al., 2011a, 2011b), mainly in nanotechnology and MEMS (Kassicieh et al., 2002; Tierney et al., 2013), biotechnology firms (Fontes, 2005), high-tech services (e.g., computer science activities, research and development services) and high-tech manufacturing (e.g., chemical industry, aerospace construction, office machinery and computer science equipment) (López Sáez et al., 2005; Martín Rojas et al., 2011a, 2011b), since they aid in the interpretation or anticipation of customer needs, leading to viable and faster solutions in technology firms (Giarratana and Torrisi, 2010).

To promote these three strategic technological variables, managers of technological firms must employ a series of OL processes (García Morales et al., 2007; Wang et al., 2013; Zahra, 2008), which can be complex and may affect both the experience and the cognitive attributes of entrepreneurs in order to improve corporate entrepreneurship (Banerjee, 2003; Martín de Castro and López Sáez, 2008; Todorovic et al., 2011). OL makes it possible to learn better from past entrepreneurial initiatives and discover opportunities by seeing where products (or services) do not exist and may be profitably exploited (Burger-Helmchen, 2009; Carayannis et al., 2006; Todorovic et al., 2011). OL may also assist employees by preparing their minds and increasing their ability to detect and identify potential entrepreneurial opportunities from the environment. Therefore, firms should pay attention to designing and running learning, training and development programs for current and future employees to achieve a good level of entrepreneurial opportunity (Wang et al., 2013).

Further, it is critical for high technology firms to invest in developing and enhance their employees' entrepreneurial opportunity recognition ability. Therefore, CE in technological companies may also lead to improvement in a firm′s performance (Luo et al., 2012; Teece et al., 1997), since entrepreneurial orientation is positively related to product advantage and to proficiency in processes such as launch budgeting, launch strategy and launch tactics, which are positively related to organizational performance (Acur et al., 2010; Bitondo and Frohman, 1981; Langerak et al., 2004; Zahra, 2008). Finally, organizational performance reflects a firm′s ability to redeploy resources in order to innovate and retain entrepreneurial employees (Newbert et al., 2008).

6. Conclusions

The results presented in the previous sections highlight that technological variables (specifically TMS, technological skills and TDCs) and organizational learning capacity are strategic keys to corporate entrepreneurship and to achieving a competitive advantage in technologically intensive industries. First, we have highlighted the role of TMS as a technological strategic variable. Second, developing technological skills has been found to be an important task for entrepreneurs, managers and leaders. Third, TDCs are important ingredients for success in the technology transfer process. Our findings show that these three technological assets jointly influence corporate entrepreneurship.

To promote these three strategic technological variables, managers of technological firms must employ a series of OL processes which allow the firm to obtain the specific knowledge and expertise that it does not possess but that are required to enhance corporate entrepreneurship (Burger-Helmchen, 2009). Consequently, entrepreneurs face both the opportunity and the challenge of catalyzing and accelerating economic development and

leveraging organizational performance, mainly in technology based firms. They can do this through technological initiatives and OL, as for example in the micro-electro mechanical systems or the nanotechnology sector (Allarakhia and Walsh, 2012; Newbert et al., 2008), biotechnology firms (Fontes, 2001; Wang et al., 2013), high-tech services (e.g., computer science activities, research and development services) and high-tech manufacturing (e.g., chemical industry, aerospace construction, as well as office machinery and computer science equipment) (Bolívar Ramos et al., 2012; Martín Rojas et al., 2011a, 2011b).

Given the importance of entrepreneurship for firms' performance and their competitiveness (Clausen and Korneliussen, 2012), we have attempted to improve understanding of which factors promote corporate entrepreneurship within firms. Finally, all of the concepts studied have affected organizational performance directly or indirectly. The choice of technologies enables flexible designs, which will permit further improvements and are often crucial to the enabling the firm to perform efficiently (Matteuzzi, 2011).

Finally, this research has various limitations. First, our data are cross-sectional, making it impossible to examine the evolution of the different variables in our study. Future longitudinal analyses should empirically reinforce the theoretical logic of our hypotheses.

Second, although the OECD questionnaire attempts to avoid bias related to data collection through survey techniques, the CEOs' influence on this study were measured subjectively by respondent perceptions. Nevertheless, completely objective measures related to CEOs influence are rarely found in research. For this reason, additional empirical evidence must be provided by future studies.

Finally, this study has considered all of these variables in the Spanish and European market – only ten OECD countries – and in their service and manufacturing industries. Future research should address these limitations. More research is needed to globalize the results by including both more countries and a greater number of questionnaires per country (budgetary constraints limited the number of questionnaires per country), as well as a greater number of economic sectors. In addition, other variables could be studied, such as the moderating effect of knowledge (Simsek and Heavey, 2011) or absorptive capacity (Jiménez Barrionuevo et al., 2011) in these hypotheses.

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Appendix A

Top management support

Indicate the degree to which you agree or disagree with the following statements about top management support.

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

Indicate the degree to which you agree or disagree with the following statements about the technological skills. The skills of the people in the technology department/unit:

1. Are very superior to closest competitors in hardware and operating systems performance.
2. Are very superior to closest competitors in business applications software performance.
3. Are very superior to closest competitors in communications service efficiency.
4. Are very superior to closest competitors in the generation of programming languages.

Technological distinctive competencies

Indicate the degree to which you agree or disagree with the following statements about whether 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.
6. Effectiveness in setting up programs oriented to internal development of technological or technology absorption competencies, from either R&D centres or suppliers and customers.

Organizational learning

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. Our 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 general, the top managers at our firm have a strong propensity for high risk projects (with chances of very high returns).
- 1.3 In general, the 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.
- 1.4 When confronted with decision-making situations involving uncertainty, our organization typically adopts a bold, aggressive posture in order to maximize the probability of exploiting potential opportunities.

2 New business venturing.
  2.1 The organization has stimulated new demands on the existing products/services in the currents markets through aggressive advertising and marketing.
  2.2 The organization has broadened the business lines in the current industries.
  2.3 The organization has pursued new businesses in new industries that are related to the current business.
  2.4 The organization has entered new businesses by offering new lines and products/services.
3 Self-renewal.
  3.1 The organization has reorganized units and divisions to increase organizational innovation.
  3.2 The organization has coordinated activities among units to enhance organizational innovation.
  3.3 The organization has adopted flexible organizational structures to increase innovation.
  3.4 The organization has trained and encouraged the employees to be creative and innovative.
4 Organizational innovation.
  4.1 The organization has significantly increased:
  4.2 The spending on new product/service development activities.
  4.3 The number of products/services added by the organization and already existing in the market.
  4.4 The number of new products/services introduced for first time in the market by the organization.
  4.5 The emphasis on R&D, technological leadership and innovations.

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 return on assets (economic profitability or ROA).
2. Organizational performance measured by return on equity (financial profitability or ROE).
3. Organizational performance measured by return on sales (percentage of profits over billing volume or ROS).
4. Organization's market share in its main products and markets.
5. Growth of sales in its main products and markets.

Control variables

Finally, please fill in the following general information that helps us to complete the statistical analysis of our study:

1 General business sector.
2 Size:
  2.1 Total number of employees in the organization in 2009.
  2.2 Volume of sales in 2009 (millions of Euros).
3 Nationality.

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