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The anatomy of business failure

A qualitative account of its implications for future business success

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Abstract

Purpose – The purpose of this paper is to analyze the aftermath of business failure (BF) by addressing: how the individual progressed and developed new ventures, how individuals changed business behaviors and practices in light of a failure, and what was the effect of previous failure on the individual's decisions to embark on subsequent ventures.

Design/methodology/approach – The authors resort to qualitative methods to understand the aftermath of BF from a retrospective point of a successful entrepreneur. Specifically, the authors undertook semi-structured interviews to six entrepreneurs, three from the north of Europe and three from the south and use interpretative phenomenological analysis.

Findings – The authors found that previous failure impacted individuals strongly, being shaped by the individual's experience and age, and their perception of blame for the failure. An array of moderator costs was identified, ranging from antecedents to institutions that were present in the individual's lives. The outcomes are directly relatable to the failed experience by the individual. The authors also found that the failure had a significant effect on the individual's career path.

Originality/value – While predicting the failure of healthy firms or the discovery of the main determinants that lead to such an event have received increasingly more attention in the last two decades, the focus on the consequences of BF is still lagging behind. The present study fills this gap by analyzing the aftermath of BF.

Keywords Business failure, Entrepreneurship, Consequences, Interpretative phenomenological analysis, Learning from failure

Paper type Research paper

1. Introduction

Business failure (BF) is a constant in today's business world, being considered an essential and significant part of new business ventures (Ucbasaran *et al.*, 2013; Walsh and Cunningham, 2016). From the extant literature on the topic of the costs bared by the entrepreneurs, it is undeniable that BF is essentially a learning process (Cope, 2011).

Although BF is hard to define, all definitions relate to the same significant event in the lives of organizations and individuals – the defining moment that unfolded over time where the survival of a company ends, creating losses for investors and creditors alike (Jenkins and McKelvie, 2016). How that moment is determined varies widely among authors who have analyzed the phenomenon (Ucbasaran *et al.*, 2013; Khelil, 2016).

There is considerable debate regarding the narrative of the creation and performance of entrepreneurial efforts, but failure has received much less attention (Mantere *et al.*, 2013;

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Shepherd *et al.*, 2015). The literature has thus far focused on predicting the failure of healthy firms, namely through prediction modeling using financial ratios (e.g. Altman, 1968; Zopounidis and Doumpos, 1999; Andreeva *et al.*, 2016); the discovery of the main determinants that lead to such an event (Lane and Schary, 1991; Ooghe and De Prijcker, 2008; Ejrnaes and Hochguertel, 2013; Artinger and Powell, 2016); and the consequences that ensue from the failure (Jenkins *et al.*, 2014; Mueller and Shepherd, 2016). While the first two research areas have received increasingly more attention in the last two decades, focus on the consequences is still lagging behind (see Amankwah-Amoah, 2015).

This paper aims to contribute to the scarce empirical research on the outcomes of BF for individuals (as emphasized in Ucbasaran *et al.* (2013)). Many researchers highlight the need to analyze the aftermath of BF, specifically addressing: how the individual progresses and eventually develops new ventures (Mantere *et al.*, 2013); how individuals change business behaviors and practices in light of a failure (Cope, 2011); and what is the effect of previous failure on the individual's future career path and/or decisions to embark on subsequent ventures (Ucbasaran *et al.*, 2013). The gap includes the learning process and all the actions and changes that are born from it. Questions like "How can these different outcomes be explained? What is it about certain individuals, BFs, and/or the nature of the stories that obstruct – rather than generate – action?" (Ucbasaran *et al.*, 2013, p. 197) are yet to be answered and require a better understanding.

The study thus intends to contribute to the empirical literature on the consequences of BF by developing insights into the consequences of BF and the reasons/conditions that enable entrepreneurs to succeed or otherwise hamper their success after a BF.

The pertinence of the study of failure is widely asserted, as are the benefits that emerge from such an experiences. The authors also believe that there is a key progression in time for the individuals, as successful business leaders are not born successful but rather fail continually until they achieve success – a concept that could prove useful to institutions and aspiring entrepreneurs.

To achieve this, we will focus on currently successful entrepreneurs who have failed in the past and try to understand the consequences of their past BF in the creation of new business ventures. Although many consider failure a pathway to success due to it being a learning experience (Cope, 2011; Mueller and Shepherd, 2016), there is a lack of research dealing explicitly with prior failure as a condition for success or other considerations that reflect long-term orientations for the individual (Ucbasaran *et al.*, 2013; Singh *et al.*, 2015).

Qualitative research is key to understanding the "how" of the phenomenon, especially when trying to understand the development of the individual within his/her context (Yin, 2009). Thus, personal accounts and narratives are essential to understand the process, although it has only recently been applied to this field (Mantere *et al.*, 2013; Byrne and Shepherd, 2015; Singh *et al.*, 2015). Specifically, we will employ the Interpretative Phenomenological Approach (Smith and Osborn, 2007), using a set of six selected case studies of entrepreneurs from several countries.

2. Research synthesis

2.1 Defining BF

BF is a not a simple concept to define (Wennberg and DeTienne, 2014). Many authors (e.g. Deakin, 1972; Chen and Williams, 1999) do not feel the need to define the concept, while others (e.g. Dimitras *et al.*, 1996; Everett and Watson, 1998; Bell and Taylor, 2011), present a wide array of definitions in order to be as comprehensive as possible.

An analysis of 201 journal articles on the topic showed that besides the studies that do not provide an explicit definition of BF (about 70 percent of the total),[1] those that explicitly give a definition focus on one or several dimensions of BF, most notably: bankruptcy, business closure, ownership change, and failure to meet expectations.

This paper considers that BF occurs when a business closes, either for financially related reasons or willingly, which in the latter case can be due to the owners not achieving their expectations (e.g. not enough current return, no growth expectation, poor performance, etc.) in contrast to personal reasons (e.g. retirement, relocation, family issues, etc.).

2.2 *On the consequences of BF*

BF occurs over several distinct phases, usually contiguous to a significant event that is considered the tipping point of “failure.” The process includes the analysis of the conditions and series of events that lead to BF. It also considers the post-failure situation, focusing on the consequences of going through such a stressful situation.

The relevant literature can be categorized into three main research streams (see Pretorius, 2008; Ucbasaran *et al.*, 2013; Amankwah-Amoah, 2015, 2016): BF prediction through modeling; determinants or causes of BF; and consequences of BF.

A brief bibliometric analysis of the documents published in journals indexed in the Web of Science (reference date: January 28, 2017), using as search keywords the combination of “business failure” or “start up failure” or “company bankruptcy,” limited to the field of Business Economics, resulted in 201 journal articles that focused on BF. More than one third of these studies analyze the determinants of failure (36 percent), with 31 percent trying to predict failure in organizations through mathematical models. The aftermath and outcomes of BF is only analyzed in 14 percent of the studies[2].

To better understand the consequences of BF, researchers draw on many theories from the field of psychology, such as Attribution Theory (Mantere *et al.*, 2013; Amankwah-Amoah, 2015) and grieving (Bell and Taylor, 2011), in order to determine what each individual goes through when they experience a BF. Others look at specific conditions of BF that might affect the impact of the costs, such as applying the personal bankruptcy law in a given region and the asset protection it provides (Hasan and Wang, 2008), and factors associated to Institutional Theory. Based on Ucbasaran *et al.*'s (2013) work, it was possible to summarize the main theoretical contributions that frame this stream of research (see Table I).

When widening the view, Figure 1 draws the theoretical framework for studying BF, in particular the consequences of BF. As illustrated, BF is a continuous process with key moments that require further study. The determinants of BF are intimately related with the consequences and the outcomes, as well as the psychological processes involved, and should not be separated from the individual, given the cognitive, behavioral and personality theories involved – all leading up to a key stage: rising from failure to achieve success.

Most of the studies analyzing the consequences of failure are focused on the individual. This may be justified by the fact that such individuals are either the survivors of the failure or the ones that support most of the consequences. In this vein, it comes as no surprise that most of the research done in this field is based on theories from psychology (e.g. Shepherd *et al.*, 2009; Yamakawa *et al.*, 2015). This specific literature stream usually considers failure a traumatic event (Ucbasaran *et al.*, 2009; Byrne and Shepherd, 2015), where the individuals related with the failure gain a series of costs and benefits during the following period. Researchers feel that it is important to understand the different phases that one goes through after the trauma, which can resemble, in many ways, the death of a family member (Bell and Taylor, 2011; Jenkins *et al.*, 2014).

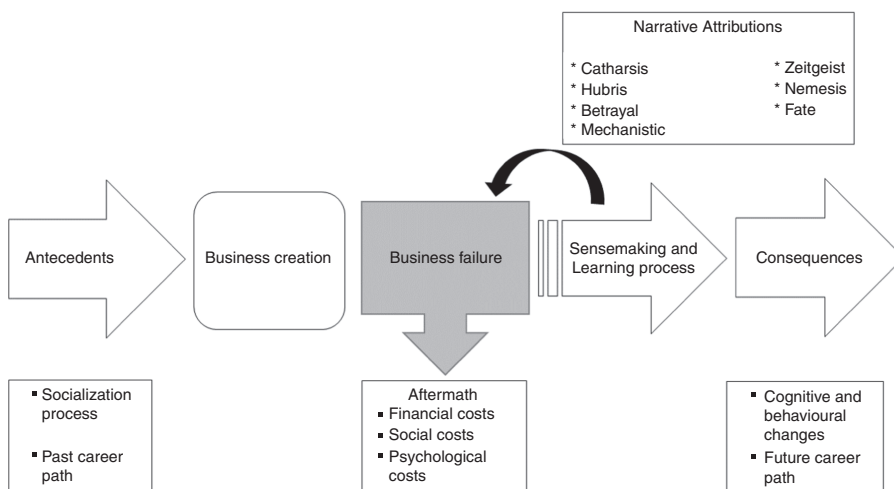
Ucbasaran *et al.* (2013) divide the consequences of BF into three main timeframes: the Aftermath – the instant consequences that are supported after the event; Sense-making and the learning process – an evolving process that starts and takes place for an variable amount of time after the failure; and the Outcomes – the long-run outcomes for the individual affected by the experience.

In the first stage, Aftermath, Ucbasaran *et al.* (2013) refer essentially to the costs, which they basically classify as financial, social and psychological. The financial costs of failure may imply

Time-Frame	Factor	Theoretical approaches	Relevant studies
Aftermath	Social costs	Institutional theory, stigma, social exclusion and network theory	Kirkwood (2007), Safley (2009), Cardon <i>et al.</i> (2011), Cope (2011), Simmons <i>et al.</i> (2014), Singh <i>et al.</i> (2015), Nielsen and Sarasvathy (2016)
	Psychological costs	Attribution theory, personality theory	Cardon and McGrath (1999), Shepherd <i>et al.</i> (2009), Cardon <i>et al.</i> (2011), Pal <i>et al.</i> (2011), Mantere <i>et al.</i> (2013), Amankwah-Amoah (2015), Yamakawa <i>et al.</i> (2015)
	Financial costs	Bankruptcy law and institutional theory	Hasan and Wang (2008), Eidenmüller and van Zwielen (2015), Wakkee and Sleenbos (2015)
Sensemaking and learning	Learning from failure	Organizational learning theory, experiential learning theory	Pretorius (2008), Politis and Gabriellson (2009), Ucbasaran <i>et al.</i> (2010), Shepherd <i>et al.</i> (2014), Yamakawa and Cardon (2015), Mueller and Shepherd (2016)
	Grief, emotions and learning from failure	Psychology theory, sense making and attribution theory	Cannon and Edmondson (2001), Shepherd (2003), Shepherd <i>et al.</i> (2009), Ucbasaran <i>et al.</i> (2010), Cardon <i>et al.</i> (2011), Cope (2011), Bell and Taylor (2011), Jenkins <i>et al.</i> (2014), Byrne and Shepherd (2015), Singh <i>et al.</i> (2015), Yamakawa <i>et al.</i> (2015), Yamakawa and Cardon (2015)
	Management of costs	Problem-focused and emotional-focused coping, personality theory	Singh <i>et al.</i> (2007), Shepherd <i>et al.</i> (2009)
Outcomes	Cognitive outcomes	Cognition and motivation theory, cognitive bias	Pretorius (2008), Politis and Gabriellson (2009), Ucbasaran <i>et al.</i> (2009), Byrne and Shepherd (2015), Mueller and Shepherd (2016)
	Behavioral outcomes	Personality theory, labor economics and sociology of careers	Cardon <i>et al.</i> (2011), Simmons <i>et al.</i> (2014), Jenkins <i>et al.</i> (2014), Rider and Negro (2015), Amankwah-Amoah (2016)

Source: Adapted from Ucbasaran *et al.* (2013)

Table I. Theoretical frame of the consequences of BF research stream



Source: Authors' compilation

Figure 1. A theoretical framework for studying the process of business failure for an individual

the loss of a main source of income, with the possibility of personal debt (Cope, 2011; Bruton *et al.*, 2011). These costs might be increased or reduced by several factors, such as the entrepreneur's current investment portfolio or the ease which they may have in obtaining new income sources (Ucbasaran *et al.*, 2013). Another factor is personal asset protection related to the bankruptcy laws that exist in some regions (Eidenmüller and van Zwieten, 2015; Wakkee and Sleenbos, 2015). As Hasan and Wang (2008) explain that exemptions might allow entrepreneurs to shield part of their assets, serving as a cushion for negative consequences.

When considering the social costs, they can understandably be devastating to the individual, both in personal and professional terms (Ucbasaran *et al.*, 2013; Nielsen and Sarasvathy (2016). Drawing knowledge from Institutional Theory and Network Theory, the authors in this field argue that relationships suffer through this process, leading to stigma and negative discrimination toward future professional endeavors (Ucbasaran *et al.*, 2013; Simmons *et al.*, 2014; Nielsen and Sarasvathy, 2016). An example of a factor that increases the social cost of failure is given by Kirkwood (2007), when he concludes that a culture with Tall Poppy Syndrome can be more unforgiving of high achievers who fail, pending on the perception of blame.

The media also often attributes BF to mistakes made by the managers (varying from region to region), being mostly linked to the impact and consequences the failure generates on its environment – all leading to a strong stigma (Cardon *et al.*, 2011). Of the 389 failure accounts in Cardon *et al.*'s (2011) data set, 331 contained statements on the impact of the failure being reported. The most frequently reported impact of failure (125 accounts, 38 percent) was the development of a sense of stigma around entrepreneurs who had experienced failure. One account stated that (see Cardon *et al.*, 2011, p. 87) "Failure leads to exile and an abrupt end to one's career path."

Singh *et al.* (2015) view stigma as a process rather than a static label, considering that it occurs before and after the failure, arguing that it influences the failure itself and future endeavors. They also describe some situations where the stigma actually motivates the failed entrepreneur into starting a new venture, increasing the complexity of the social phenomenon.

The other costs considered in this framework are the psychological ones. These costs can be either motivational or emotional (Shepherd *et al.*, 2009; Ucbasaran *et al.*, 2013). Indeed, failure can be emotionally very stressing, creating negative emotions that are "inextricably linked to its complex social cost" (Cope, 2011, p. 611). Cope (2011) and Yamakawa *et al.* (2015) present empirical evidence where shame and embarrassment arise in failed entrepreneurs, derived from their strong commitment to the business stakeholders. These negative emotions often lead to withdrawal and, eventually, to loneliness, possibly impacting so strongly on the individual to the point of interfering "with the individual's allocation of attention in the processing of information" (Shepherd, 2003, p. 320).

An example of an intensifier of psychological costs which is presented by Cannon and Edmondson (2001) is the individual's own personal life experience and early socialization processes. The authors argue that parents often shield their siblings from harm while schools reward students who committed fewer mistakes, creating control-oriented behavior rather than learning-oriented behavior that leads to a significant decrease in self-esteem when focusing on one's own failure. This ultimately leads people to engage in activities that improve their self-esteem rather than potentially damaging ones (i.e. to say, riskier situations of failure).

Motivation may also take a deep hit with failure, creating "a sense of helplessness, thus diminishing individuals' beliefs in their ability to undertake specific tasks successfully in the future and leading to rumination that hinders task performance" (Ucbasaran *et al.*, 2013, p. 179). However, it may also serve as a boost for future endeavors as a compensation for missing a self-defined goal (Cardon and McGrath, 1999; Ucbasaran *et al.*, 2013).

Ucbasaran *et al.* (2010) conclude that both serial and portfolio entrepreneurs were less emotionally attached to their businesses, being less likely to have an adjusted optimism bias and having more resistance to psychological costs. Ucbasaran *et al.* (2013, p. 180) also mention that entrepreneurs displaying “learned optimism” are prone to make sense of failure in a more beneficial way, motivating them to engage in future entrepreneurial activity and to see adversity as a challenge, for instance.

The sensemaking and learning dimension highlights the social-psychological process associated with failure, which might be framed by grief (Bell and Taylor, 2011; Jenkins *et al.*, 2014) and attribution theory (Mantere *et al.*, 2013; Yamakawa *et al.*, 2015), as well as the positive learning from experience (Cope, 2011; Singh *et al.*, 2015).

An important article to consider here is that of Mantere *et al.*'s (2013) on narrative attributions of BF, where the authors attempt to reconstruct and define the determinants of failure through the attributions of different points of views related to a single situation, thus analyzing how the individuals make sense of reality. Through an inductive analysis, the study categorizes seven distinct categories of attributions: catharsis, hubris, betrayal, mechanistic, zeitgeist, nemesis and fate. The authors ultimately relate these attributions with the sensemaking and recovery process, concluding how they are “driven by the cognitive and emotional needs of organizational stakeholders to maintain positive self-esteem and recover from the loss of the venture” (Mantere *et al.*, 2013, p. 470).

As Shepherd (2003) highlights, the experiential nature of learning from one's mistakes is also present in owners of businesses that failed, prompting a revision on the individual's knowledge of how to manage their own business effectively. However, the author also clearly establishes that failure induces a process of grief, creating an obstacle to learning from the event experienced (Shepherd, 2003). This is allied with the need to make sense of the situation, as it is “an interpretive process [that] requires people to assign meaning to occurrences [...] and involves ongoing interpretations in conjunction with action [...]”. It [sensemaking] involves both the cognitive and emotional aspects of the human experience” (Ucbasaran *et al.*, 2013, p. 184).

Interestingly enough, Yamakawa and Cardon (2015) find evidence that entrepreneurs that focus on their role in the failure are most likely to learn more from their experience than individuals that focus on external influences.

The last dimension is related to the long-term Outcomes for the individual due to the experience he/she had with the failure, its costs and how he/she made sense of them (Ucbasaran *et al.*, 2013; Mueller and Shepherd, 2016). This includes how much the individual learned and how the individual changed their business practices. As Cope (2011) argues, the importance of failure lies in all the changes that follow from it, where the individual reviews a set of ways and might even create longer-term positive consequences.

Deriving from cognitive and behavioral theories, Politis and Gabrielsson (2009) conclude in their work that experience with business closure is associated with more positive attitudes toward failure. Basing on the Experiential Learning Theory, the authors argue that “experience from closing down a business seems to lead to a more positive attitude toward failure by rendering existing behaviors and routines inadequate, which in turn can trigger change in underlying values and assumptions” (Politis and Gabrielsson, 2009, p. 376).

Cardon *et al.* (2011) and Rider and Negro (2015) further explore the impact of failure on the future career path of entrepreneurs, finding that some prefer to continue to engage in entrepreneurial activities while others opt for jobs in more established companies.

3. Methodology

The method of qualitative research employed in this study consists of a set of case studies, using the methodology design advanced by Yin (2009), based on a collection of personal accounts from individuals that meet pre-defined criteria through face-to-face interviews, using the Interpretative Phenomenological Analysis (IPA) (Smith and Osborn, 2007). The IPA

approach has been used before in the research on “BF Consequences” (Cope, 2011) and enables an introspective view of experiencing failure. Cope’s (2011, p. 608) use of interpretative phenomenological research is justified with “the strength of a qualitative research design such as this lies in its capacity to provide situated insights, rich details and thick descriptions. Richness is provided by paying close attention to both context and process [...]” This methodology allows the researcher to empirically achieve a better understanding of the emotional consequences of failure and its relation with the learning process.

For the purposes of this study, the main advantage of this methodological approach lies in the possibility of thoroughly investigating an individual and his/her progression over time, within a real-life context (Yin, 2009) – which, as we have determined from the framework (cf. Figure 1), is fundamental for the appropriate analysis of the experience.

The analysis will start with an account of the BF process, trying to extrapolate what the individual considered were the determinants of the failure. The research should therefore include a full overview of the BF. The analysis will then focus on understanding the impact of the aftermath, in terms of the financial, social and emotional costs (Ucbasaran *et al.*, 2013; Singh *et al.*, 2015; Nielsen and Sarasvathy, 2016). This includes not only identifying the moderators of the cost, but also an effort to identify how the individual managed to overcome those costs, acting on the assumption that they are closely related to the learning process (Cope, 2011; Yamakawa and Cardon, 2015; Mueller and Shepherd, 2016). Since this is reported through a personal account, it is also part of the sensemaking process (Cope, 2011; Yamakawa *et al.*, 2015). In a following stage, we will focus on the sensemaking process, learning process and the outcomes of the individual.

Particular attention should be paid to the psychological processes that influence learning, such as grieving (Cope, 2011; Jenkins *et al.*, 2014), narrative attribution (Mantere *et al.*, 2013; Amankwah-Amoah, 2015), and loss of orientation strategy (Shepherd, 2003).

Figure 2 summarizes the main steps and the guideline research questions of the empirical work.

To obtain a valid data set, the following criteria were defined with which all submitted cases had to comply in order to be considered for this study:

- (1) The individual must be an entrepreneur, being directly involved in the creation of both the failed and the successful business;
- (2) The individual must have been closely related to a BF situation as defined in Section 2, preferably with one or several of the following conditions:
 - part of the venture’s founding process;



Figure 2.
Operationalized
framework for
studying business
failure (BF)
experiences

- CEO or other high management level position; and
 - personal or family-related ownership stakes in the venture.
- (3) The failed business must also follow one or several of the following conditions:
- there must have been significant losses associated with the failure (e.g. initial round funding, years of dedication); and
 - the reason for closure must not be personal (e.g. retirement, as mentioned by Watson and Everett, 1996).
- (4) The successful business should have a significant commercial success with a considerable profit rate, solid enough to support the founders or show sufficient recognized potential growth.

For this study, and in line with other qualitative studies in the area (e.g. Cope, 2011; Pal *et al.*, 2011; Singh *et al.*, 2015), the cases selected were purposive by nature, meaning that any individual that filled the pre-requisites would be of significance for the research project. An effort was made to not contain the search within a single country, in particular the concentration within a single region in Europe, although admittedly being difficult due to the selection criteria defined and the very own personal nature that study subject demands.

To obtain these case studies, extensive contacts with potential candidates were made through personal networks, social networks, references and internet research. In total, the research was advertised through several European social networks of entrepreneurs, 12 personal reference requests plus 2 academic research reference requests. This initial effort resulted in 19 potential case studies (from a variety of countries, namely Belgium, Denmark, Finland, France, Portugal, Spain, and The Netherlands), of which 13 contacts were followed through. Of these 13 contacts, four did not respond and three failed to pass the pre-verification phase. The final result yields the six case studies presented in Section 4, composed of individuals that generously agreed to participate in this study.

Six data collection interviews were conducted with successful entrepreneurs from two main regions in Europe, specifically the Nordic region (with Finnish and Danish representatives) and the South of Europe (with Portuguese representatives) (see Table II). Although two studies on the consequences of BF already focused on individuals located in Nordic countries, most notably Denmark (Nielsen and Sarasvathy, 2016) and Sweden (Jenkins *et al.*, 2014), no study has yet analyzed individuals from the South European countries, less so in comparison with their Nordic counterparts. Such comparison is potentially very interesting as these two regions contrast significantly in terms of culture, particularly in terms of uncertainty avoidance and indulgence (Hofstede and McCrae, 2004), two traits significantly associated with entrepreneurial behaviors and attitudes (Mueller and Thomas, 2001). Though from the South of Europe we only have Portuguese representatives, according to Hofstede's cultural dimensions Portugal and the other Southern European countries (Italy, Greece, and Spain) share common traits. These countries are characterized by very high uncertainty avoidance and very low indulgence, which means that in these cultures innovation may be resisted, security is an important element in individual motivation, and there is a tendency toward pessimism. In contrast, Nordic countries (Denmark, Finland, Iceland, Norway, and Sweden) citizens do not need a lot of structure and predictability in their work life and evidence a tendency toward optimism (see <https://geert-hofstede.com/>).

As can be observed in Table II, the Nordic representatives are younger (26 years old, on average) than their Portuguese counterparts (44 years old, on average), presenting lower levels of formal education (at most they have a bachelor degree, whereas the Portuguese entrepreneurs have master degrees or MBA). Regarding the business areas of the ventures that have failed, they were diverse, including manufacturing (food cutlery, medical/

	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
<i>Individuals traits</i>						
Name	Marius	Brian	Mikko	Paulo	José	André
Nationality	Danish	Danish	Finnish	Portuguese	Portuguese	Portuguese
Age	25	26	27	49	48	35
Education level	High school	Bachelor degree	Bachelor degree	Master degree	MBA	Master degree
<i>Business that failed</i>						
Business area	Medical/cosmetics	Food cutlery	Food services	Leisure activities	Sound engineering	Automation engineering
Investment	€300 thousand	€7 thousand	n/a	n/a	€300 thousand	n/a
Year started	2007	2005	2008	1998	2007	2007
Year closed	2013	2006	2009	Undefined (but closer to 2007)	2013	Undefined (but closer to 2011)
<i>Current business</i>						
Business area	Consumer electronics	Consultancy and education	Business events operator	Wearable devices (manufacture of electrical equipment)	Consumer sound engineering	Retail consulting
Investment	n/a	Residual	n/a	€4.5 million	n/a	€500 thousand
Year started	2012	2010	2009	2007	2004	2011
Previous year revenue	€1.1 million (Crowdfunded)	€40 thousand	€2.9 million	Undisclosed	Undisclosed	Undisclosed (positive)
<i>Interview</i>						
Interview date	6/6/2014	3/25/2014	3/11/2014	2/27/2014	6/2/2014	5/26/2014
Duration (minutes/hours)	50 m	1 h	1 h	2 h	50 m	45 m
Note: n/a, not available						

Table II.
Case study participants basic information

cosmetics), and low (food and leisure) and high knowledge intensive (sound and automation engineering) services. When disclosed, the amount of financial investment in the failed venture was relatively low (between 7 and 300 thousand euros). The failed ventures were, on average, six years in operation, with the time invested in the business being higher for the Portuguese (seven years, on average) in comparison to the Nordic (four years, on average) entrepreneurs. All the new entrepreneurial ventures operate in a distinct business area of the failed venture. They seem to be rather successful, with more than five years in business (at the time of the interview), entailing a considerable investment (Cases 4 and 6) or yielding relatively large revenues (Cases 1-3).

After an initial contact and agreement to participate in the study, a pre-screening meeting with the selected entrepreneurs was scheduled, followed by the data-gathering interview where additional information was required to prepare the interview script. The semi-structured interviews, which had specific questions prepared in scope of the proposed research framework, took place during the months of February, March, May and June 2014 in various physical locations, such as company headquarters and college campuses, but also via Skype. They were recorded, transcribed and analyzed through the IPA methodology and the predefined framework in Figure 2 during the months of April and June 2014.

4. Results

4.1 *How the individual progresses and eventually develops new ventures*

The first aspect considered was what follows a BF, in particular how the individual progresses and eventually develops a new venture. Related to this topic, a cost-benefit trade-off analysis seems relevant.

The benefits seem to be truly significant for the individuals, even when costs are not. The individuals also naturally tend to focus on the benefits, telling the lessons learned when they were asked for the narrative – particularly visible with Brian, André and Marius. Furthermore, there are key events that can be directly related to the creation of the future successful business – Brian met one the future business partners who had acted as a mentor of his failed project, Paulo decided to go back to college only to find the next business idea, and Marius kept the same partner in all of the started 4 companies. Business connections are known to be synergic, thus it is no surprising to find that the effect continues even when amidst failure.

It is worth noting that some of the successful projects were already being started while the failures were taking place, most specifically at the end. Mikko was already quite involved in the first steps of the subsequent successful business when before the sale of the failing family business; and Marius was preparing a crowdfunding campaign when the first company closed.

Another dimension to consider after the failure is how the individuals deal with the costs. As previously discussed, none of the cases present overwhelming financial losses, meaning that the individuals required minimal effort in order to overcome them. This was mainly attributed to institutions that served as moderators (e.g. governments, family). The reduced financial costs generated relatively minor social and psychological repercussions (Ucbasaran *et al.*, 2013).

Still, a few actions taken to restore normality to the individuals' lives are discernable. Paulo admitted to cutting back on the family budget, taking fewer vacations, along with also going back to college – an action that could surely be connected to a sensemaking process. Actions during the failure are also visible, very likely an anticipatory sign of grief (Shepherd *et al.*, 2009). These actions are visible in the projects that are described as “fading,” for instance, when André claimed that the focus shifted back on the full-time day job or when Marius admits to have focused on creating new businesses rather than just investing in one.

Focusing on the psychological costs, they were visible for some of the younger entrepreneurs but the serial experienced entrepreneurs appeared minimally affected. Mikko and Brian admitted to have suffered a significant amount of stress, while Marius felt that it would have been much worse with the absence of the previously created successful ventures by the time the first one failed. Paulo reduced the costs to a “post-failure depression” to a 24-hour period, while José merely admitted to some frustration for nearing loss immunization. André rationalized the failure as a calculated risk and is proud of it for being a rich experience. The fact that both André and Marius's project faded away could be pivotal for their emotional reaction, in particular in the case of Marius, admitting some attachment to the failed company.

It is also arguable how opportunity costs are smaller when the entrepreneur is younger. Paulo's narrative focused much more on the family responsibility, while Marius' focus was on where the nature of such a professional life would take.

It is also very easy to identify the benefit of certain skills gained during the BF. For example, Marius admitted to the usefulness of learning how to set up a company in the first business while Mikko valued the knowledge of how to manage a financial budget. These skills seem to be more prevalent in younger individuals, as would be expected, since they have much more to learn. André recognized this, stating that the professional experience stemming from entrepreneurial business or established business is similar, only the risk involved changes.

Similarly to the costs/learning relationship, a small-scale business investment does not necessarily mean that it does not yield important lessons for the individual. Brian claimed learning a lot in terms of working with teams, considering that it was good that it happened with an investment of €7,000 rather than a much higher amount. This also includes time investment, with Marius and André both admitting to have gained a great deal from a relatively small investment of time when compared to their other projects.

An unexpected observation was made when half of the cases explicitly or implicitly declared that failing was a very stressful situation, and that the moment the company closed was somewhat of a relief. Mikko spoke of “seeing the light at the end of the tunnel” during the stressful demise, claiming a invigorated will to start new projects, right after a small vacation. Brian reported alleviating overall stress and generally feeling better after closing the project, at a time when the pressures was already having very negative influences. Marius vividly described immediate moment after closing the first company, without however showing negative feelings:

Actually, when we said to each other “Hey, okay, it’s over [...] [...] it was a big relief. It was like taking the biggest backpack off your shoulders [...] it was a really great feeling, I can so easily remember where we were sitting, what the weather was like and the feeling in my body. It was a crazy feeling, only kind of positive somehow.

Such a detailed description is revealing of the importance of the event and the backpack actually illustrates perfectly the figurative burden off the shoulders.

It is interesting to see other individuals that were not as lucky to have those types of moments, where the connection was simply cut off. Paulo was still in legal court battles at the time of the interview, a decade after the BF. It was clear the whole tiredness of dealing with the issue. José also stressed a failed expectation to shut down the eventually failed venture much faster than it actually happened, admitting that the goal was to be as fast as possible in order to cut losses, unattainable due to facing a lot of slow-moving stakeholders that delayed the process several months.

Of course, the situations illustrated here do not have significant follow-up costs, like many entrepreneurs with personal debt issues and the lack of a source of income. Still, it might be relevant in removing the uncertainty that is so stressful for many.

Some propositions can be derived from the above exposition on the process how the individual progresses after the BF and eventually develops new ventures:

- P1. The likelihood and profitability of progressing toward a new business are increased when (a) individuals perceive positive learning benefits from the BF (b) individuals share meaningful/useful business connections and/or support from science and technology infrastructures (c) failed projects did not present substantial personal financial loss and (d) there are moderate factors, such as the support of formal (government) and informal (e.g. family) institutions, that curb the perceived costs involved in the BF.
- P2. Age impacts significantly on the perceived psychological costs of BF.
- P3. Age moderates the effects of learning benefits perceived from BF.

4.2 How individuals change business behaviors and practices in light of a failure event

In business, learning usually means a change in “how things are done.” In the case of the defined framework, these changes are usually most visible in the longer-term outcomes.

In terms of cognitive changes, the existing literature focuses on optimism (Ucbasaran *et al.*, 2013), an aspect this study does not specifically address. Instead, it focuses on other cognitive changes, especially on the perception the individuals have of themselves,

entrepreneurship and other life-related topics that were brought up in the non-rigidity nature of the interviews. The behavioral literature focuses on the intention of continuing to launch ventures (which was a pre-requisite for this study) and changes/improvements in business practices, which is also addressed in the course of this study.

In light of this, several key points were identified that could support the current literature, add other relevant information and indicate further paths to better understand the phenomenon.

The main question lies in what way do the individuals change their business behaviors and practices in light of a previous failure event – a process that turned out to be easily observable with clear links between the two different experiences.

For instance, and as previously discussed, it is easy to associate Paulo's values and the measures implemented by the entrepreneur of the successful company with the betrayal previously experienced by the failure. One could identify that it does relate these with these aspects on some levels, such as in the attention paid to drawing up much more tightly written contract with the owners of his business to avoid litigation and ill intentions. Brian also claimed some business practices changes, specifically regarding team picks, much as André said that on the following projects, the partners were chosen in a very different way from the previous project.

Marius also learned cognitive changes that shaped his behavior, by discovering that, in this particular case, the motivation was affected by what was daily developed, asserting that it was not enjoyable to just focusing on developing a product without having business tasks, a feature that drove Marius to start new businesses. However, the narrative progressed to another important behavior change, where it's decided that one could not be running multiple successful businesses and a much needed focus in order to produce better results, culminating in the closure of two projects and the launch of the latter most successful one.

A specific type of behavior worth analyzing is the individual's actions with regard to risk after failure. While it is evident that these cases present a somewhat biased analysis for this factor, it seems clear that the individuals maintained the same attitudes toward prospecting and assessing new market opportunities. Even though they failed, they kept trying, with many reporting an increase in confidence. André, Brian and Marius also admitted that they have invested more of themselves and taken more risk in the projects, claiming to value more attitudes such as a "commitment," "focus" and "100% in" within their projects.

Of course, these behavioral changes are also accompanied by significant cognitive change. As stated, confidence and self-awareness of their skill was repeatedly brought up by the interviewees. Brian and Mikko also said that knowing they can survive failure is important, most certainly increasing their resilience. This might indeed support Shepherd's (2003) conclusion that being aware of these normal negative emotions resulting from failure can in fact reduce the stress associated with it.

André was proud of the failure and Marius called it a unique learning experience. This outlook is mostly highlighted by the younger individuals, whereas the older entrepreneurs tend to focus much less on this dimension, although some changes in their behavior are still visible (perhaps to lesser degree), as previously discussed. For instance, Paulo decided to no longer work for the Portuguese market and ended up with a Portugal-based international company without a single Portuguese client; and José admitted to have never used venture capital money again, stating that forward such financing would be raised in a much more careful way.

Based on the above discussion, we derive the following propositions on changing business behaviors and practices in light of a BF:

- P4.* BF tends to entail changes in subsequent business behaviors and practices (e.g. legal procedures/contracts; choices of the management team; choices of the funding partners/sources; strategic business focus).

4.3 The effect of previous failure on the individual's future career path and/or decisions to embark on subsequent ventures

Regarding the effect that the failure has on the future path of the individuals, it is safe to say that it had a significant impact. The literature usually refers to changes in career path as a coping mechanism to overcome financial costs (Ucbasaran *et al.*, 2013). Ucbasaran *et al.*'s (2013) study, however, does not have such a narrow view of career change (although one of the individuals admitted this applied in his case). It tries to identify smaller shifts in the entrepreneur's progression, such as changing industries, changing roles and even investing in further education to achieve a different career path.

First and foremost, it should be noted that these cases present a biased view of how the careers may possibly progress – after all, by design, these are considered people who followed and became successful entrepreneurs.

But even within the entrepreneurial culture, differences and deviations can be found between success and failure. For instance, Paulo shifted from a low-tech venture to a full-fledged tech start-up, focusing mostly on research and development. This was fully intentional, as it was one of the reasons why Paulo went back to college, to afterwards engage in such a project with expectations of entering the international market.

In truth, all the interviewees changed their industry when they started new projects. Mikko shifted from food services to event management and Brian focused on entrepreneurship education. André preferred to stay on the path of corporate job career and invested in the IT retail market, re-applying the knowledge previously gained, taking advantage of opportunities detected previously and compensating for the costs of the failed venture. José also showed no indication of continuing to invest in projects within the music equipment industry, admitting that it was an extremely difficult industry to enter.

Marius presented an even clearer picture, by claiming that the failure was a help in deciding what professional career to choose. The failed business was in medical/cosmetic products and the successful one in pure consumer electronics, but they do however share key traits – they both focus on a physical product with global potential. Marius adds that it is exactly what he wants to do with his career, acknowledging that the latter successful investment was identified and pursued based on the knowledge gained with other businesses and the failed venture.

From the above, we propose that:

- P5.* BF is likely to significantly impact on individuals' future career path.
- P5a.* Subsequent business ventures tend to operate in distinct business areas of the former failed ventures.
- P5a.* Subsequent business ventures tend to require new knowledge and/or the application of entrepreneurs' accumulated knowledge to new areas.

4.4 How can these different outcomes be explained? What is it about certain individuals, BFs, and/or the nature of the stories that obstruct – rather than generate – action?

An entrepreneur's lifestyle is often considered a continuous iterative process. André appears to share this vision, when claiming that individuals that share these kinds of traits will try again until they are successful – only to later distance themselves and support new projects, by developing or investing in them. This progress is not always continuous.

Considering this sample, many individuals had to launch several projects until they achieved a desirable level of success. Marius owned three companies at a point, until identifying his current venture, deciding to separate from all other projects and focus on the one that foresaw the highest return. Paulo, after having businesses in the IT industry, real estate industry and leisure industry, decided to put his professional activity on hold to

return to college in order to be able to start a different kind of company. Another example of how this progression is somewhat chaotic is the case of Mikko, who was already involved in his next project while still tied to the failing venture. André kept working for the IT company for years while gathering the required resources to launch his technological start-up.

Context seems to influence the actions and decisions of the individuals in the short term, but a wider view shows that success can be achieved in spite of unfavorable environments, as it appears to stem from the nature of these remarkable individuals. These individuals found success most likely due to the characteristics they possess, such as resilience, favorable personal background to overcome the costs and, perhaps, a bit of luck.

The individuals' cognitive traits and the changes they experience could also prove to be pivotal for the future outcomes. A good example is when Paulo firmly states that managing a business is key driver, along with wanting to lead and to be the boss. Paulo shows great self-awareness when admitting to be stimulated by unstable environments – a contrast with André's case, which seems to be very risk averse but, nevertheless, manages to plan a career in accordance in order to avoid high exposure to the risk of failure.

Another important phenomenon occurs when Marius distances himself from the failure. Dwelling on the fact that of previously creating two other relatively successful companies when the first one was nearly shutting down, admitting that had the focus been put exclusively on the one company that failed it would have been a “more personal failure.” Marius talks later about being unsure of he would have invested in the last and more successful business if the previous had not occur – specifically, if the chance of learning “what to do and what not to do,” the chance of trying different things and projects, or even if the focus had only been set on one project, concluding that actually would never have met his current partners of the successful business.

Still on the issue of factors that can generate or prevent action, a common important narrative point is related to how the business venture ends. The interviewees seem to value a decisive and fast closure, as the source of stress seems to derive more from “failing” than from the actual “failure.” The contrast is also visible in cases that dragged out over time and passed from stakeholder to stakeholder, battling in procedural and legal disputes.

Even if the individual wishes to try again or keep the venture going (as previously mentioned, a possible method of anticipatory grief; Shepherd *et al.*, 2009), when the time comes to inevitably shut the business down, there is evidence that the faster it happens the better it is for the individual to move on – much like removing a bandage quickly.

From the above, we propose that:

- P6. Subsequent business success encompasses business intermittence and several past BFs.
- P7. Fast closure of the failed venture is likely to push entrepreneurs to subsequent new business creation.

5. Conclusions

5.1 Main contributions of the study

The evidence gathered shows that previous failure impacts on individuals strongly. Such an impact appears to be conditioned by the individuals' experience and age, and their own perception of blame within the failure. However, for these particular individuals, it does not appear to be affected by the size of the project or the amount of financial loss.

Moreover, certain antecedents, specifically, the involvement of institutions in the individuals' lives, can significantly curb the costs suffered after the failure. Some case studies reported a feeling of relief when the failed business closed. It is possible that a quick

cease of contact with the failure may be beneficial, in contrast to the case that endured long legal battles.

It was also found that all the individuals' career paths were influenced by the failure, with some having a much more significant impact than others. Failure or failing were a pivotal moment in the lives of the participants in this study – some individuals were even already developing or had already developed their next full-time project while the failure occurred, having immediately changed focus afterwards.

5.2 Implications of this research on theory and practice

Theoretical and practical implications can be drawn from these conclusions. For young and aspiring entrepreneurs, their future ventures should be seen first as a learning experience and should be prepared with serious consideration for failure. They should adapt their expectations to the fact that, in case of failure, it is not a lifetime ban on success. It is possible to bounce back and the lessons that they acquired during the failure may prove very significant in the future. Evidence was also found on the development of key cognitive and behavioral changes that the individuals directly relate to the failure and are considered crucial for their current success. Other key aspects that influence success were identified from the previous failure, like meeting a future business partner or connection during the process.

With regard to the implications for institutions, cases have been described where entities restricted or inflated the aftermath costs. In the case of NGO and education professionals, failing to maintain a business venture is still a very significant learning experience, especially at a young age. In these cases, three individuals participated in such programs and two launched businesses within a prepared risk-controlled framework, later growing out of it. Thus, preparation of a controlled environment for failure appears to produce truly interesting results. Bolinger and Brown (2015) make a similar case when claiming that entrepreneurship education should take a role in focusing the positive consequences of failure.

Regarding public institutions, there were positive aspects produced with the reduced risk funding programs that some individuals opted for. These benefits appear to have been mostly at the level of the individuals that owned the business. Cost enhancers were also visible, specifically with the complications that some individuals faced in closing their venture. Long legal battles were the main reason for this, and should be considered very detrimental for entrepreneurial development within a country.

5.3 Limitations of this research

This research focuses on the personal point of view of the subjects, which for most of them occur in a point of time after a certain kind of redemption has been achieved from their past failed projects. This view is somewhat reductive of the full scope of the phenomenon, not capturing the advent of the failure, the immediate following period nor the atonement achieved later on.

Additionally, it should be noted that this study only focuses on individuals that successfully tried again to launch a business of their own after having failed previously. However, insufficient evidence can support or steer future research on a path to better identifying the factors that hinder or foster action toward future entrepreneurial efforts, either based on individual actions or originated from the context. For example, as discussed in the section on financial cost moderators, all the cases had significant help from others or other sources of income that shielded them from more damaging costs. This could certainly be an important factor for their careers. It is also a rather poorly researched topic, since most of the institutional theory in BF research focuses on bankruptcy law – the government, however, is not the only institution that affects the lives of the entrepreneurs.

5.4 Future research recommendations

Implications for the further development of this field are mostly related with the need for further empirical evidence (both quantitative and qualitative). This study focuses on individuals that failed and then found success in entrepreneurial ventures – there is still a wide array of longer-term outcomes (or stages in life that can be considered different outcomes) that need to be analyzed, as they can produce very interesting results.

Relating to each of the stated conclusions, one could draw on the observations and potentially identify many research opportunities for the future. For instance, one could learn more from the entrepreneurs' personal and professional development if analyzed through a longer period of years and in different contexts and stages of his/her life. The identified key events of their lives, social developments, specific skills and learning points, and perhaps even personal and financial cost bearings would most likely be identifiable in a quantitative research initiative, perhaps providing a much clearer insight.

A much wider sample might also allow a deeper understanding of the conclusion present in Section 5.2, as the research project is only designed to analyze one specific outcome after a BF. For example, the analyzed set of individuals kept the same attitude toward new business ventures and potentially risk assessment – one could argue that it might not always be the case after a traumatic experience. It also relates to the point stressed in Section 5.3 – the changes on one's persona potentially led to a specific outcome, a future career that involved another business venture. It would also be interesting to see how these changes are perceived by a larger target – would the eventual success be attributable to the previous traumatic experience? Would the weight of the costs be worthy? Relating to Section 5.4, and perhaps even more interestingly, would failure be a significant variable in the explaining of eventual success? In a quantitative research, it would be difficult to perceive certain decisions in a timeline, but some clear key event would still be identifiable – business creation and business closure, cost moderators and investment risks. Correlation between events and outcomes could guide research to a better understanding of the phenomena.

Finally, evidence was found of significant factors and patterns within the cases that deserve a more in-depth and qualitative analysis. For instance, younger individuals showed a much more emotional response to the phenomenon, also reporting much deeper lessons. In contrast, senior individuals showed lower psychological costs. Similar to other studies, context is still very present within the narratives of the entrepreneurs, as are the antecedents of the failure – although it is not a focus of this study, several relationships were established between previous facts of the failure, expectations of the venture, and the process of failure itself with the aftermath costs endured by the individuals and the sensemaking process.

The resilience shown by the “serial entrepreneurs” analyzed lets them endure cost after cost, feeding their drive even when they actually achieve success. These individuals deserve a study dedicated only to them.

Notes

1. A thorough search on Web of ScienceTM, performed in January 2017, using the keywords “business failure” or “start up failure” or “company bankruptcy,” in the field of Business Economics resulted in 213 journal articles (excluding eight non English and one response), of which 12 proved to be mostly unrelated to our subject. Out of the sample (201 journal articles), 78 percent were empirical studies, 12 percent were discursive in nature, 7 percent were revisions of the state-of-the-art, and 3 percent dealt with theoretical issues.
2. The remaining 25 percent of the journal articles dealt with, among other issues, how failure is conceptualized, fear of failure in constraining decision for taking advantages of entrepreneurial opportunities, or the role of funding and capital availability and other policies in mitigating/preventing business failures.

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Moderators of telework effects on the work-family conflict and on worker performance

Moderators
of telework
effects

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Abstract

Purpose – The relations telework-work interference with the family (WIF), telework-family interference with work (FIW), and telework-performance have been widely studied; however, results of different investigations are contradictory. This may be related to third variables that moderate the effect of relations. The purpose of this paper is to analyze the moderating effect of worker responsibilities outside of the work environment on telework-FIW and telework-WIF relations, as well as the moderating effect of control by the supervisor on teleworkers in the telework-performance relation.

Design/methodology/approach – A total of 92 teleworkers were interviewed, and 72 non-teleworkers who work in four public institutions. Non-teleworkers work in the same departments as teleworkers, and carry out similar functions. In addition, 33 supervisors were interviewed who evaluated performance of both groups. Hierarchical linear regression analysis models were used to evaluate the influence of telework on the dependent variables.

Findings – The results obtained reveal that where there are low-responsibility levels, teleworkers present a lower FIW than non-teleworkers; however, with high levels of responsibility, teleworkers show higher FIW. Additionally, supervisors' control of teleworkers was found to have a negative effect on their pro-activity and adaptability to tasks.

Originality/value – The findings provide new empirical evidence about the effect of moderating variables in the relation between telework-work-family conflict and telework-performance. Besides the results provide practical and useful implications to organizations that implement telework programs.

Keywords Performance, Telework, Work-family conflict, Teleworkers, Moderator variables

Paper type Research paper

Introduction

Several studies have investigated the effects of telework on family-work relations, and on work performance, but in spite of this, the effects of telework are not clear, given that results of the different studies are contradictory. For instance, some researchers emphasize the benefits telework has on work-family balance (Hill *et al.*, 2003; Allen, 2001; Gajendran and Harrison, 2007), while others encounter opposite results (Ordoñez 2012; Kossek *et al.*, 2006, Vittersø *et al.*, 2003; Lapierre and Allen, 2006). The findings of studies about the effect of telework on worker performance also show diverse results. Golden and Veiga (2008), Harker Martin and MacDonnell (2012), Dutcher (2012) and Mekonnen (2013) found that the telework tends to increase worker performance, while Kossek *et al.* (2006) and Golden *et al.* (2008) did not find a significant relation between telework and worker performance. Gajendran

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and Harrison (2007) even carried out a meta-analysis of 38 investigations, and did not find positive effects of telework on worker performance. At the same time, O'Neill *et al.* (2009), and Grant *et al.* (2013) warn of different psychological and environmental factors that can have a negative effect on productivity when work is carried out at a distance.

The discrepancies found between results of various studies may be based on different variables that eventually moderate telework effects (Sullivan, 2012). For this reason, some researchers emphasize the need to have information about the circumstances that lead telework to have positive effects for teleworkers, and which circumstances lead telework to have negative effects on different response variables (Madsen, 2011; Sullivan, 2012; Shockley and Allen, 2007).

Given the discrepancy of results and the need carry out in-depth studies of this situation, the present study is intended to analyze the moderating effect of responsibilities of individuals outside of the work environment on the relation between telework and work-family and family-work conflicts. This analysis was previously addressed by Shockley and Allen (2007), but their study was focused only on women, and they did not use a control group to compare telework effects, which is done in this investigation.

I will also analyze whether control of teleworkers by supervisors moderates the relation between telework and performance. Some authors have indicated that methods based on control must be set aside for telework to be more effective (Wiesenfeld *et al.*, 1999; Pyörä, 2011); however, the present study will assess this empirically.

Interaction between responsibility and telework on work-family conflict

Persons tend to perceive telework as a factor that facilitates child care and organization of household chores (Hilbrecht *et al.*, 2008; Ammons and Markham, 2004; Crosbie and Moore, 2004). These perceptions can be supported by the results of scientific analysis. Some research indicates that the telework has a positive effect on the work-family balance (Hill *et al.*, 2003; Allen, 2001; Gajendran and Harrison, 2007), because it has the potential to provide autonomy and flexibility for persons to carry out leisure activities and fulfill their family duties. Evidence obtained by Baruch (2000) showed that teleworkers experience less stress because they are better able to tend to urgent family affairs. In addition, persons gain free time that they can invest in family and household chores, given that they save commuting time from their home to their office (Baruch, 2000; Noonan *et al.*, 2007). DuBrin (1991) observes that work satisfaction may be increased when persons have flexibility for dealing with household and family responsibilities.

The level of responsibilities individuals have in their home may have an influence on telework effects. Shockley and Allen (2007) showed that when persons have more family responsibilities, space and time flexibility generates positive results on the family-work balance, but when there is a low level of responsibility, the results are negative. According to the authors, it is possible that persons with greater responsibilities have experienced high levels of conflict between work and family, and telework helps them get reorganized, but those with a low level of responsibility tend to become disorganized. Consistent with these findings, Madsen (2011) mentions several studies in which it was determined that persons with children report stress reduction thanks to telework. This may be associated with the fact that telework facilitates handling household chores and child care (Sullivan and Smithson, 2007). Given that some authors have indicated a positive impact of telework on work-family balance because it provides flexibility for organizing family and personal responsibilities with work responsibilities, and the evidence of Shockley and Allen (2007) in this regard, the following hypotheses are proposed:

- H1a.* Teleworkers with greater responsibilities outside of the work environment are able to reduce family interference with work (FIW).
- H1b.* Teleworkers with greater responsibilities outside of the work environment are able to reduce work interference with the family (WIF).

Interaction between control by supervisors and telework on work performance

Favorable job attitudes like commitment (Harker Martin and MacDonnell, 2012; Desrosiers, 2001) and motivation (Hill *et al.*, 2003) are exchanged in reciprocity for a more flexible work arrangements. These attitudes can promote positive outcomes as individual competence, pro-activity and adaptability to changes in the tasks. However, if the supervisors do not give autonomy enough to work independently or does not trust in its employees and they are controlling its actions, it could not diminish the positive attitudes and performance. The job autonomy is an determinant of pro-activity outcomes (Frese *et al.*, 1996) and make the people more receptive to change because they feel more able to control the work outcomes (Parker and Sprigg, 1999). Besides, supervisor trusting on employee promotes behaviors beyond the formal expectative and productivity (Deluga, 1994; Atuahene-Gima and Li, 2002; Nyhan, 2000). Desrosiers (2001) have found that it is important the employee feels organizational support when they telework, because it promotes positive outcomes. Therefore, the autonomy, trust and support that the supervisor give to teleworks can influence the effect of telework on performance.

Additionally, Dahlstrom (2013) states that democratic and non-authoritarian leadership focused on relations rather than on tasks is required, because telework success depends on communication, confidence and support provided by supervisors. Consistent with this, Wiesenfeld *et al.* (1999) pointed out that methods of control for worker supervision may be dysfunctional for teleworkers. At the same time Pyöriä (2011) and Golden (2009) indicated that supervisors must set aside traditional control-based management and focus more on results-based management for telework to function. This conclusion is supported by Mello (2007), who states that the adequate functioning of telework depends on a supervisor feeling comfortable delegating responsibilities for the entire work unit and allowing employee discretion with respect to the way he or she completes work assignments. On their part, Kowalski and Swanson (2005), and Dimitrova (2003), agree that the level of control exerted by supervisors is a determining factor for telework success. Malhotra *et al.* (2007) even mention that one of the most common reasons for failures of telework programs is the perception of directors that employees must be constantly supervised to assure that they are always busy. In addition, Sullivan (2012) states that one of the challenges for telework to continue growing is changing supervisors' fear of losing control of their workers if they cannot oversee them visually.

Since different authors support the point of view that telework requires supervisors who trust their workers and set aside control-based management, the present paper analyze if the supervisors control on teleworkers moderates the relation between telework and three variables that Griffin *et al.* (2007) use for measuring worker individual performance such as task proficiency, task pro-activity and individual adaptability to tasks. Thus the following hypothesis are proposed:

- H2a.* Telework has a positive effect on individual workers' task proficiency when supervisors control work of their subordinates less strictly.
- H2b.* Telework has a positive effect on individual task pro-activity (ITPA) when supervisors control work of their subordinates less strictly.
- H2c.* Telework has a positive effect on individual adaptability to tasks when supervisors control work of their subordinates less strictly.

Methodology

Sample and procedure

A letter was sent to the chiefs of telecommuting program of ten public institutions, in order to find the institutions interested to participate in the study. The letter clarified the

objectives of the study and invited the chiefs at a meeting to explain the details. Only four institutions showed interest and provided contact information of their telecommuters and non-teleworkers who performed similar functions.

A total of 92 teleworkers were interviewed, and 72 non-teleworkers who performed functions similar to those of the teleworkers. The information was collected in September and October 2014. The 50 percent of the sample was composed by men, and the average age was 40.13 years. In addition, 33 supervisors were interviewed who evaluated performance of both groups.

The group of teleworkers is composed by individuals with a variety of professions (e.g. Lawyers, Business managers, Psychologists, Agronomists, etc.) who work in four public Costa Rican institutions, while the non-teleworkers group made up by individuals who work in the same unit or department of the teleworkers. In addition, the non-teleworkers had similar tasks to their teleworking co-workers; this allows work-family conflict and performance to be compared between groups.

A self-administered questionnaire was applied to teleworkers and non-teleworkers with questions about aspects related to work-family conflict, sociodemographic characteristics, and other aspects related to the way in which they teleworked (for instance, amount of days, control by supervisor, schedule flexibility, etc.). A self-administered questionnaire was applied to supervisors of teleworkers and non-teleworkers to evaluate worker performance during the last month.

An invitation with a link to the questionnaire was sent to participants, via electronic mail. Eight days later a reminder was sent to those who had not responded. If after four reminders they had not responded, they were contacted on the telephone to apply the questionnaire directly, or to coordinate an appointment at their place of work, so that they could answer the questionnaire in a self-administered manner.

Measures

Family-work conflict. This variable was measured using eight items of Gutek *et al.* (1991). Four items measure WIF (for instance, "I am worried about my work during my free time"), and four items measure FIW (for instance, "My personal duties are so numerous that they keep me away from my work"). The response scale used for these items had four values: very frequently, frequently, seldom, or never. Cronbach's α for WIF was 0.83, and for FIW was 0.76.

Performance. Griffin *et al.* (2007) created and validated a new model of work role performance based on three dimensions: individual task behaviors, team member behaviors and organization member behaviors. Each one of these dimensions has three sub-dimensions. According to the authors, each sub-dimension may be used as an independent scale. This investigation uses the three sub-dimensions of individual task behaviors. These are as follows.

Individual task proficiency (ITP). This describes task fulfillment behaviors and the role assigned to a worker. It was measured with three items of Griffin *et al.* (2007) plus an additional item which was included to give strength to the construct "Completes tasks or chores in the allotted time." The response scale has a range of 1-5, where 5 represents the most positive rating. The value of Cronbach's α was 0.92.

ITPA. This describes whether a worker has the initiative to propose and look for better ways to carry out his or her tasks. It is also measured with three items. The response scale has a range of 1-5, where 5 represents the most positive rating. The value of Cronbach's α was 0.87.

Individual adaptability to tasks (ITA). This describes whether a worker responds correctly to changes in his or her tasks. It is measured with three items. The response scale has a range of 1-5, where 5 represents the most positive rating. The value of Cronbach's α was 0.89.

Telework (TEL). Teleworkers were assigned the code 1 and non-teleworkers were assigned the code 0.

Control (CTR). The code 1 was assigned to those cases when teleworkers perceived that their supervisor was constantly or occasionally monitoring (high control) them during their work, and code 0 if they perceived that their supervisor almost did not monitor them while they teleworked, or not monitored them at all (low control).

Responsibility (RE). An indicator was constructed to measure the level of responsibility individuals have outside the work environment, based on the following items:

- has children younger than 13;
- must carry out chores related to care of some relative or loved one due to old age, disease or another reason;
- is currently studying (for a high school diploma, or for a bachelors, masters or other degree); and
- percentage of household chores he or she carries out at home (cooking, washing, cleaning, ironing, etc.).

The three first items were coded with a 1 if the person was living the indicated situation and 0 if he or she was not living that situation. The fourth item was coded between 1 and 0, where 0 corresponded to an individual who carried out 0 percent of household chores, and 1 corresponded to a person who carried out 100 percent of his or her household chores. The indicator was constructed by averaging the score obtained in the four items and then multiplying it by 100. Scores therefore range between 0 and 100, where 100 is the highest level of responsibility.

Control variables. Four variables are controlled for, which could confuse the effect of independent variables on dependent variables. They are: gender (where woman = 1 and man = 0), age (current age), time in months of working under the current supervisor (T.SUP), time in months of working in the institution (T.INS), institution for which he or she works (PJ: The Judicial Branch, PROCU: Attorney General's Office, FITO: Plant Protection Services of the Ministry of Agriculture and Livestock Breeding, and CNFL: the National Power and Light Company).

Data analysis

Hierarchical linear regression analysis models were used to evaluate the influence of telework on the dependent variables, following Baron and Kenny (1986) method. Thus, in the first step the control variables was added, then in a second step the variables with direct effects, and finally the moderator variable (Baron and Kenny, 1986). Compliance with the assumption of homoscedasticity was evaluated for each model, using the Breusch-Pagan test at 10 percent significance. In models that used WIF, FIW and ITPA as dependent variables, the null hypothesis of Breusch-Pagan test was not rejected, so the homocedasticity assumption is approved. When ITP and ITA are the dependent variables, the assumption of homoscedasticity is not met. In these cases, Huber and White Robust-Error calculation was applied to the models, as stands Freedman (2012). Data analysis was performed on the software R.

Results

Table I presents the averages, standard deviations, and correlations among the variables studied. Table II presents the results of the hierarchical regression model with which *H1a* and *H1b* are evaluated. It is important to mention that the variable responsibility was standardized to prove the moderating effect, as suggested by Cohen *et al.* (2003). The data

Table I.
Means, standard deviations, total sample and intercorrelations

	<i>M</i>	<i>SD</i>	<i>N</i>	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
WIF	2.50	0.78	164	—														
FIW	1.39	0.44	164	0.43**	—													
ITP	4.55	0.61	143	0.13	-0.10	—												
ITPa	4.33	0.69	143	0.04	-0.16	0.64**	—											
ITA	4.50	0.69	143	0.03	-0.11	0.63**	0.57**	—										
TEL	0.56	0.50	164	0.05	-0.07	-0.03	-0.01	0.02	—									
RE	26.02	17.61	164	0.06	0.09	-0.20*	-0.18*	-0.19*	-0.04	—								
CTR	0.47	0.50	92	0.04	-0.04	-0.34**	-0.21	-0.24*	0.05	0.04	—							
Age	41.13	8.42	164	0.13	0.01	-0.10	-0.17*	-0.27**	0.09	-0.11	-0.15	—						
Gender	0.50	0.50	164	0.31**	0.15	0.18*	0.05	0.14	0.22**	0.11	0.01	0.02	—					
T.INS	168.85	100.39	164	0.13	0.00	0.04	-0.01	-0.09	-0.01	-0.16*	-0.16	0.73**	-0.12	—				
T.SUP	58.35	56.66	164	0.07	-0.06	-0.13	-0.08	-0.07	0.12	-0.11	0.05	0.25**	-0.05	0.39**	—			
CNFL	0.24	0.43	164	-0.03	-0.11	0.00	-0.05	-0.22**	0.03	0.00	-0.04	0.03	-0.27**	0.12	0.11	—		
PROCU	0.26	0.44	164	0.19*	0.11	0.32**	0.13	0.33**	-0.07	-0.24**	-0.15	0.16*	0.14	0.17*	0.26**	-0.33**	—	
FITO	0.12	0.32	164	-0.06	0.18*	-0.38**	-0.22**	-0.22**	0.09	0.03	0.18	-0.16*	0.02	-0.23**	-0.06	-0.20**	-0.212**	—
PJ	0.39	0.49	164	-0.11	-0.12	-0.02	0.07	0.02	-0.02	0.20*	0.03	-0.07	0.10	-0.11	-0.29**	-0.45**	-0.47**	-0.29**

Table II.
Hierarchical
regression analysis
for WIF and FIW

Variable	WIF			FIW		
	Model 1	Model 2	Model 3	Model 1	Model 2	Model 3
<i>Step 1</i>						
Age	0.01	0.01	-0.01	-0.03	-0.02	-0.05
Gender	0.33**	0.32**	0.33**	0.14	0.15	0.18*
T.SUP	0.13	0.14	0.15	0.10	0.10	0.11
T.INS	-0.02	-0.02	-0.01	-0.11	-0.10	-0.08
CNFL	0.11	0.12	0.11	0.03	0.05	0.03
PROCU	0.17	0.20*	0.16	0.16	0.18	0.10
FITO	0.03	0.03	0.02	0.23**	0.24**	0.21*
<i>Step 2</i>						
Telework (TEL)		0.00	-0.01		-0.10	-0.12
Responsibility (RE)		0.09	-0.06		0.11	-0.23
<i>Step 3</i>						
TEL × RE			0.18			0.38**
R ²	0.15	0.15	0.16	0.08	0.10	0.14
Adjusted R ²	0.11	0.10	0.11	0.04	0.05	0.09
F	3.80**	3.09**	2.98**	1.99	1.97	2.66**
df	156	154	153	156	154	153

Notes: Values represent standardized coefficients. * $p < 0.05$; ** $p < 0.10$

obtained from these first models show that the telework variable does not have a significant effect on WIF and FIW; it is, however, shown that the effect of telework on FIW changes according to the level or responsibility individuals have outside of the work environment ($B = 0.19, p < 0.05$). As can be seen in Figure 1, telework helps reduce FIW when the level or responsibility is low, however, when the level of responsibility is high, teleworkers show a higher level of FIW.

Table III presents the results of testing $H2a-H2c$. Data were divided into two groups to apply the models. The first group consists of teleworkers who responded that they were monitored constantly or occasionally by their supervisors during their work, and their co-workers who do not telework, which makes up the control group. The second group consists of teleworkers who responded that they were not monitored or monitored only occasionally by their supervisors while they worked, and their co-workers who did not telework.

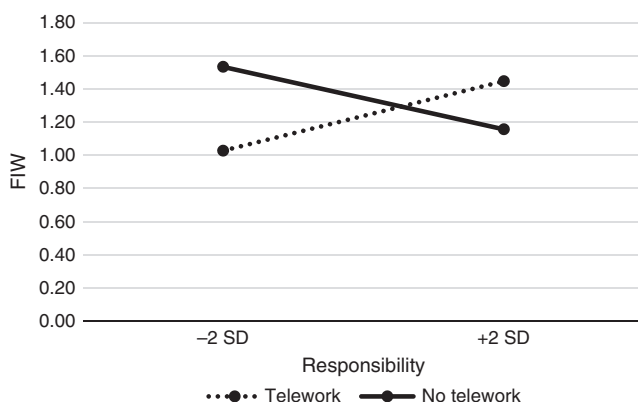


Figure 1.
Moderating effect
of responsibility
on family
interference work

Table III.
Hierarchical
regression analysis
for ITP, ITPa and
ITA, according to
control level

Variable	ITP (high control)		ITP (low control)		ITPa (high control)		ITPa (low control)		ITA (high control)		ITA (low control)	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
<i>Step 1</i>												
Age	-0.4*	-0.39**	0.14	-0.17	-0.19	0.24	-0.53**	-0.60**	-0.51**	-0.48*	-0.56*	-0.10
Gender	0.21	0.24**	0.15	0.13	0.21	-0.19	-0.07	-0.13	0.27*	0.28*	-0.04	-0.10
T.SUP	-0.35*	-0.33**	-0.04	-0.06	-0.20	0.01	-0.06	-0.13	-0.20	0.03	-0.04	-0.04
T.INS	0.10	0.08	0.08	0.11	0.02	0.06	0.33	0.40	0.17	0.16	0.23	0.23
CNFL	0.15	0.16	0.11	0.10	0.05	0.38	-0.14	-0.15	0.01	-0.30	-0.31	-0.31
PROCU	0.41**	0.40**	0.28**	0.30**	0.39*	-0.20*	-0.10	-0.06	0.38*	0.20**	0.24*	0.24*
FITO	-0.26	-0.23	-0.38	-0.37	-0.22	-0.18	-0.15	-0.13	-0.18	-0.24	-0.22	-0.22
<i>Step 2</i>												
TEL		-0.14		0.09		-0.10		0.24*		-0.05		0.24*
R ²	0.38	0.40	0.32	0.32	0.24	0.25	0.15	0.19	0.35	0.35	0.30	0.35
Adjusted R ²	0.29	0.29	0.24	0.24	0.14	0.13	0.06	0.10	0.26	0.24	0.23	0.27
F	4.30**	4.0**	4.6**	4.10**	2.20	2.03	1.76	2.20*	2.80**	3.25**	4.40**	4.70**
df	49	48	72	71	49	48	72	71	49	48	72	71

Notes: Models with ITP and ITA as dependent variables were estimated with robust errors of Hubber and White to solve biases in heteroscedasticity values represent standardized coefficients. * $p < 0.05$, ** $p < 0.10$

Hierarchical regressions are applied to each group, which explain the telework effect on the three performance variables analyzed. The results support *H1b*, given that the group of teleworkers who are not monitored or monitored only occasionally by their supervisors show greater pro-activity than the control group ($B = 0.24, p < 0.05$), while teleworkers who are monitored more by their supervisors do not show significant differences with respect to the control group ($B = -0.10, p > 0.05$). *H2b* is also supported because teleworkers who are monitored only occasionally or not at all, show significant differences in terms of adaptability to tasks compared to individuals in the control group ($B = 0.24, p < 0.05$).

Differences regarding individual proficiency are not found between those who telework and those who do not, both for those who are highly monitored ($B = -0.14, p > 0.05$) and for those who are not monitored ($B = 0.09, p > 0.05$).

Discussion and conclusions

Given the differences found in the results of several investigations about the impact of telework on work-family balance and worker performance, the present study analyzed two possible variables that could moderate those relations. Specifically, it proposed that the level of responsibility individuals have outside of the work environment moderates telework-FIW and telework-WIF relations. The study also analyzed if the level of control over teleworkers exercised by supervisors affected the relation between telework and individual performance.

Regarding the first hypotheses, the results obtained showed that teleworkers with a higher level of responsibilities have a higher FIW, contrary to *H1a* and findings by Shockley and Allen (2007). According to them, telework provides flexibility for organizing family and personal responsibilities with work responsibilities, however, teleworkers participating in this study do not have the flexibility to carry out their tasks on a schedule defined by themselves (77 percent indicate having little or no flexibility for teleworking on their own schedules). They are therefore prevented from taking care of non-work activities at the time that is most convenient for them, just as those who work at their office. It may even be possible that being at home brings about more conflicts because many times relatives or friends do not understand that the individual is not available to take care of other matters (Kossek *et al.*, 2006).

To evaluate *H2a-H2c*, the relations between telework and three individual performance variables proposed by Griffin *et al.* (2007) were analyzed: individual proficiency, pro-activity and adaptability to tasks. These relations were evaluated in two groups. The first consists of teleworkers who are monitored frequently or occasionally by their supervisors, and the corresponding non-teleworkers who carry out similar functions as teleworkers. The second group consists of teleworkers who are almost not monitored or not monitored at all by their supervisors, and non-teleworkers who make up the control group.

The results obtained do not support the hypothesis proposed concerning the individual proficiency variable (*H2a*). Of the three performance measurements, this is the most similar to measurements used in other studies of telework (Golden and Veiga, 2008; Hurd, 2010; O'Neill *et al.*, 2009; Kossek *et al.*, 2006), because also assesses adequate compliance with rules and formal tasks. Based on these types of measurements, Gajendran and Harrison (2007) had already proposed that after 20 years of telework research, data about its influence on worker effectiveness were not conclusive. Sometimes the research shows positive influence and sometimes not. This situation may be related to the type of task carried out by the individuals studied. According to Dutcher (2012), telework has a positive impact on performance in creative tasks, but this is not the case in tasks that require little creativity.

With respect to pro-activity, the *H2a* proposed is supported, given that teleworkers who are more monitored do not show significant differences with respect to non-teleworkers, while teleworkers with a low-control level show a greater pro-activity

than non-teleworkers. There is evidence indicating positive effects of worker autonomy and trust from supervisors on variables that are closely related to pro-activity, such as entrepreneurship and innovation (Moon, 1999; Denti and Hemlin, 2012; Bakovic *et al.*, 2013). Therefore, it is not surprising that individuals that have flexibility to work from their homes, and are trusted by their supervisors, are sufficiently empowered to become more pro-active in their work.

With respect to adaptability to their tasks, *H2c* is supported, given that teleworkers with low control showed significant adaptability differences as compared to the non-teleworker group, while teleworkers with high control did not show differences in terms of adaptability. Telework implies substantial changes for workers; for this reason it is expected that those who telework will develop a greater capacity to adapt to other organizational changes. However, if supervisors are constantly monitoring their work, this may reduce teleworkers' interest in adapting, or otherwise limit the possibility that workers learn to confront new situations independently.

Practical implications

Workers and organizations should be aware of the responsibility degree that possible teleworkers possess outside the workplace, especially if telecommuting mode will not allow the flexibility to work in the schedule of convenience. For this reason, organizations must establish mechanisms to evaluate the living conditions of the worker before including it in the modality of telecommuting. In that sense it is important to investigate the responsibilities of the subject in the home, if he or she is in charge of caring for other people, for example, children or older adults, and of course if it cursing some kind of study. These variables can largely define the burden of responsibilities that subjects have.

If a subject has broad responsibilities, the organization and the subject should define together possible strategies to prevent FIW. Two strategies that can help are: the evaluation and strengthening of the individual time management ability (Kossek *et al.*, 2006; Osnowitz, 2005), and the appropriation and legitimation of a quiet space to work in the home (Fonner and Stache, 2012). Thus, if the subject has a large load and few skills to manage the time, it may require some type of training on time management, before sending it to telework. Besides, if the subject does not have an adequate space conditions at home for teleworking, may require a conditioning of their workspace. Take possession of a space in the home to work could help reduce the interruptions of their personal responsibilities in the life, partly due to the fact that one of the main symbols used by persons to separate the work and the family environments is physical space (Fonner and Stache, 2012).

Telework programs must also train supervisors to set aside traditional control-based management. Piskurich (1998) points out that supervisors and workers spend an excessive amount of time reviewing what they are doing at home, instead of focusing on reviewing completed work. Supervisors should thus focus on developing worker evaluation mechanisms based on objectives and goals, so that what is monitored is the quality of completed products and compliance with deadlines. Although supervisors must set aside control, they cannot lose sight of the need for communication, given that this is an equally necessary mechanism for telework to function properly (Pyörä, 2011; Mello, 2007). Given this situation, it is also important that the organization has identified those supervisors who are more controllers, because if they are to take charge teleworkers can harm them in terms of pro-activity and adaptability. As mentioned above, these supervisory styles should be made aware of the negative effect that can generate on the worker.

The trust that must be shown in teleworkers cannot be disregarded either, so that they can act with flexibility while they telework, which may lead to higher levels of pro-activity and adaptability to changes. In this way a constant communication should be maintained but focused on coordinating and not controlling.

Limitations and future research areas

It is important to highlight that the sample for the study is mostly made up by individuals who telework for short periods of time (the average time of teleworking of individuals in the sample of the study is 1.9 days of a total of 5 work days in a week). It is therefore relevant to verify if the effects found are replicated or change in populations that telework more intensively.

To analyze telework effects with greater methodological rigor, it is necessary to create an experimental design. However, this is not always possible with the topic of telework. If a quasi-experiment is carried out, it would be useful to have response variable measurements before the individual starts teleworking. This was not possible in the present investigation because the individuals had already been teleworking for some time when evaluations were carried out – on average; they had teleworked for 22.6 months.

Another limitation is that the number of individuals in the experimental group is larger than that in the control group, because in some departments where more than one individual was teleworking, there was a smaller number of non-teleworkers who performed functions similar to those of teleworkers. In spite of this limiting factor, it was assured that every teleworker had a counterpart properly representing the counterfactual.

This study analyzed the impact of control by supervisors, but there are several variables related to the management style of supervisors, which may also influence telework effects, and they must be analyzed in further investigations. These include communication between supervisor and worker, transactional leadership exercised by supervisors, and empathy between supervisor and worker.

With respect to the impact of responsibility on telework, it is necessary to analyze triple interactions arising from combining telework-responsibility, time management ability, or, telework-responsibility and possible methods to separate family chores and work duties.

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Pragmatic impact of workplace ostracism: toward a theoretical model

Pragmatic
impact of
workplace
ostracism

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Abstract

Purpose – The purpose of this paper is to extend the ostracism literature by exploring the pragmatic impact of ostracism on performance.

Design/methodology/approach – Ostracism workplace, social relations and empowerment structures are discussed. The paper then develops a theoretical framework that explains why and under what conditions workplace ostracism undermines employees' performance. The author proposes that empowerment structures mediate the link between ostracism and in-role and extra-role performance. In addition, it was proposed that relational links buffer the negative relationship between ostracism and empowerment structures on performance and weaken the negative indirect effect of ostracism on performance.

Findings – The theoretical arguments provide support for the model showing that empowerment structures mediate the relationship between ostracism and performance, and the mediation effect only occurred when external links were high but not when external links were low.

Originality/value – The author has expanded the extant literature by answering recent calls for research exploring the pragmatic impact of workplace ostracism where past research has typically focused solely on the psychological impacts such as psychological needs.

Keywords Workplace ostracism, Structural empowerment, Social network, In-role performance, Extra-role performance

Paper type Research paper

In different social contexts, we see a pervasive phenomenon accompanied by social pain called ostracism (Robinson *et al.*, 2013). Being ostracized – marginalized, excluded or ignored by other individuals or groups – is a harsh and painful psychological experience that might threaten basic human needs (Williams, 1997, 2001). Compared with the large accumulation of knowledge in the literature of social sciences about the ostracism, little attention has been given to this phenomenon in the workplace by organizational psychologists (Xu, 2012; Wu *et al.*, 2011; Ferris *et al.*, 2008). Although there is initial empirical and theoretical support that workplace ostracism has a noticeable impact on a variety of outcomes, this support is limited in at least three aspects. First, in the past, most research on workplace ostracism has quite explicitly focused on the psychological impact (e.g. psychological needs and emotional outcomes), with less attention given to theorizing work examining the pragmatic impact. The pragmatic effect of ostracism does not occur because of the threat of psychological needs or emotions, instead being the result of an ostracized individual's loss of empowerment structures (i.e. task-related resources, power, and opportunity) that was obtained through his/her association with others. Robinson *et al.* (2013) have confirmed that the pragmatic impact should be given considerable attention by researchers because it has a negative impact on behavioral contributions to the organization in question.



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Second, although the negative performance outcomes of ostracism, such as less in-role behaviors and less extra-role behaviors, have been studied (Ferris *et al.*, 2008; O'Reilly and Robinson, 2009; Balliet and Ferris, 2013; Leung *et al.*, 2011), no published research that examines the lack of access to empowerment structures (pragmatic impact) as a potential mediator in the relationship between ostracism and negative performance outcomes has been published (Robinson *et al.*, 2013). Previous studies that have attempted to provide answers regarding how workplace ostracism undermines employees' performance have focused only on psychological mechanisms (e.g. thwarted belongingness) as a mediator between ostracism and negative performance outcomes (e.g. O'Reilly and Robinson, 2009; Leung *et al.*, 2011); therefore, in the present study we argue that empowerment structures are mediating mechanisms that can provide managers with a complementally picture of why ostracism can result in undermined employee performance.

Third, despite a wealth of literature exploring the consequences of what ostracized individuals experienced or lose, little attention has been paid to potential solutions that could help ostracized individuals reduce these effects. According to the structuralist network approach (Seibert *et al.*, 2001; Adler and Kwon, 2002; Oh and Labianca, 2004), individuals are embedded in social relationships within and outside groups and through these relationships resources are made available to them. Once an individual is being ostracized by in-group members, his/her external connections may become an alternative source for access to benefits (Oh and Labianca, 2004). Thus, when an individual with many valuable external links experiences ostracism, it is likely that he/she will have more opportunities to access empowerment structures compared with ostracized individuals with fewer external links (Seibert *et al.*, 2001; Cohen *et al.*, 2003). The present research focuses on relational links to individuals in others groups and/or in higher organizational levels (Seibert *et al.*, 2001; Oh and Labianca, 2004) in order to capture the types of links that are likely to buffer the negative pragmatic effects of ostracism.

In this study we propose two mechanisms that are theoretically significant and relevant to our goals: empowerment structures (access to opportunity and access to power through information, resources and support) (Robinson *et al.*, 2013) are suggested as a pragmatic impact mediating the ostracism-performance relationship, and external links (relational links to individuals in others groups and in higher organizational levels) (Seibert *et al.*, 2001; Oh and Labianca, 2004) are conceptualized as a condition buffering the negative link between ostracism and empowerment structures (see Figure 1).

The purpose of this study is to explore the relationship between ostracism and individual performance. We develop a theoretical framework that explains why and under what conditions workplace ostracism undermines employees' performance. In developing our conceptual framework, we have made three theoretical contributions to the extant literature. First, this paper answers recent calls for research exploring the pragmatic impact of workplace ostracism where past research has typically focused solely on psychological impacts such as psychological needs (e.g. Robinson *et al.*, 2013). Second, our study contributes to the understanding of how workplace ostracism relates to employee performance by extending the search to include the mediating mechanisms that underlie these relationships. The pragmatic impact or the lack of access to power and opportunity has been proposed as one of these mechanisms (Robinson *et al.*, 2013). Third, an explicit contribution has been made to merging the literature on the social network perspective and workplace ostracism; specifically, we assess how the external links of an employee's personal network moderate the relationship between workplace ostracism and empowerment structures.

Literature review and propositions development

Workplace ostracism

Drawing from common core features of related constructs (e.g. social exclusion, organizational shunning, social ostracism and rejection), Robinson *et al.* (2013) define

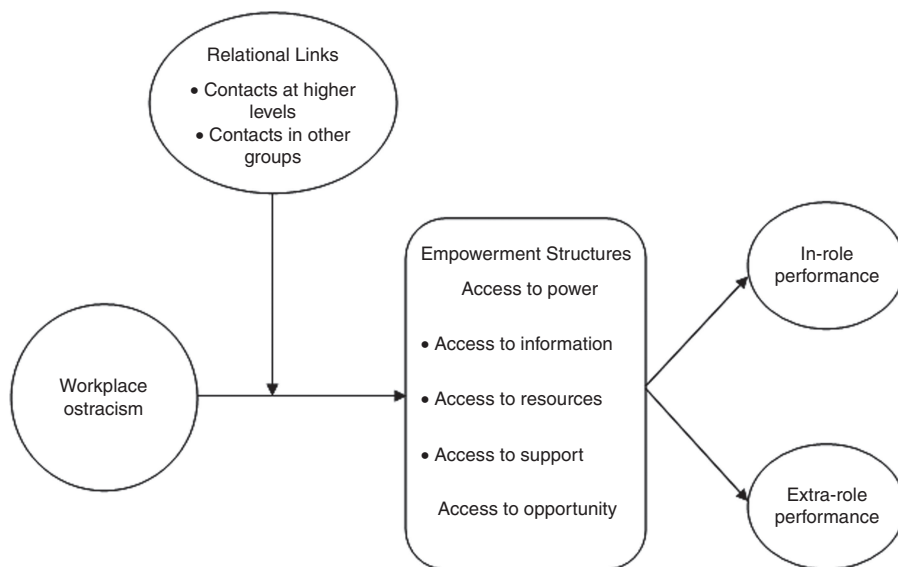


Figure 1.
Theoretical model

workplace ostracism as the extent to which an individual or group omits another organizational member from engaging in socially appropriate actions. This omission may vary in motives and intensity; for example, employees in the workplace can be intentionally or unintentionally ostracized by several foci such as supervisors, peers and subordinates (Ferris *et al.*, 2008). Intentional ostracism occurs when the source is aware that he or she deliberately omits another individual (target) when engaging in socially appropriate behaviors (Robinson *et al.*, 2013), such as refusing to converse with or avoiding eye contact with the target (Williams, 2001). In unintentional ostracism, which is more common, the source is not aware that his or her actions socially exclude another. For instance, when we do not respond to a greeting from our colleagues this does not mean that we have unrighteous intentions; in contrast, we may be preoccupied or engrossed in our own work (Williams and Zadro, 2001). Concerning intensity, ostracism can range from partial to complete. Partial ostracism can occur when an individual is excluded only by certain members of the group, while in complete ostracism the individual is excluded by all members (Williams and Sommer, 1997; Banki, 2012).

Previous literature has given much attention to the impacts generated by the occurrence of ostracism. These impacts can have negative results on employees and organizations and are mainly divided into two categories: psychological and pragmatic impacts (Robinson *et al.*, 2013). Both are caused by a rupture in the network of social interactions, threatening fundamental human needs and psychological health and preventing the exchange of various work-related resources. The psychological impact is related to the extent to which targets perceive that they are ignored, rejected or excluded by other employees in the workplace (Ferris *et al.*, 2008). Therefore, ostracism will have a psychological impact in the sense that the targeted individual perceives that he or she is being ostracized by others (Robinson *et al.*, 2013; Ferris *et al.*, 2008). Compared with pragmatic effects, these effects have been investigated extensively by researchers and include a variety of areas; for example, according to the model of ostracism developed by Williams and colleagues (Williams, 1997), previous studies have demonstrated that ostracism threatens four fundamental human needs: the need to belong, the need for

self-esteem, the need for a meaningful existence and the need for control (Ferris *et al.*, 2008; van Beest and Williams, 2015; Banki, 2012). In addition, ostracism is not associated only with the target's motivation but is also likely to result in increased psychological strain (Heaphy and Dutton, 2008; Wu *et al.*, 2012), negative moods (Gonsalkorale and Williams, 2007) and anger (Chow *et al.*, 2008).

Regardless of the significant progress that recent studies have made in investigating the psychological impacts of ostracism, the pragmatic effect has been largely neglected. In their integrated model of the antecedents and consequences of ostracism, Robinson *et al.* (2013) indicate that there are two reasons why researchers should give particular attention to the pragmatic effect. First, this effect costs the target in terms of work-related pragmatic resources (e.g. access to information and resources, getting advice, and the opportunity to have influence and power). Thus, the pragmatic effect likely results in reducing the target's behavioral contributions to the organization. Second, compared with other interpersonal mistreatments such as bullying and incivility, ostracism will generate direct and considerable pragmatic impacts. Moreover, unlike the psychological effects of ostracism, the pragmatic effects are independent of the target's perception of ostracism. Accordingly, ostracism will have a pragmatic impact to the extent that intentionally or unintentionally the source of the ostracism will ignore, reject or exclude other employees in the workplace.

Social relations and empowerment structures

The theoretical foundation underlying the link between social relations and empowerment structures is derived from social capital theory (Burt, 1992; Lin *et al.*, 1981a, b) and the theory of structural empowerment (Kanter, 1979, 1993). Both theories highlight the importance of the social relations an employee has in the workplace as a tool for accessing network benefits. According to social capital theory, most employees have different contacts with others individuals within or outside the group in which they belong (Burt, 2000); the strong and positive contacts which a group member has with other members within a group are called closed ties, while the contacts that are frequent with different people outside the group are called bridging ties (Oh *et al.*, 2006). Combined, these contacts constitute the member's personal network in which important benefits are embedded (Lin *et al.*, 1981a; Burt, 2000). These benefits include access to information, control over resources, power, support and mutual trust (Burt, 1992; Seibert *et al.*, 2001; Coleman, 1990).

Kanter's (1979, 1993) theory of structural empowerment assumes that the work conditions that provide access to structural benefits will make employees feel empowered to accomplish their tasks and duties. Kanter believes that access to structural benefits (e.g. resources, information and opportunities) is influenced by the degree of informal power an employee has in the workplace. Informal power comes when an employee has a network of interpersonal relationships inside the organization (sponsors, peers and subordinates). For an employee who has a lot of social relationships there is an increased likelihood of access to these benefits and vice versa.

In general, our study selected three important benefits of networks which can help individuals in achieving their tasks and goals, which are access to opportunity and access to power through information, resources and support (Burt, 1992; Kanter, 1993; Seibert *et al.*, 2001; Spreitzer, 1996). Power refers to the "ability to mobilize resources to get things done" (Kanter, 1979, p. 210) through access to information, resources and support. Access to information is described as the data, technical knowledge and expertise required for accomplishing the job effectively. Access to resources is having the ability to acquire the materials, money, rewards, time and personnel support needed to get the job done. Finally, access to support refers to feedback and guidance gained from superiors, peers and subordinates (Kanter, 1979; Chandler, 1986; Laschinger, 1996; Spreitzer, 1996). Opportunity refers to access to challenge, growth and advance in job/career (Sarmiento *et al.*, 2004).

Pragmatic impact of ostracism: the lack of access to empowerment structures

Our study begins with a basic notion indicating that one manifestation of the pragmatic impact of ostracism is the lack of access to empowerment structures. Once an employee is being ostracized by in-group members, her/his access to personal network benefits will be threatened (Robinson *et al.*, 2013). This is likely to happen because workplace ostracism reduces the target employee's opportunity to establish positive interpersonal relationships and cuts social ties which they have with other organizational members (Williams, 2001; Wu *et al.*, 2011; Ferris *et al.*, 2008). Task-related resources, power and information are embedded in these social ties and employees use them as conduits for transferring or exchanging with others at work (Wasserman and Faust, 1994; Podolny and Baron, 1997; Wu *et al.*, 2011). Therefore, ostracism may be one of the reasons why an individual loses part of their informal power within the organization, which in turn threatens their access to empowerment structures (access to opportunity and access to power through information, resources and support) (Kanter, 1993). Given that they have few social ties, ostracized employees face greater difficulty in accessing to work-related network benefits (Wu *et al.*, 2011). According to Robinson *et al.* (2013), the pragmatic impact of ostracism obstructs the ability of an employee to access the task-related resources, power and opportunity that comes from being connected to others. In addition, Jones *et al.* (2009) indicate that being excluded from the informational and resource loop at work is a specific form of ostracism.

Overall, workplace ostracism includes pragmatic or practical consequences that threaten an employee's ability to access empowerment structures (access to opportunity and access to power through information, resources and support). Following above discussion, we propose that:

- P1.* Workplace ostracism is negatively related to access to (a) opportunity, (b) resources, (c) information, and (d) support.

The mediating role of access to empowerment structures

Our study proposes that the lack of access to empowerment structures is a potential mediator within the relationship between ostracism and performance outcomes (extra-role and in-role performance). Our prediction is that employees in a workplace are embedded in social networks, these networks can provide opportunity for them to the sharing of various kinds of resources (Sparrowe *et al.*, 2001; Gulati *et al.*, 2002). Pragmatic benefits (e.g. access to opportunity and access to power through information, resources and support) shared through these networks are important for completing work effectively (Robinson *et al.*, 2013). These benefits are based on the positive social relationships and alliances employees possess with others (e.g. superiors, peers and subordinates) (Baldwin *et al.*, 1997). Ostracism in the workplace removes many signs of social ties with other organizational members, meaning that employees lose the network benefits that are often embedded in these ties (Williams, 2001; Wu *et al.*, 2011). The benefits that are lost because of ostracism, in turn, lead to lower job performance levels (Wu *et al.*, 2011; Robinson *et al.*, 2013). Consequently, it can be expected that a positive working relationship between an employee and his or her others organizational members increases the likelihood that the other members will be more willing to offer resources such as materials, feedback and information to facilitate his or her duties. Many studies have found that work performed by individuals is undermined due to the lack of network benefits provided by others in the workplace (Baldwin *et al.*, 1997; Beehr *et al.*, 2000; Castilla, 2005). For example, Sparrowe *et al.* (2001) have shown that individuals who lack access to advice in their work network have lower levels of in-role and extra-role performance than individuals who have access to advice in that network.

The lack of access to has a negative impact on self-efficacy, feelings of autonomy and employee commitment to the organization (Laschinger and Wong, 1999). In contrast,

individuals with access to empowerment structures perceive themselves as having more power and having control over conditions that facilitate their duties (Laschinger, 1996).

Because ostracism causes employee to perceive that pragmatic resources (e.g. information and opportunity), that are directly derived from interacting with other members in the workplace, are depleted, they would attempt to conserve these resources in order to deal with threatening conditions (Wu *et al.*, 2012). But conserving against further losses may be harmful in itself because energy is expended (Hobfoll, 1989). The cost of expended resources adds negative outcome to individuals efforts (Wright and Hobfoll, 2004), thus leading in a lower level of performance (Wu *et al.*, 2011). This means that workplace ostracism reduces employees' ability to access to pragmatic resources, which in turn, negatively influence employee's job performance. In short, this indicates that access to (a) opportunity, (b) resources, (c) information, and (d) support can examine the relationship between workplace ostracism and employee job performance.

Based on the previous discussion, we propose that:

- P2. Access to (a) opportunity, (b) resources, (c) information, and (d) support is positively related to in-role performance.
- P3. Access to (a) opportunity, (b) resources, (c) information, and (d) support is positively related to extra-role performance.
- P4. Access to (a) opportunity, (b) resources, (c) information, and (d) support will mediate a negative relationship between ostracism and in-role performance.
- P5. Access to (a) opportunity, (b) resources, (c) information, and (d) support will mediate a negative relationship between ostracism and extra-role performance.

The moderating role of relational links

Our study suggests that the relationship between workplace ostracism and access to empowerment structures (access to opportunity and access to power through information, resources and support) will be dependent on how ostracized individuals have alternative sources to offset their need for pragmatic resources. According to the social network approach, most employees have different contacts with others individuals within or outside the group in which they belong (Burt, 2000); the strong and positive contacts a group member has with other members within a group are called closed ties, while the contacts that are frequent with different people outside the group are called bridging ties (Oh *et al.*, 2006). The total sum of these contacts constitutes the member's personal network in which social resources are embedded (Lin *et al.*, 1981a; Burt, 2000).

As previously mentioned, when targets are deprived of social interaction because of ostracism, they are likely to lack access to pragmatic resources which would lead in future to reduced performance outcomes (Robinson *et al.*, 2013). Scholars suggest that in work settings a group member is not fully ostracized by all others individuals in an organization (Chen and Williams, 2007); therefore, sometimes this member maintains relational ties with individuals in others groups or organizational levels. We suggest that these relational ties may become alternative sources to offset the depleted network benefits (such as opportunity, resources, information and support). Specifically, the present research argues that relational ties with individuals in others groups and relational ties in higher organizational levels are links that are likely to act as buffers to the adverse pragmatic effects of ostracism. Our suggestion is consistent with Seibert *et al.* (2001) who tested the influence of social capital on career outcomes by gathering ego-network data from a sample of 2,781 alumni randomly selected from a large private Midwestern university. The researchers found that contacts in others functions and in higher levels in the organization were positively related with three benefits of network: access to information,

access to resources and career sponsorship. In the same vein, Oh *et al.* (2006) suggest that a group member can access a broader range of social capital resources in outside groups through two types of relationships: horizontal relationships and vertical relationships. Horizontal relationships refer to frequent communications with different people in other functional groups (e.g. contacts in other groups). These communications with other group members over time occasionally become positive social relationships and friendships. The existence of these interpersonal ties gives members who are enmeshed in them a greater opportunity for the exchange of information and access to advice and psychological support (Baldwin *et al.*, 1997; Ibarra, 1992). Therefore, we expect that horizontal contacts with members of other functional groups are alternative sources of access to the information and support that is lost due to ostracism. In contrast, those ostracized individuals with fewer links with members of other groups will have less opportunities to gain alternative sources of information and support base, thus facing a more significant pragmatic impact. Our expectation is also consistent with Seibert *et al.* (2001) in that horizontal contacts with members of other functional groups will not provide access to resources and opportunity to advance in job/career because resources and opportunity to advance in job/career are less likely to be both available for transfer and of use across functional boundaries." This argument allows the following hypothesis to be proposed:

- P6.* The number of contacts in other functional groups moderates the negative relationship between workplace ostracism and access to (a) information and (b) support such that the relationship is stronger when the number of contacts is fewer.

In contrast, vertical relationships (e.g. contacts at higher organizational levels) refer to specific external communications with people who possess relative control over valued resources, information and opportunity to advancement (Coleman, 1990; Lin, 2004). According to the premises of social resources theory, people at higher levels can be considered as a valuable social resource for three reasons: first, they have greater access to information pertaining various issues, especially information about the locations of valued resources in organization; second, people in higher positions authorize or control the allocation of resources to a greater extent than lower-level occupants; and third, they have informal bases of power and control due to affiliations in dominant coalitions within the organization (Seibert *et al.*, 2001; Lin, 2004). Thus, greater connections at higher levels should therefore provide a group member with access to valuable resources, information and opportunity to advancement, replacing resources that have been lacking due to the ostracism practiced by other group members. In contrast, those ostracized individuals with fewer links to people in higher levels will have fewer opportunities to replenish or reinforce network benefits reduced by workplace ostracism. Furthermore, while support from individuals of equal level is often familiar, receiving support from higher level occupants is unexpected and infrequent (Marcelissen *et al.*, 1988; Lin, 2004). Thus, we expect that access to support through higher level contacts will have much less to be gain by ostracized individuals at the lower levels. Based on the above, we hypothesize the following:

- P7.* The number of contacts at higher organizational levels moderates the negative relationship between workplace ostracism and access to (a) information, (b) resources, and (c) opportunity such that the relationship is stronger when the number of contacts is fewer.

So far, we have proposed that relational links moderate the negative relationship between ostracism and empowerment structures (*P6* and *P7*), and that empowerment structures mediate the relationship between ostracism and performance (*P4* and *P5*). It is therefore likely that relational links (i.e. contacts in other functional groups and contacts at higher organizational levels) also moderate the strength of the mediator function of empowerment

structures for the relationship between ostracism and performance outcomes. As we predict a weaker relationship between ostracism and empowerment structures among employees who have high-relational links than among employees who have low-relational links, the negative and indirect effect of ostracism on performance via network benefits should be weaker among employees who have high-relational links than among employees with low-relational links. Based on the above, we hypothesize the following:

- P8. The number of contacts in other functional groups moderates the negative and indirect effect of ostracism on in-role performance (through access to information and support). Specifically, access to (a) information and (b) support mediates the indirect effect only when the number of contacts in other functional groups is low and not when it is high.
- P9. The number of contacts in other functional groups moderates the negative and indirect effect of ostracism on extra-role performance (through access to information and support). Specifically, access to (a) information and (b) support mediates the indirect effect only when the number of contacts in other functional groups is low and not when it is high.
- P10. The number of contacts at higher organizational levels moderates the negative and indirect effect of ostracism on in-role performance (through access to information, resources and opportunity). Specifically, access to (a) information, (b) resources, and (c) opportunity mediates the indirect effect only when the number of contacts at higher organizational levels is low and not when it is high.
- P11. The number of contacts at higher organizational levels moderates the negative and indirect effect of ostracism on extra-role performance (through access to information, resources and opportunity). Specifically, access to (a) information, (b) resources, and (c) opportunity mediates the indirect effect only when the number of contacts at higher organizational levels is low and not when it is high.

Discussion

In this study, we develop a conceptual framework that explores the relationships between workplace ostracism, empowerment structures and performance outcomes. Specifically, we investigated whether high contacts at external links buffer the negative effect of ostracism on empowerment structures and weaken the negative and indirect effect of ostracism on performance outcomes through empowerment structures. Specifically, we proposed that higher levels of workplace ostracism were negatively related to lower levels of empowerment structures, which in turn negatively affected employee performance (in-role and extra-role performance). We also proposed that contacts in others groups moderated the relationship between workplace ostracism and access to information, and we found that contacts in higher organizational levels moderated the relationship between workplace ostracism and access to information, resources and opportunity. In addition, our results demonstrated that empowerment structures acted as a mediator of the relationship between ostracism and both in-role and extra-role performance. We showed that high levels of contacts in others groups weakened the negative and indirect effect of ostracism on both in-role and extra-role performance (through access to information and support), while high levels of contacts at higher organizational levels weakened the negative and indirect effect of ostracism on both in-role and extra-role performance (through access to information, resources and opportunity).

Theoretical implications

This study enriches the current workplace ostracism literature in several ways. First, in exploring the pragmatic impact of workplace ostracism; our study contributes to an overlooked

area as more research has focused on the effects of ostracism that emanate when the target perceives that he or she is being ostracized by others (psychological effects) (Xu, 2012; Wu *et al.*, 2011; Ferris *et al.*, 2008) than the effects that emerge when the target loses out on task-related network benefits that are the result of being connected to others (pragmatic effects) (Robinson *et al.*, 2013). Although prior research has successfully examined the psychological effects of ostracism (e.g. Xu, 2012; Wu *et al.*, 2011; Ferris *et al.*, 2008), our proposed relationships extend these studies by factoring the pragmatic effects into the equation. We expect that this extension will help in developing a model of ostracism consequences to better reflect the organizational reality in which employees experience ostracism.

Second, previous research has demonstrated direct relations between workplace ostracism and performance outcomes (Ferris *et al.*, 2008); and it has investigated which psychological intervening variables are able to explain the aforementioned relationship (O'Reilly and Robinson, 2009; Leung *et al.*, 2011; Wu *et al.*, 2011). In the present study, we have addressed a need for researchers to move their efforts beyond the main effects of workplace ostracism and also include the non-psychological mechanisms such as empowerment structures. Our model can serve as a next step toward imparting more precise understanding about why workplace ostracism affects performance outcomes by incorporating access to information, resources, support and opportunity as important mediating variables into the model of ostracism consequences.

Third, the theoretical model also suggests that access a group member has to the social capital resources of outside groups through horizontal relationships and vertical relationships can buffer the negative effects of ostracism on network benefits and weakened the negative and indirect effect of ostracism on employee performance (through empowerment structures). This means that the present study appears to be a promising first step in merging insights from the literature on social networks perspective and workplace ostracism in two ways: it has attempted to move beyond the research that focuses intensively on the links between positive relationships and social capital benefits (Seibert *et al.*, 2001; Brass and Burkhardt, 1993; Baldwin *et al.*, 1997) to a consideration of the negative aspects of network relationships; and although some of the previous network studies have successfully demonstrated the significant effect of intragroup social relationships on social capital benefits for employees, we have extended these studies by adding the intragroup social relationships into the equation. This idea enhances our understanding of considerations leading to strengthened or minimized network benefits by considering the significance of relationships both within and outside the group.

Practical implications

Our theoretical model has a number of important practical implications for managers and organizations. First, our study aims to enhance managers' understanding about the nature of ostracism in terms of its impacts in the workplace by inform them that they should not only focus on the psychological effects of ostracism but also the pragmatic effects. Managers cannot just focus on negative psychological signs in diagnosing the presence of ostracized individuals in a workplace; they need to note the ability of individuals to access to empowerment structures (e.g. power and opportunity) as another indicator. Second, another important implication suggests that pragmatic impacts such as the lack of access to resources and information can contribute to the negative performance outcomes. Unfortunately, managers might consider employee-related issues such as self-efficiency and motivation to be reasons that undermine performance and may have less understanding of pragmatic issues such as cutting social ties with others and thus losing resources and information. Therefore, organizations can conduct seminars to increase managerial awareness that cutting social ties with in-group members may weaken employee performance. Third, our model advises managers to invest efforts in managing ostracism in

teams through several means. Within the team, managers need to eliminate ostracism by creating practices encouraging trust and transparency and discouraging the use of ostracism as a punishment. Furthermore, organizations should establish specific rules to guide social relationships among employees and reject any behaviors that fail to create positive interactions. In terms of the outside team, managers should encourage employees to develop bridging ties (horizontal and/or vertical) as an alternative conduit to access network benefits. Organizations can enhance bridging relationships by supporting formal and informal social activities and computer-based social networking (Oh and Labianca, 2004). In short, managerial and organizational practices should help the employees to invest their time and efforts in building balanced social relationships within and outside their group; they should help employees equally in terms of closure and bridging relationships.

Fourth, the presence and source of negative ties at workplace may be difficult to identify. Therefore, our study advises managers to map these ties by using network analysis tools. Network analysis can help managers to identify patterns of relationships and understand the dynamic web of relationships that have an impact on employees work. According to our theoretical model, network analysis perspective not only identify an employee who makes it difficult for other employees to complete their work by withholding information or resources, but also provide a rich picture of how work actually happens. Fifth, our model advises HRM managers that their programs and practices should not focus only on increasing the ability and willingness of their employees. But they should take in consideration some variables that affect the employee's opportunity to perform, such as social influences (workplace ostracism) (Blumberg and Pringle, 1982). In our theoretical model, we indicate that ostracized employees face greater difficulty in accessing to work-related network benefits such as information and resources. To reach high levels of performance, therefore, HRM managers should design opportunity-enhancing HR practices such as work teams, employee involvement and information sharing (Jiang *et al.*, 2012).

Measuring ostracism and testing propositions

A scale developed by Ferris *et al.* (2008) to measure the awareness of ostracism in the workplace was the starting point for progress in the study of ostracism in organizational psychology (Wu *et al.*, 2011, 2012; Leung *et al.*, 2011; Zhao *et al.*, 2013; Liu *et al.*, 2013). Although this scale has significance in the study of the psychological effects of ostracism in the workplace, it is not appropriate for pragmatic effects. This is because Ferris *et al.*'s (2008) scale is designed to measure the extent to which targets perceive that they are being ostracized by others, while the pragmatic effects do not necessarily require awareness from the target. Therefore, our study suggests another measurement that can determine the extent that individuals (source) actually ostracize another employee (target) in the workplace even when the target may be unaware of it. In response to this limitation, it is highly suitable that the focus of the future research would be on the sources of ostracism and not the targets. Therefore, we suggest to use a round robin design (Warner *et al.*, 1979) in order to get a more realistic picture of the situation and also to reduce the common method bias that may arise from the use of self-reporting measurement instruments. In round robin design, a researcher asked every team member to rate the extent to which he or she ostracized each other member of their team (Warner *et al.*, 1979). Testing our propositions requires collecting data from teams working in diversity organizations to test a moderated-mediation model to account for the relationship between ostracism and performance outcomes (in-role and extra-role performance).

Future qualitative studies can also be beneficial. These can complete quantitative investigations by capturing the rich descriptions employees provide about their work environment experiences. For example, qualitative interview data can examine how employees describe the social relationships that potentially hinder their ability to achieve

the required tasks. By doing so, a rich and valid conclusion can be complemented with the proposed relationships in our model.

Our theoretical model is proposed to analyze at the individual level without taking nested nature into account. Therefore, multilevel analysis can also be appropriate as future research. According to our model, the multilevel approach will include two levels: group and individual levels. The group level regards ostracism, relations links and empowerment structures. The group level requires averaging each group member's perceptions about ostracism, relations links, and empowerment structures and assigning to each member the group rating. Job performance (in-role and extra role) measures at the individual level.

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Relationships between structural social capital, knowledge identification capability and external knowledge acquisition

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Abstract

Purpose – The purpose of this paper is to analyze the mediating effect of the identification of valuable external knowledge on the relationship between the development of inter-organizational ties (structural social capital) and the acquisition of external knowledge.

Design/methodology/approach – Using a sample of 87 firms from Spanish biotechnology and pharmaceuticals industries, the authors have tested the proposed mediation hypothesis by applying the partial least squares technique to a structural equations model.

Findings – The study results show that those firms with stronger, more frequent and closer inter-relationships are able to increase the amount of intentionally acquired knowledge, partly due to the greater level of development of their knowledge identification capability. Thus, firms with a higher capability to recognize the value of the knowledge embedded in their inter-organizational networks will be more likely to design better strategies to acquire and integrate such knowledge into their current knowledge bases for either present or future use.

Originality/value – This research contributes to knowledge management and social capital literature by means of the study of two key determinants of knowledge acquisition – structural social capital and knowledge identification capability – and the explanation of their relationships of mutual influence. The paper thus tries to fill this literature gap and connects the relational perspective of social capital with the knowledge-based view from a strategic point of view.

Keywords Knowledge management, High-tech industries, Structural social capital, Knowledge identification capabilities, External knowledge acquisition

Paper type Research paper

1. Introduction

External knowledge acquisition is a highly relevant knowledge management (KM) process owing to its strategic importance and its contribution to a company's competitive advantage (Fey and Birkinshaw, 2005). In dynamic environments, firms continuously attract and integrate external knowledge to their business processes since it is both complex and inefficient to develop alone all the knowledge that they need to be able to compete successfully (Liao and Marsillac, 2015). Nevertheless, management scholars have not yet



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analyzed this process in depth, especially when compared to other KM processes, such as knowledge creation or sharing (Park, 2010). Moreover, we agree with Patterson and Ambrosini (2015) that there are gaps in the KM literature concerning the identification of the main antecedents of external knowledge acquisition and their implication in the identification of the most valuable knowledge for firms' competitive purposes. This is a very relevant issue since companies must develop the most adequate strategies oriented toward the subsequent acquisition of valuable knowledge and integrating it into their existing knowledge base (Zack, 1999).

Social capital as an antecedent of external knowledge acquisition processes is a new line of research that has been growing in recent years (see e.g. Yli-Renko *et al.*, 2001; Presutti *et al.*, 2007; Ebers and Maurer, 2014). Specifically, this paper focuses on the structural dimension of social capital (i.e. the configuration of the relationship networks of a firm) as an antecedent of external knowledge acquisition in organizations which carry out their activities in technology/innovation-intensive industries such as biotechnology or pharmaceuticals. Although a number of research papers have tried to analyze the influence of structural social capital on knowledge acquisition processes (see e.g. Krackhardt, 1992; Maula *et al.*, 2001; Yli-Renko *et al.*, 2001; Presutti *et al.*, 2007; Zhou *et al.*, 2014), in our view a clear agreement is lacking in two essential aspects. The first of these refers to the structural characteristics that a firm's network should have to optimize its knowledge acquisition processes. The second has to do with the array of variables involved in the relationship between structural social capital and the success of knowledge acquisition processes, especially when a firm is trying to find and acquire complex pieces of knowledge (i.e. how can a firm design and/or select the most advantageous knowledge acquisition strategy?).

In this regard, this paper suggests that a firm's capability to identify valuable knowledge (Patterson and Ambrosini, 2015) is a key aspect to understanding the processes of external knowledge acquisition. Furthermore, knowledge identification, along with the assessment of its potential value, is a necessary step to ensure a company undertakes the most effective knowledge absorption process (Cohen and Levinthal, 1990). Our paper will thus try to fill this literature gap on social capital, absorptive capacity and external knowledge acquisition in dynamic environments.

External identification and value recognition of knowledge for a firm require the existence of a background within the environment from which such knowledge originates (Cohen and Levinthal, 1990). If a company does not have such a background (e.g. expertise, know-how, technology, competences) to assess the strategic potential of new external knowledge, it will be very problematic to either acquire or integrate new external knowledge correctly (Zack, 1999). Therefore, this paper poses that the development of "strong" links with agents in a network is an essential determinant of a firm's background which will enable it to identify new and valuable knowledge. Thus our approach differs slightly from the "potential" absorptive capacity perspective (see e.g. Zahra and George, 2002; Jansen *et al.*, 2005; Jiménez-Barrionuevo *et al.*, 2011) by considering a firm's network itself as a source of learning that can be used to identify valuable knowledge, instead of considering other types of variables such as R&D efforts or internal technology development to create absorptive capacity (see e.g. Cohen and Levinthal, 1990; Stock *et al.*, 2001; Tsai, 2001; Zahra and Hayton, 2008).

From this perspective on social capital as being an antecedent of knowledge acquisition, the main aim of this paper is to analyze the role of a firm's identification capability as an outcome of structural social capital, i.e. as a mediating variable, for the development of an optimal external knowledge acquisition process. Consequently, we contribute to KM and social capital literature through the study of two key determinants of knowledge acquisition – structural social capital and knowledge identification capability – and the clarification of their relationships of mutual influence.

The structure of the paper is as follows. First, we show the main conceptual aspects and the main hypothesis of our research study. Next, we describe the research methodology and the results obtained from the statistical analyses that were applied in order to test the hypothesis. Finally, we set out the discussion and main conclusions of the paper along with possible research lines to be followed in the near future.

2. Theory and hypotheses

2.1 *Inter-organizational structural social capital and external knowledge acquisition*

Knowledge acquisition is a mechanism by which a firm intentionally incorporates new technologies, ideas and know-how to its existing knowledge base from the external environment. Such acquisition is especially important in dynamic and innovative environments where organizations need to continuously access a wide range of highly specialized technologies, expertise and capabilities that are difficult to be developed internally by a single firm (Iansiti, 1997). As knowledge is widely recognized as an essential strategic asset (Grant, 1996), firms need to manage it in order to gain competitive advantages (Alavi and Leidner, 2001).

Moreover, in the recent years the external or inter-organizational perspective of social capital has focused on companies' external links as being the determinant factors to explore and exploit new opportunities and competitive advantages (Teng, 2007). Social capital is a collection of assets that derive from, are embedded in, and are accessible from a firm's networks of relationships (Nahapiet and Ghoshal, 1998). This definition of social capital includes different aspects of the social context such as interactions and social links – structural social capital, trusted relationships, relational social capital, and systems of shared values that facilitate the interactions between individuals located in a specific social context – cognitive social capital (Nahapiet and Ghoshal, 1998). Of the three dimensions of social capital (structural, relational, and cognitive), it is the structural one which has attracted more attention from social capital theories (Presutti *et al.*, 2007). Moreover, structural social capital has generated controversy regarding its potential to achieve business results such as, for instance, product innovation or economic profitability (Filiari *et al.*, 2014).

Several studies show the influence of aspects related to links in organizational networks – contact frequency, interaction types – on the willingness of companies to acquire and transfer external knowledge (see e.g. Uzzi, 1997; Lane and Lubatkin, 1998; Maula *et al.*, 2001; Yli-Renko *et al.*, 2001; Inkpen and Tsang, 2005; Presutti *et al.*, 2007; Mu *et al.*, 2008; Zhou *et al.*, 2014). Nevertheless, the results obtained in these research studies are inconsistent with the theoretical statement on a positive and strong connection between structural social capital and knowledge acquisition, especially for tacit and complex knowledge types (Maula *et al.*, 2001; Yli-Renko *et al.*, 2001; Mu *et al.*, 2008; Zhou *et al.*, 2014). On the one hand, authors such as Burt (1992) and Presutti *et al.* (2007) assert that a highly dense inter-organizational network integrated by strongly connected agents is likely to provide similar information, and therefore knowledge acquisition implies obtaining redundant benefits. Similarly, existing roots in these kind of relationships can lead organizations to acquire knowledge from agents which are already known (Uzzi, 1997), which suggests that situations of “blindness” or “short-sightedness” with regard to knowledge acquisition can arise (Inkpen and Tsang, 2005).

On the other hand, another line of research suggests that densely connected networks provide organizations with opportunities to access expertise, information and experiences that are complex in nature and, thus highly valuable (Hansen, 1999; Maula *et al.*, 2001; Inkpen and Tsang, 2005; Zhou *et al.*, 2014). The reason behind the positive effects of possessing strong inter-organizational links on knowledge acquisition are based on their role for facilitating knowledge transfer from one firm to another (Hansen, 1999; Inkpen and Tsang, 2005). Therefore, when knowledge is highly specific and difficult to codify, its acquisition and

transfer should be developed within a context of close interactions (Maula *et al.*, 2001). Similarly, frequent and intense interactions allow companies to develop routines for the exchange of complex information and non-articulated knowledge (Nahapiet and Ghoshal, 1998). Consequently, cohesive relational bonds would make flows of high-quality information and the transfer of tacit knowledge easier for firms in the network (Zhou *et al.*, 2014).

This paper proposes knowledge identification capability as a possible solution to this controversy by considering it as a mediating variable in the relationship between structural social capital and external knowledge acquisition. We will develop this argument extensively in the next section.

2.2 The mediating role of knowledge identification capability in the relationship between structural social capital and external knowledge acquisition

Research literature on absorptive capacity[1] typically recognizes a firm's identification capability – i.e. the search and recognition of external valuable knowledge (Patterson and Ambrosini, 2015) – as an inherent element in the knowledge acquisition process, with both concepts forming the so-called “potential absorptive capacity”[2] (Zahra and George, 2002). This supposes that knowledge acquisition automatically starts once a firm identifies valuable knowledge; but, in fact, it rarely happens this way in practice (Todorova and Durisin, 2007). For example, Zahra and George (2002) focus on the intensity, speed and effort through which a firm obtains external knowledge as being the key elements of the potential absorptive capacity, ignoring aspects related to the design and implementation of strategies for such acquisition.

Alternatively, following the work of Todorova and Durisin (2007) or Patterson and Ambrosini (2015), this paper considers that (valuable) knowledge identification is an indispensable previous step for knowledge acquisition to be successfully developed by a firm, and would be the first phase in the process of knowledge absorption. Moreover, this paper proposes the consideration of the capability of external knowledge identification as a mediating variable in the relationship between structural social capital and knowledge acquisition, with the aim of overcoming the aforementioned issues. In this regard, this paper considers that such a variable would be a fundamental mechanism with which to guide structural social capital toward the acquisition of the most valuable knowledge for an organization.

Research literature on organizational networks reveals various examples of social networks playing an important role in the identification and understanding of the value of external knowledge for a firm or groups of firms. For example, Tripsas (1997) found that organizations with previous social relationships are more efficient at identifying and recognizing new knowledge during periods of aggressive competition and change than those firms with fewer relationships. Similarly, the study developed by Hughes *et al.* (2014) showed a positive relationship between the intensity of the relationships in a firm's network and its ability to understand new useful knowledge for decision making on the development of new products and projects.

Moreover, Smith *et al.* (2005) highlighted the way that certain structural features of a network of relationships influenced the value identification of specific pieces of knowledge inside such a network. These authors found that the strength of the links between the members of an organization positively affects its capacity to access groups or people with specialized expertise, to emphasize with these agents and to anticipate the value of the knowledge exchanges. Furthermore, they found that the network links provide access to resources and are a powerful source of information and learning on the types of knowledge that may be the most valuable for a firm (Nahapiet and Ghoshal, 1998). The more intense the links that a firm has in the network, the more its exposure to newer and more complex knowledge will be (Zaheer and McEvily, 1999; Stuart and Sorenson, 2007). Close interactions

also increase a firm's exposure to a more diverse understanding and interpretation of the meaning and relevance of knowledge and taking that knowledge on board (Zaheer and McEvily, 1999).

Indeed, the positive effect of possessing strong, frequent and close inter-organizational links – all of which characterize dense networks – on valuable knowledge within the firm's network is also supported by the theories based on social exchange and transaction costs (e.g. Blau, 1964; Landry *et al.*, 2002). For example, following the theory of social exchange, when a company gets higher benefits than those expected from a relationship with another firm, it generates a feeling of commitment that motivates the company to develop new exchanges in the future (Blau, 1964). From our point of view, having strong, frequent and close links with other agents in a network will enhance the visibility and access to know-how, technologies, assets and expertise for a firm, provided that the benefit that such a firm gets or perceives from a relationship with any other company is higher than the cost of developing and maintaining such a relationship.

Similarly, from the transaction costs theory, a firm that builds strong, close and frequent links with other agents in an inter-organizational network will be able to reduce the cost of the information search for new knowledge (Landry *et al.*, 2002). A firm will be willing to develop and maintain a network when the benefit from identifying (and subsequently acquiring) knowledge in the network is higher than the cost of developing relationships and establishing links. In this regard, Granovetter (1985, p. 540) points out that the effort and cost associated with building a network can be compensated by: access to valuable information at a lower price than in the market; obtaining reliable information, since agents with stable relationships have economic motives behind their information exchange as there exist expectations for future transactions; and the establishment of social relations that entail strong expectations of trust and non-opportunistic behaviors deriving from the maintenance of long serving economic relationships.

Moreover, once an organization has the possibility of identifying potential valuable knowledge owing to the configuration of its structural capital, the next step would be oriented to acquire such knowledge. Authors such as Cohen and Levinthal (1990), Lane and Lubatkin (1998), Todorova and Durisin (2007) and Patterson and Ambrosini (2015) agree that identifying knowledge value is an undisputable previous stage for a firm in order for the process of external knowledge acquisition to be developed optimally.

Research literature on KM highlights the specific aspects that influence the identification and acquisition of external knowledge by an organization (see e.g. Almeida *et al.*, 2003; Segarra, 2006). For example, in a study in technological industries, Almeida *et al.* (2003) consider that before a firm acquires external knowledge it should explore its environment to search for useful knowledge from a technological point of view. Almeida *et al.* (2003) also point out that such exploration can only exist if a company has previously developed its exploration capabilities, which depend on those internal efforts dedicated to learning from the development and implementation of proprietary technologies within the firm. Similarly, other authors emphasize the importance of possessing search capabilities in order to get information and novel ideas, which once acquired and integrated into the existing company knowledge base, will improve the firm's organizational performance (Voudouris *et al.*, 2012). Other studies indicate specific instruments to contribute to such knowledge search. For instance, Ebers and Maurer (2014) discuss the role of gatekeepers[3], who are individuals or specialized teams dedicated to finding and connecting the firm to external agents with the aim of being able to identify knowledge from a large variety of sources.

Generally speaking, there is not a great amount of empirical evidence on the relationships between identification capability and external knowledge acquisition. An exception is Patterson and Ambrosini's (2015) research, a qualitative study of 38 biotechnological firms in the UK. In this study, the authors find evidence of a positive

relationship between specific efforts to identify valuable technological knowledge and the assimilation level of such knowledge by the companies within the sample.

Bearing in mind all the above ideas, we consider that establishing strong, frequent and close links – structural social capital – has an important influence on the way a firm is able to take advantage of external knowledge (by acquiring it) when this firm has previously developed knowledge identification capabilities. Due to its identification capabilities, a firm will have a wider range of previously identified knowledge from its inter-organizational network, which will enable it to prioritize the acquirement of new specific knowledge, depending on its current and future necessities[4]. Knowledge acquisition will be faster and more effective for firms with highly developed identification capabilities from the exploitation of its structural social capital. In other words, the development of higher levels of structural social capital will allow a firm to acquire knowledge that is highly valuable if this firm is able to previously build and develop capabilities in order to identify this knowledge value. From these arguments, we propose the following hypothesis:

- H1.* A company's capability to identify external knowledge value will have a mediating effect in the relationship between its inter-organizational structural social capital and external knowledge acquisition.

3. Methods

3.1 Population, data collection and sample

This study selected Spanish biotechnological and pharmaceutical industries on which to carry out the empirical analysis. The first reason for selecting firms in these industries was that they develop innovation-intensive activities for which external knowledge acquisition is a key process (Marca España, 2015). Moreover, indicators such as internal R&D expenditure – €533.8 million for the biotechnological industry and €953.4 million for the pharmaceutical industry in 2014 – or the number of R&D employees – 9,795 for biotechnology and 4,496 for pharmaceutical activities in 2014, show the relevance of these industries for the Spanish innovation system[5].

Furthermore, scientific and technological advances are frequent and constant in both sectors, and firms need to upgrade continuously their pools of knowledge (Owen-Smith *et al.*, 2002). They are industries that share common features in relation to the discoveries and developments of new complex drugs, such as inter-organizational networks through which resources and knowledge are regularly exchanged (DeCarolis and Deeds, 1999). Another feature is that there are close relationships between the industries, since frequently their activities are vertically integrated, such as product development (biotechnology) and marketing (pharmaceuticals) (Schilling, 2009).

This study used SABI database (system for accounting information analysis in Spanish and Portuguese firms) to compile company data and information. Thus, we used a search criterion based on the Spanish industry classification CNAE-2009, obtaining a population of 735 firms. Subsequently, we launched an online survey, for which a questionnaire was drawn up by the authors of the study. This questionnaire included questions about the firm's absorptive capacity, its relational capital and different types of performance. Regarding the measures for the study variables, we used Likert scales ranging from 1 to 7[6], which had been used and validated in previous studies and were easy to adapt to the context of our research. Other objective measures were also included (e.g. profitability, investment in R&D).

Previous to launching the survey, we developed a pre-test for two firms to analyze its reliability[7]. The self-administrated questionnaire was then sent to firms via an e-mail invitation to participate and links to the electronic questionnaire in two stages (December 2014 and February 2015). During the fieldwork, 111 questionnaires were received.

In total, 24 of these questionnaires were considered invalid owing to inconsistencies in responses or through being incomplete. The final sample thus consisted of 87 firms representing a response rate of 11.84 percent, which may be considered acceptable, as it is similar to rates used by other similar organizational studies in which participation is not incentivized (e.g. Maula *et al.*, 2001; Parra *et al.*, 2010; Foss *et al.*, 2013) (Table I).

In order to assess sample biases, we applied *t*-tests to representative variables – Table II. This test[8] allows the researcher to test hypotheses related to the average of some relevant variables between two groups (Wilden *et al.*, 2013). In this case, age and size (number of employees), previously selected as the control variables, were used to compare firms that answered the questionnaire with those that did not. We did not find significant differences in relation to either size or age.

As the study has a cross-sectional design, the Harman test was used to assess the existence of a common variance for our data set. We applied an exploratory factorial analysis (principal components with varimax rotation), and the results showed the existence of four factors with eigenvalues above one, explaining 67.5 percent of the total variance. As the first factor explains only 37.4 percent of the total variance, common variance does not seem to be a significant issue for our research (Podsakoff and Organ, 1986).

3.2 Measures

Inter-organizational structural social capital. With the purpose of establishing an accurate measurement scale for structural social capital, multi-item scales validated in previous studies were considered by the authors (e.g. Yli-Renko *et al.*, 2001; Maula *et al.*, 2001; Inkpen and Tsang, 2005). We finally selected and adapted five items referring to the strength, frequency and closeness of links of a firm with other firms in a network, with an acceptable reliability level (Cronbach's $\alpha = 0.908$).

Identification capacity of valuable knowledge. To measure this variable, we considered nine items taken and adapted from the studies of Segarra (2006) and Jansen *et al.* (2005). Such items reflect the relevance of a firm's monitoring activities in order to identify the valuable knowledge (Cronbach's $\alpha = 0.860$).

External knowledge acquisition. In this case, the study included eight items taken from the studies on knowledge acquisition by Fey and Birkinshaw (2005), Diaz *et al.* (2006) and Valmaseda and Hernández (2012). The measure aims to represent different intentional options that a firm might have to acquire external knowledge[9] in one of two ways: by developing

Table I.
Research specifications

Population	735
Geographical scope	Spain
Sample size	87 firms
Unit of analysis	Firm or business unit
Data collection method	Online survey
Response rate	11.84%
Sampling error	9.87%; $p = q = 0.5$
Confidence level	95%

Table II.
T-test for means equality when equal variances are supposed

	<i>t</i>	Sig. (bilateral)	SE differences
Age	1.159	0.247	8.6262
Size	1.119	0.263	17.7843

strategic alliances or collaboration agreements (three items, $\alpha = 0.734$), or by contractual arrangements with other agents, public or private (five items, $\alpha = 0.739$).

Control variables. For control variables this study took into account firm age, (natural logarithm from the year of foundation to 2014); firm size (natural logarithm of number of employees in 2014 (2014)); and the firm's main industry focus (biotechnology or pharmaceuticals). These variables have been widely used in studies about knowledge acquisition (see e.g. Maula *et al.*, 2001; Yli-Renko *et al.*, 2001; Jansen *et al.*, 2005; Parra *et al.*, 2010). Regarding age, older companies may benefit from their accumulated experience to achieve knowledge acquisition. On the other hand, those organizations with a larger size are likely to have more resources to invest in acquiring external knowledge and developing knowledge identification capabilities (Yli-Renko *et al.*, 2001; Parra *et al.*, 2010). Finally, biotechnological and pharmaceutical firms may have different incentives to choose from among the existing options for external knowledge acquisition (e.g. licenses, mergers & acquisitions, alliances) owing to their structural characteristics.

4. Statistical analysis and results

The hypothesis was tested by using a structural equations model through partial least squares (PLS). PLS is a statistical tool of multivariate analysis, that is used for modeling latent constructs considering non-normality conditions for data and small sample sizes (Hair *et al.*, 2013). The PLS path method is typically applied in two stages. First, the measurement model is analyzed; second, the structural model is calculated and the hypotheses are tested.

4.1 Measurement model

We estimated study's measurement model using a confirmatory factor analysis in order to assess reliability – individual items, constructs and validity – convergent, discriminant of item measurements. The results (shown in Tables III and IV) confirm that the measurement model is reliable and valid.

Individual item reliability is measured through the analysis of standardized loadings (λ) or simple correlations of items with their own construct, meaning that shared variance between a construct and its items is higher than the error variance. Individual item reliability is acceptable when the value of its standardized loading is at least 0.707 (Chin, 1998; Hair *et al.*, 2013).

For construct reliability, we examined the composite reliability in order to analyze the degree of consistency with which the measure of an item belongs to the same latent variable (Cepeda and Roldán, 2004). Nunnally (1978) suggests a composite reliability index of 0.7 as a benchmark for modest reliability in early research stages, and a stricter value of 0.8 for later research stages.

Convergent validity implies that a set of items represents one unique underlying construct. It can be established through the analysis of the average variance extracted (AVE), which should be greater than the threshold limit of 0.5 (Fornell and Larcker, 1981).

Finally, discriminant validity indicates to what extent a construct is structurally different of other constructs of the research study. An accepted method to measure discriminant validity is to check that the AVE for a construct is higher than the variance that the construct shares with the rest of the model constructs (Fornell and Larcker, 1981).

4.2 Structural model

Through the analysis of the structural model, we tested the proposed mediation hypothesis of the study by analyzing path coefficients (β) and the determination coefficient (R^2) as the basic indicators.

	Items Outer loadings	Reliability Constructs IFC	Convergent AVE	Validity Discriminant Fornell and Larcker criterion ^b			
				DIR_ACQ	COOP	ID_C	ST_SC
DIR_ACQ ^a	0.783	0.806	0.580	<i>0.762</i>			
DIR_ACQ2	0.763						
DIR_ACQ3	0.775						
DIR_ACQ4	0.747						
COOP	0.893	0.850	0.654	0.407	<i>0.809</i>		
COOP1	0.845						
COOP2	0.815						
COOP3	0.765						
ID_C1		0.894	0.584	0.294	0.512	<i>0.764</i>	
ID_C1	0.754						
ID_C2	0.715						
ID_C3	0.812						
ID_C4	0.809						
ID_C7	0.725						
ID_C8	0.765						
ST_SC		0.932	0.733	0.350	0.506	0.451	<i>0.856</i>
ST_SC1	0.837						
ST_SC2	0.839						
ST_SC3	0.932						
ST_SC4	0.870						
ST_SC5	0.797						

Table III.
Measurement first-order model

Notes: ^aItems DIR_ACQ1, DIR_ACQ5, ID_C5 and ID_C6 were removed as they did not satisfy the individual item reliability criterion; ^bvalues in italics are the square root of AVE. The other values are the correlations between constructs

	Construct reliability IFC	Convergent AVE	Validity Discriminant Fornell and Larcker criterion ^a		
			KW_ACQ	ID_C	ST_SC
KW_ACQ	0.826	0.705	<i>0.840</i>		
ID_C	0.894	0.584	0.509	<i>0.764</i>	
ST_SC	0.932	0.733	0.519	0.451	<i>0.856</i>

Table IV.
Measurement second-order model

Notes: ^aValues in italics are the square root of AVE. The other values are the correlations between constructs

We used bootstrapping analysis to calculate the direct and indirect effects in the model (Hayes and Scharkow, 2013). Bootstrapping results should fulfill four conditions according to Baron and Kenny (1986) (Table V). First, the direct effect between structural social capital and external knowledge acquisition is strong and highly significant ($\beta = 0.539, p < 0.001$) [10]. Similarly, both direct effects between structural social capital and identification capability ($\beta = 0.451, p < 0.001$), and knowledge identification capability and external knowledge acquisition ($\beta = 0.318, p < 0.001$) are significant. Finally, the path coefficient of the relationship between structural social capital and external knowledge acquisition was reduced when the mediating variable was introduced in research model, although it remained significant ($\beta = 0.396, p < 0.001$).

To complement this analysis, we applied a percentile approach, both for direct and indirect effects. None of the relationships of the research model has a confidence interval

that contains a zero value; therefore they are significant for these effects (Chin, 2010). There is thus only a partial mediating effect of the identification capability of valuable knowledge in the relationship between structural social capital and external knowledge acquisition.

The determinant coefficient (R^2) indicates the degree of variance that it is explained by the relationships in the model. This analysis allows the researcher to accept or refuse the proposed hypotheses, considering the significance of the standardized regression coefficients (Chin, 1998). Figure 1 shows that structural social capital explains 41.5 percent of external knowledge acquisition variance and 20.4 percent of identification capability variance. Authors such as Falk and Miller (1992) suggest that this value should be at least 10 percent for the model to be considered to have sufficient predictive power. Lower values of R^2 , even being significant, provide limited information and accordingly, the hypotheses would have non-significant predictive power. Following this assumption, our model seems to show predictive power (Chin, 1998).

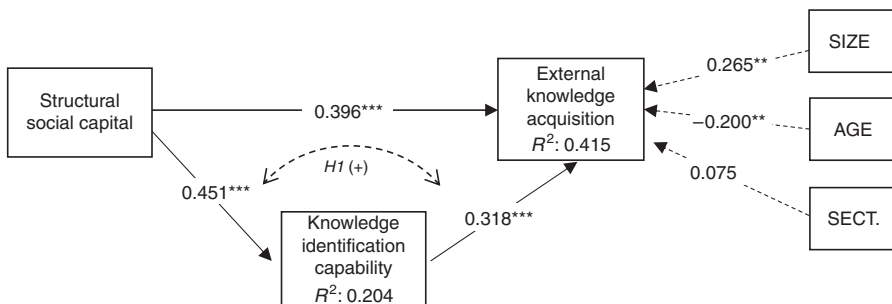
We used an additional criterion, the Stone-Geisser-test (Q^2), to assess the predictive relevance of the dependent constructs. Dependent variables will generally be relevant with a positive Q^2 coefficient (Chin, 1998; Hair *et al.*, 2013). Consequently, and given that all constructs of the research model have positive values for Q^2 (Table VI), we consider that their predictive value is relevant.

Finally, with regard to the control variables, as shown in Figure 1, only firm size and age have a significant effect on external knowledge acquisition. While the size effect is positive ($\beta = 0.265$, $p < 0.01$), age influence is negative ($\beta = -0.200$, $p < 0.01$), with both relationships being significant. The result of age on external knowledge acquisition could

Effect	Relationship	Type	Path coefficient (β)	t	Confidence interval of 95%	Hypothesis contrasting
Total	ST_SC → KW_ACQ	Direct	0.539***	8.549	0.451-0.646	Partially supported
Mediation	ST_SC → KW_ACQ	Direct	0.396***	5.066	0.265-0.520	
	ST_SC → ID_C	Direct	0.451***	4.570	0.303-0.622	
	ID_C → KW_ACQ	Direct	0.315***	3.538	0.175-0.463	
	ST_SC → ID_C → KW_ACQ	Indirect	0.142**	2.732	0.070-0.238	

Notes: * $p < 0.05$ ($t_{(0.05; 4,999)} = 1.6479$); ** $p < 0.01$ ($t_{(0.01; 4,999)} = 2.3338$); *** $p < 0.001$ ($t_{(0.001; 4,999)} = 3.1066$)

Table V. Mediation hypothesis contrasting



Notes: * $p < 0.05$ ($t_{(0.05; 4,999)} = 1.6479$); ** $p < 0.01$ ($t_{(0.01; 4,999)} = 2.3338$); *** $p < 0.001$ ($t_{(0.001; 4,999)} = 3.1066$)

Figure 1. Research model and results

be explained by arguing that younger firms usually have more need to acquire external knowledge than older firms, which have accumulated a longer knowledge background.

However, the inclusion of age, size and industry belonging in the research model does not affect the significance of the relationships between structural social capital, identification capability of valuable knowledge and external knowledge acquisition. Similarly, the effect of each control variable on the identification capability as a mediating variable was considered, but it was not significant in any case. For this reason and for simplicity purposes, we decided not to include them in the graphic model.

5. Discussion and conclusions

The purpose of this research has been to study the relationship between structural social capital, external knowledge acquisition and a firm's capability to identify external valuable knowledge. Given its strategic relevance in the last few years, the study of the external knowledge acquisition process has been of great interest amongst scholars in business management. However, the identification of the antecedents of knowledge acquisition continues to be one of the challenges that the discipline of KM faces nowadays. With this in mind, this study proposes that inter-organizational structural social capital and the capacity for identifying valuable knowledge are two essential antecedents of external knowledge acquisition. Therefore, one of the theoretical contributions of this paper has been to try to connect the relational perspective of social capital with the knowledge-based view from a strategic point of view.

The effect that the structural social capital has on the acquisition of external knowledge – particularly when knowledge is complex and tacit – has given rise to the emergence of studies with opposing arguments and divergent empirical results with regard to the intensity that inter-organizational relationships should exert in order to increase or reduce such acquisition (Yli-Renko *et al.*, 2001; Presutti *et al.*, 2007; Zhou *et al.*, 2014). Hence, a contribution of this study has been to consider a firm's capability to identify valuable knowledge as a mediating variable in this relationship. Nevertheless, the obtained results only partially support the hypothesized mediating effect. Thus, the results support there being both a direct and an indirect effect – via identification capability – of structural social capital on external knowledge acquisition. Consequently, the development of a high level of structural social capital will directly allow organizations to acquire a greater amount of external knowledge (than those firms that have a low level of structural social capital). As a result, we can state that the stronger, more frequent and closer the inter-organizational links of a company are, the higher the level of available knowledge will be, as this kind of links increase the likelihood that agents will carry out and complete market transactions or cooperative agreements to acquire knowledge. This idea of positive links is consistent with the findings of Maula *et al.* (2001) and Yli-Renko *et al.* (2001), that repeated and intense interaction facilitates the acquisition of external knowledge, especially when firms deal with technical issues for which complex and tacit knowledge is needed and such knowledge only can be found in networks of specialized innovative companies. In any case, a firm must intentionally invest to create such networks and at the same time build capabilities that allow it to identify and subsequently acquire the kind of knowledge that it requires to develop competitive advantages through its realized absorptive capability (Zahra and George, 2002).

Table VI.
Predictive power
of the model

Dependent variable	R^2	Q^2
KW_ACQ	0.415	0.159
ID_C	0.204	0.399

When we introduce the capability to identify valuable knowledge into the model, this variable contributes to explain in a better way the acquisition of external knowledge and reaffirms its importance as a driving mechanism of structural social capital toward the acquisition of valuable knowledge. In this regard, apart from increasing the aforementioned variance, we observe that the direct effect of structural social capital on the acquisition of knowledge is significantly lower. A possible explanation of this result is that the capability to identify valuable knowledge directly affects the acquisition of knowledge, as was suggested in the research of Patterson and Ambrosini (2015). In this regard, whether a company develops to a greater extent than others this capability to identify and assess the value of knowledge their network's partners possess, may be dependent upon the decision about which acquisition method would be better for the acquisition of specific pieces of knowledge. For example, in the case of both the pharmaceutical and the biotechnical industries, it often occurs that when there is no need to possess a specific kind of knowledge immediately, companies fund research works in various institutions with the aim of obtaining development licenses and the commercialization of the research results. On the contrary, when a patent or non-licensed technology is needed urgently, companies usually opt for either buying shares or establishing cooperative agreements based on the exchange of resources that could be of interest to all the parties involved in the process (Hansen, 1999). The ability to identify valuable knowledge could thus enable a firm to establish different forms of acquisition depending upon their availability and the urgency or necessity that the company has to acquire such knowledge.

On the other hand, the relationship between inter-organizational structural social capital and the capability to identify valuable knowledge within a company has not been extensively studied in the literature. This becomes a challenge when trying to establish the factors that could be highly influential in the generation of incomes using inter-organizational networks by innovative companies in highly dynamic and complex contexts (Liao and Marsillac, 2015). In this regard, this paper has also contributed to the line of research on social capital and KM, as it has shown the influence of these relationships on the intentional acquisition of external knowledge. Therefore, the existence of high levels of strength, frequency and closeness of structural social capital would entail a higher development of the capability to identify and understand the role/value of external knowledge for a company, as has been suggested in the analyzed literature (Zaheer and McEvily, 1999; Adler and Kwon, 2002; Smith *et al.*, 2005; Stuart and Sorenson, 2007; Hughes *et al.*, 2014), especially in industries dealing with complex technologies, know-how and expertise such as biotechnology or pharmaceutical activities. (Hansen, 1999).

The results obtained could produce a series of interesting prescriptive implications for company managers linked to high-tech industries. Organizations must understand that "good" management of their inter-organizational structural social capital may allow companies to develop dynamic capacities related to the identification and acquisition of unique and complex knowledge, so that they can expand, reconfigure and adapt their own resources to changes in their environment (Teece *et al.*, 1997; Eisenhardt and Martin, 2000). Moreover, in order for the company to make the best strategic use of the knowledge acquired from the inter-organizational networks, it is crucial that the development of cohesive links with the agents of these organizations be oriented to the improvement of the capability to identify valuable knowledge. In this sense, organizations could improve their level of acquisition selecting a method of acquisition that better matches their necessities and particular circumstances, which are dependent upon the availability of the knowledge that has previously been identified as valuable. Finally, if a company is able to adequately manage its network of inter-organizational relationships, the development of internal capabilities allowing it to identify and access valuable assets held by other agents will be enhanced (Castro and Roldán, 2013).

As far as limitations of the study are concerned, first, the cross-sectional nature of the empirical study makes it difficult to analyze the relationships between social capital and knowledge acquisition over time (Hughes *et al.*, 2014). In this regard, it was necessary to work on the premise that the development of social capital, the patterns of acquisition of knowledge and the evolution of the capability to identify valuable knowledge remain constant over time. Another limitation of the study arises from not having established specific relationships between structural social capital and the dimensions of the deliberate acquisition of knowledge (i.e. cooperation; hiring). In this regard, it should be borne in mind that this research focused on the study of relationships of a generic type. Future studies may focus on specific acquisition strategies depending on the characteristics of the interactions, their frequency and their density. Furthermore, the distinction between types of knowledge (e.g. tacit vs explicit), which adds value to the epistemological dimension, has not been taken into consideration (Nonaka and Takeuchi, 1995). For example, the issue of the transferring of explicit knowledge between businesses is very different to acquiring and transferring tacit knowledge between organizations.

In order to address the previous limitations, what may be of interest for further study would be the analysis of the effect that particular characteristics of the network of external relationships for a company may have on the acquisition and transfer of knowledge, depending on whether it is tacit or explicit, or even simple or complex. Furthermore, the replication of the study in other types of contexts (low-tech; other countries) or the inclusion of new industries with similar characteristics (high-tech) could be used to validate the model and evaluate the suggested relationships between variables. Finally, the development of a longitudinal study would contribute to the analysis of the effects of change within a network and the configuration of strategies for knowledge acquisition that are developed by a company.

The aforementioned areas of further study, along with other possibilities, would help to unravel the complex relationships within a company's networks and the use of such networks to achieve further innovation in intensive technological sectors.

Notes

1. Absorptive capacity is a firm's ability to identify the value of new external knowledge, assimilate it, transform it and exploit it in an effective manner (Cohen and Levinthal, 1990).
2. The distinction between potential and realised absorptive capacity proposed by Zahra and George (2002) is the first study that shows absorptive capacity as a dynamic capability, and it is the most commonly accepted concept by the strategic management literature.
3. Gatekeepers are information managers with decision capacity in both a proactive and reactive way. Ebers and Maurer (2014) consider that these individuals (or teams) are essential agents who contribute to a firm's absorptive capacity, since they work as the links between suppliers and receivers of expertise and information for a firm.
4. Not all the agents that are able to generate valuable knowledge for a firm are willing to share or commercialize it.
5. Data from ASEBIO (2015) and www.ine.es
6. We have reversed the order of some scales in order to avoid non-response biases as far as possible (see Table A1).
7. A draft of the questionnaire was first sent to the scholars of the Department of Business Administration from the University of Castilla-La Mancha who have an extensive publication record in knowledge management and/or intellectual capital. The second test was developed through several in-depth interviews with CEOs of two biotechnological companies. Those items whose response seemed to be problematic (wording, understanding) were deleted or changed from the original questionnaire by the authors.

8. The *t*-statistic, with its bilateral level of significance, provides information about the rate of compatibility between the equality of means hypothesis and the difference between the observed population averages. Its value should be higher than 0.05 in order to assume the hypothesis of equal averages.
9. Owing to the difficulty of measuring non-intentional knowledge acquisition, this research only deals with intentional knowledge acquisition.
10. As every hypothesis of the research model specifies the relationship direction, one-tail student *t*-test ($n-1$ grades of freedom, being n the subsamples' number) was used for determining their significance.

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Construct	Item	Source	
External knowledge acquisition	<i>Cooperation</i>		
	COOP1	My company usually develops alliances and/or cooperation agreements with universities	
	COOP2	My company usually develops alliances and/or cooperation agreements with customers and suppliers	
	COOP3	My company usually develops alliances and/or cooperation agreements with participants in the development of joint research projects promoted by government institutions	
	<i>Direct knowledge-purchase</i>		
	DIR_ACQ1	My company has equities in technological development firms	
	DIR_ACQ2	My company hires staff with professional experience	
	DIR_ACQ3	My company hires external consultants	
	DIR_ACQ4	My firm acquires technological licenses	
	DIR_ACQ5	My company acquires complex technology incorporated into equipment or specialized machinery	
	Identification capability of valuable knowledge	ID_C1	My company has the ability to seek information within its environment
		ID_C2	My company has the ability to anticipate competitors movements
		ID_C3	My company has the ability to anticipate customers necessities
		ID_C4	My company has the ability to keep in touch with external institutions and specialized sources
		ID_C5	My company has personal, equipment and specialized services for environment monitoring
ID_C6		My company has problems to recognize changes in our market/products ^a	
ID_C7		My company understands new opportunities to satisfy our customers quickly	
ID_C8		My company interprets changes in market pull quickly	
ID_C9		My company knows intuitively which areas can use acquired technology or external knowledge	

Fey and Birkinshaw (2005), Díaz *et al.* (2006), Valmaseda and Hernández (2012)

Segarra (2006), Jansen *et al.* (2005)

Construct	Item		Source
Inter-organizational structural social capital	EST_SC1	My company usually acquires knowledge from our inter-organizational contacts' network	Yli-Renko <i>et al.</i> (2001), Maula <i>et al.</i> (2001), Inkpen and Tsang (2005)
	EST_SC2	My company personally meets contacts who acquire external knowledge	
	EST_SC3	My company maintains narrow inter-relationships with contacts who acquire external knowledge	
	EST_SC4	My company maintains frequent inter-relationships with contacts who acquire external knowledge	
	EST_SC5	My contacts frequently acquire knowledge from among themselves	

Table AI. Note: ^aItem with inverted coding

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Determinants of corporate financial performance relating to board characteristics of corporate governance in Indian manufacturing industry

Corporate
financial
performance

67

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An empirical study

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Abstract

Purpose – The purpose of this paper is to examine if certain board characteristics have an impact on the financial performance of manufacturing firms in India.

Design/methodology/approach – The study draws on data from 275 firms listed in NSE during from 2011 to 2015, using a multiple regression model. The present study examines the effect of board characteristics such as board size, CEO duality, independence and board activity devoted to the effectiveness of firms performance regarding market and accounting based financial performance measures.

Findings – The finding supports an inverse association between the extent of board characteristics and the firms' performance indicators. The study also finds a statistically significant negative relationship between board size and Tobins Q , ROA and ROE. The evidence also shows that the board independence and meeting frequency moderate the relationship between return on equity and return on assets by enhancing these measures among corporate governance mechanisms.

Research limitations/implications – The present study does not include all possible board characteristics, i.e., large shareholders dominance on the board and promoter's and institutional shareholding, to support firm's performance. Further research might include the ownership structure of the board to improve firm's performance.

Originality/value – The study focuses on the corporate governance issues such as size, duality, independence and activity of the boards and their influence on firm performance. The subject analyzes the possible impact of board characteristics and firm-related features that have received much attention from academic research, which has largely focused on studying the publications of corporate governance in India and Asian context.

Keywords Corporate governance, CEO duality, Board characteristics, Firms performance, Tobins Q

Paper type Research paper

Introduction

Corporate governance has become a popular discussion topic in developed and developing countries. Corporate governance comprises several elements of the structure of the government, which includes capital, labor, market and organization along with their regulatory mechanisms. The literature widely held view to contain the interests of shareholders has led to increasing worldwide attention. Today corporate governance has become a worldwide issue, and the



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development of corporate governance practices has become a prominent issue in all countries in the world. Corporate governance is a system of structures and processes to direct and control the functions of an organization by setting up rules, procedures and formats for managing decisions within an organization. It specifies the distribution of rights and responsibilities among company's stakeholders (including shareowners, directors and managers) and articulates the rules and procedures for making decisions on corporate affairs. It thus provides the structure for defining, implementing and monitoring a company's goals and objectives and ensuring accountability to appropriate stakeholders. Hence, the corporate governance issue widely debated in the developed market economies needs to be discussed in a different vein in the Indian context. India, for example, did not share the set of factors responsible for the Asian crisis, which were largely macroeconomic and related to bank failure due to unprecedented and unchecked growth (Jaiswal and Banerjee, 2010). Similarly, structural characteristics in the Indian corporate sector are quite different from that of USA and UK leading to a different set of corporate governance issues here.

Corporate governance norms in India have evolved well over the year's post-economic liberalization, with SEBI constituting a number of committees to suggest codes of conduct for good governance of corporate organizations. This was followed by the listing agreement under Clause 49 and by the voluntary guidelines of corporate governance in 2009 laid out by the Ministry of Corporate Affairs. These norms are inherently related to the legal and institutional environment in the country. The legal framework for corporate regulations by the Ministry of Corporate Affairs and vital formulation of the Companies Act 1956 and the new companies Act 2013, also with fairly functional stock exchanges and their detailed listing requirements and corporate must be ensured that globally accepted standards. India is one of the major emerging economies in the world, and the importance in the global economy has increased in recent years as the aspects of global commerce are expected to grow in the future. The Indian approach to corporate governance, accounting and auditing, however, differs in many ways from the US model (and the Chinese model). India, as well as many other developing countries, often has the form but not the substance of governance when it comes to matters of law. Strict enforcement of laws and speedy punishment of the violators are as much a part of the rule of law as the written law itself (Narayanasamy *et al.*, 2012). After Satyam scam, lot has been said and done in India related to board mechanisms. After Clause 49 implementation, it was mandatory to comply with its recommendations. The Clause 49 listing agreement of independent director for listed companies was deferred for nine months till December 31, 2005. Finally, it was implemented from January 1, 2006. In response, many companies have done shuffling at the board level. The question arises whether these changes pertaining to internal governance structures are related to firm performance measures. In the Indian context, the term corporate governance is defined more in terms of agency problem. Managers and researchers see a corporate governance problem as a conflict between management and shareholders. The limited data available so far has confirmed that among corporates, only those companies who are going global follow strict international accounting standards and policies. Presently, Indian business system is moving toward the Anglo-American model of corporate governance. The Anglo-American model gives importance to the shareholders over other stakeholders. Here, the usefulness of this model to current Indian system can always be questioned (Gugnani, 2013).

Literature review

The effect of corporate governance on firm performance is the focus of extensive analysis in majority of the previous studies (Choi *et al.*, 2007; Donaldson and Davis, 1991; Jensen, 1993). It is indispensable to realize the corporate governance in the Indian context, a detailed critique of relevant literature explained with deliberate corporate governance practices and firm performance.

Gompers *et al.* (2003) developed a governance index from a sample of 1,500 large firms using the governance rules and investment strategy. They also found that the firm with strong shareholder's rights has higher fund value and higher growth. Black (2001) found that the governance practices are strongly related to price-earnings ratio, and similar results were found by Klapper and Love (2004). Shleifer and Vishny (1997) view corporate governance as a set of mechanisms which ensure that potential providers of external capital receive a fair return on their investment, because the ownership of firms is separated from their control. It also increases the firms' responsiveness to the need of the society and results in improving long-term performance (Gregory and Simms, 1999).

CEO duality is an important issue in corporate governance because the status of the CEO and chairperson may have an influence on firm performance. There are arguments in favor of CEO duality, meaning CEO duality has a positive impact on firm performance, and the result is consistent in favor of the stewardship theory. Likewise, there are arguments against CEO duality, asserting that it has a negative impact on firm performance and these support the agency theory (Huining, 2014). The monitoring role of the board and its effectiveness on the behalf of shareholders depend upon its size and composition while carrying out the functional areas of the corporate governance (John and Senbet, 1998). The board characteristics like size, independence and meetings have an impact on current or prior performance, and a weak association was found between the two in the case of Indian firms (Arora and Sharma, 2015). Another study by Brick and Chidambaran (2010) also stated the intensity of board activity as an important dimension of oversight function performed by the board. Furthermore, it had used number of "director-days" to proxy for the level of board monitoring activity. Some studies were used the board composition and board size to represent the board's monitoring ability; it is the outside directors who have the ability to provide more effective than internal monitoring, more specifically, appointment of the independent directors leads to effective monitoring (Mak and Li, 2001; Choi *et al.*, 2007; Agarwal and Knoeber, 1996). The board index which consist of composition and meetings has been found to have a negative and significant association on firm performance of selected IT companies in India (Palaniappan and Rao, 2015). Kathuria and Dash (1999) observed that size of the board increased with the size of the corporation. Using a sample of top Indian Bombay Stock Exchange (BSE)-listed companies, Jackling and Johl (2009) had also showed significant positive correlation between firm size and size of the board (Kumar and Singh, 2013). The average board size was significantly different between small and large firms. However, in contrast, Lange and Sahu (2008) in their study on Nifty-listed Indian companies found an insignificant (but negative) effect of firm size (measure for scale) on board size. Substantiating the same, Linck *et al.* (2008) found that small firms had the smallest boards, with greatest proportion of insiders. In addition to the frequency, board meeting attendance also acts as a proxy for supervising quality of the board (Lin *et al.*, 2013). The measures of board attendance have been determined the participation of directors in meetings, also called board diligence that have been tested in supplement to the governance measures which was conducted on the firms listed on the NSE in India (Ghosh, 2007).

As far as the relationship between board characteristics and firm-specific characteristics is concerned, the past literature has established that large firms need more number of directors due to the complexity involved in their operations (Boone *et al.*, 2007; Chen and Al-Najjar, 2012; Coles *et al.*, 2008; Monem, 2013). However, in those studies, the percentage of non-executive directors (NEDs) on the board and firm performance was found to be statistically insignificant. Connell and Cramer (2010) also noticed a significant difference between the average board size of small and large firms listed on Irish stock markets.

Indeed, previous studies in several other countries also found a negative relationship between board size and firm performance. A positive relationship between the variables of corporate governance and firm's performance was found in Sri Lankan companies (Velnampy and Pratheepkanth, 2012). According to the studies of Black *et al.* (2006), Drobetz *et al.* (2004), Ong *et al.* (2003) and Gedajlovic and Shapiro (2002), there was a positive significant relationship between corporate governance practices and firm performance in various countries; in contrast, based on the studies of Gugler *et al.* (2001), Hovey *et al.* (2003) and Alba *et al.* (1998), there was no significant relationship between corporate governance and firm performance. The primary contribution of the study is that it examines the determinants of firm performance on board characteristics for which existing literature is limited, especially in the Indian context. This study further contributes to the literature by providing a comprehensive analysis of the relationship between board characteristics and firm performance. The empirical analysis focuses on a large number of companies (around 275 firms) covering 18 important industries from the manufacturing sector in India; moreover, instead of considering just a single measure of firm performance, the study considers three alternate measures of performance covering both accounting (ROA and ROE) and market-based (Tobin's *Q*) measures. Finally, this study also proposes another governance measure, board meeting, which is also related to firm performance (Table I).

Conceptual model and research hypothesis

Based on the previous section, extensive literature shows that corporate board characteristics affect firms' financial performance.

In this sense, the current research makes the contributions of empirically testing the effect of board characteristics on firm's performance. In line with the extant literature, the current study hypothesizes directional relationships between the measures of corporate governance on firm's performance. Figure 1 summarized the relational paths among

Sl. no.	Statement	Previous studies
1	The larger boards tend to have a negative influence on firm performance, judged in terms of either accounting- or market-based measures of performance. CEO duality has a significant effect on the firm performance	Ghosh (2006), Kathuria and Dash (1999), Lipton and Lorsch (1992)
2	Clause 49 along with other recommendations has emphasized the role of independent directors over executive directors for better governance structure. So board composition is a natural variable of interest in relation to firm's performance	Kumar and Singh (2012), Gugnani (2013)
3	A greater proportion of outside directors on boards was associated with improved firm performance	Jackling and Johl (2009), Fama (1980)
4	The study measure the independence of a board as percentage of independent directors on a board and is expected to have a positive relationship with firm performance	Hermalin and Weisbach (1991), Bhagat and Black (2002)
5	A positive relation between CEO duality and performance of a firm. Knowledge of the fact that the influence of CEO duality on firm performance can be a great benefit	Sanda <i>et al.</i> (2005), Huining (2014)
6	The board index, which consist of composition and meetings, has been found to have a negative and significant association on firm performance	Palaniappan and Rao (2015), Shivdasani (2004)
7	A positive significant relationship between corporate governance practices and firm performance was found in various countries	Ong <i>et al.</i> (2003), Gedajlovic and Shapiro (2002), Velnampy and Pratheepkanth (2012)

Table I.
Summary of literature review

governance-related board characteristics and the firm's performance regarding both accounting- and market-based measures. The following subsections discuss in depth the hypotheses related to each selected board characteristics.

Board size

The corporate governance literature is highly contradictory on board size being linked with corporate performance. The number of directors on board is an important variable, though literature does not have a consensus on the influence of board size toward increasing in firm's performance. Some studies describe a positive association between firm performance and board size due to lag in decision making owing to lack of harmony. Valenti *et al.* (2011) pointed out that when there is some dispute regarding the effect of board size on performance in general (Alexander *et al.*, 1993; Yermack, 1996), the evidence suggests that larger boards are preferable than smaller boards (Dalton *et al.*, 1999). This consistency results were in-line with a study by Coles *et al.* (2008) which states the board size should increase with the optimal board size to achieve higher financial performance. In the previous literature, both smaller boards and larger boards have been favored on different grounds. For instance, larger boards have been favored on the grounds of greater monitoring and effective decision making. According to Shivdasani (2004), board composition of a firm is affected by the fall in financial performance because companies react to performance downturns by adding outside directors to the board for corrective actions and effective decision making. Bradbury *et al.* (2006) report no association. Board size is known to be correlated with observable and unobservable firm characteristics that potentially correlated with firm financial performance (Bennedsen *et al.*, 2007). This endogenous effect is in-line with significant relationship of a firm's financial performance and board size (Black *et al.*, 2003). Therefore, the study hypothesizes the subsequent based on inconclusive evidence of the association without predicting its direction:

H1. There is no significant association between board size and firm's performance.

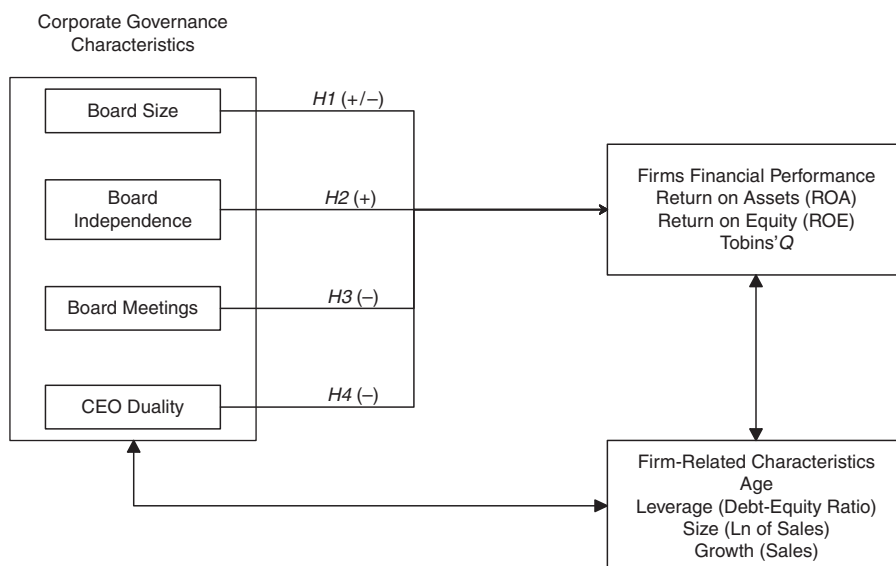


Figure 1.
Proposed conceptual
model

Board independence

The number of independent director on the board is often used as proxy for good governance. The role of board of directors as effective monitoring mechanism for management is dependent upon them being non-executive and independent. Furthermore, the inclusion of independent directors on corporate boards is an effective mechanism to reduce the potential divergence between management and shareholders. Fama (1980) argued that more NEDs on the board act as professional referees and work for value maximization of shareholders. The independent directors are invited onto the board for oversight on behalf of shareholders (Baysinger and Butler, 1985). Rosenstein and Wyatt (1990) also suggested that higher proportion of independent directors is positively associated with excess returns. Similarly, Mak and Kusnadi (2005) revealed that a higher fraction of independent directors on the board is linked to greater firm value. Outsider-dominated on the boards in terms of percentage of independent directors which will enhance the reputation of the firm, as the firm is viewed as follows good corporate governance, improving the reliability of its financial disclosures. These shortcomings can be taken care of by choosing efficient board members. Bhagat and Black (2002) in their studies found that there is no significant relationship between number of independent directors and performance of a firm. These conflicting results on the association between board independence and firm's performance, with studies by Beasley (1996), Klein (2002) and Davidson *et al.* (2005), find significant negative association between the two. On the other hand, Park and Shin (2004), Peasnell *et al.* (2005) and Bradbury *et al.* (2006) fail to report any association between earnings management and independence of the board. Board independence is measured by the number of non-executive independent directors working on the board. The study measure the independence of a board as percentage of independent directors on a board and is expected to have a positive relationship with firm performance. Thus, the study examines the following hypothesis:

- H2. There is a positive and significant association between firm's performance and board independence.

Board meetings

Next, the study estimated the impact of firm performance on board meetings, which is measured by the frequency of meetings annually. According to Vafeas (1999), board meeting is an important board attribute, but the relationship between firm performance and board meetings is not clearly established. There are several costs associated with board meetings such as managerial time, travel expenses and directors' remuneration. If a firm is not performing well, it might be possible that it may reduce the number of board meetings to avoid the costs associated with them. Jensen (1993) also pointed out that the meeting time might not be utilized for a significant dialogue among directors. Hence, the company might try to save upon the meeting costs by reducing the number of board meets. On the contrary, the firms have poor performance may try to conduct more meetings to discuss crucial issues like the reasons for their poor performance and setting strategies for improvement in performance. When directors meet frequently, they are more prone to discuss the concerned issues and monitor the management effectively, thereby performing their duties with better coordination (Lipton and Lorsch, 1992). If a firm is reasonably efficient in setting the frequency of its board meetings, it will also likely to attain high efficiency in agency costs. Thus, the impact of firm performance on board meetings is a valid research question, which should be examined empirically by following hypothesis:

- H3. There is a significant negative association between attendance of directors in board meetings and firm's performance.

CEO duality

The literature argues that the status of CEO has direct impact on governance of firms. CEO position should be independent of the chairperson of the board to enable balance and check on misuse of power by the same. Agency theory supports the same to avoid conflict of interest for the board chairman to formulate the strategies and be responsible for implementing the same. This in turn would check firms' performance through better monitoring. Jensen (1993) argued that lack of independent leadership creates a difficulty for boards to respond to any failure. Fama and Jensen (1983) also argued that concentration of decision making makes it difficult for the board in independent decision making, and it affects the performance of a firm. Contrary to this view, Rechner and Dalton (1991) argued for role CEO duality as it would provide better incentives by linking CEO pay which will affect the firms' performance. Klein (2002) shows that role duality leads to unchecked powers and finds significant positive association with firm performance. Sanda *et al.* (2005) found a positive relation between CEO duality and performance of a firm, while Dalton *et al.* (1998) could find no significant relationship between CEO duality and firm performance. A number of studies report no significant relationship. Berg and Smith (1978) and Brickley *et al.* (1997) stated that it increases the conflict of interest, and the agency cost increases when CEO and the board chair is the same person. However, in another study, Rechner and Dalton (1991) argued that it is good if the board chair and the CEO is the same person as it reduces the bureaucracy in decision making. The study used CEO duality as a dummy variable and used a score of 1 when a person holds both position and 0 otherwise. This proposes that firms segregating the role of the chairperson of the CEO positively and significantly contributes to the firm's performance:

H4. There is a significant negative association between CEO duality and firms' performance.

Methodology

With the aim of analyzing the proposed model to explore the effect of board characteristics on firms performance and to empirically test the proposed hypothesis, the study conducted a content analysis among Indian manufacturing firms during 2011-2015 using firms' annual reports. Indian has become one of the most attractive destinations for investments in the manufacturing sector because of strong integrations of governance and control mechanism. The Government of India has taken several initiatives to promote a healthy environment for growth of manufacturing sector in the country (Media Reports, 2016). The data were collected with consist of detailed governance-related and financial performance information and indicators about the most actively traded and listed companies on the BSE of India during 2011-2015.

Sample selection and data collection

The data for empirical analysis are extracted from PROWESS (Release 4.0), a research database widely used in India, and from the corporate governance and annual reports of companies. The firms in our sample are chosen from important firms in the manufacturing sector. Banking and finance sector and government companies are completely excluded for the purpose of analysis because these firms have different type of structure and governance (Faccio and Lasfer, 2000). The firm classification of these 18 sectors is given in Table II. The total number of manufacturing firms listed under BSE in these sectors are 3,230 firms. The firms with missing data are excluded from the sample, which left with the final sample size of 275 firms. This study covers the time period of 2011-2015.

Table II.
Sample companies
for various sectors

S. no.	Sectors	No. of samples
1	Apparels	9
2	Automobile and auto parts	5
3	Cement	11
4	Chemical and paint	36
5	Commercial trading	7
6	Consumer electronics	11
7	Diversified range of products	6
8	Engineering products	23
9	Fertilizers and agro-chemicals	15
10	Fibers and plastic products	9
11	Coal mining, and gas and oil exploration	13
12	Iron and steel	27
13	Packed foods and personal products	19
14	Sugar and paper	13
15	Pharmaceuticals	12
16	Power	16
17	Textiles	25
18	Miscellaneous industries	16
	Total	275

Variables construction

For the estimation purposes, the study use both accounting-based (ROA and ROE) and market-based (TQ) performance measures with respect to board characteristics such as size, independence, board meetings and CEO duality as the dependent variables in the analysis (Gompers *et al.*, 2003). The calculation of these variables has been shown in detail in Table III.

Empirical research results

In the analysis of the relationship between board characteristics and firm performance, the below regression equation will be used to test the main hypothesizes. To test the hypotheses, this study adopts the following empirical model:

$$\text{ROA} = a + b_1\text{BS} + b_2\text{BI} + b_3\text{BM} + b_4\text{CEODUAL} + b_5\text{AGE} + b_6\text{LEV} \\ + b_7\text{SIZE} + b_8\text{GROWTH} + e$$

$$\text{ROE} = a + b_1\text{BS} + b_2\text{BI} + b_3\text{BM} + b_4\text{CEODUAL} + b_5\text{AGE} \\ + b_6\text{LEV} + b_7\text{SIZE} + b_8\text{GROWTH} + e$$

$$\text{TQ} = a + b_1\text{BS} + b_2\text{BI} + b_3\text{BM} + b_4\text{CEODUAL} + b_5\text{AGE} \\ + b_6\text{LEV} + b_7\text{SIZE} + b_8\text{GROWTH} + e$$

where ROA, ROE and TQ are firm performance indicators of a company and $b_1, b_2, b_3, b_4, b_5, b_6, b_7$ and b_8 are the parameters for the explanatory variables. a is the constant number of the formula and e is the standard error.

This section presents the analysis and discussion of the empirical results.

Assumption of normality test

The normality assumption assumes that the errors of prediction are normally distributed. The Jarque-Berra statistics was used to check the null hypothesis that the sample is drawn

Table III.
Constructs, items
and description
of variables

S. no.	Variables	Full form	Description	Expected outcome
<i>Panel A: corporate governance measures</i>				
1	BS	Board size	Number of directors serving on the board	Positive/Negative
2	BI	Board independence	Number of non-executive independent directors on the board	Positive
3	BM	Board meetings	Number of annual meetings	Negative
4	CEODUAL	Duality	A binary variable which equals 1 if a chairperson of the board is also the CEO of the firm and "zero" otherwise	Negative
<i>Panel B: firm performance variables</i>				
	ROA	Return on assets	PBDIT/Total assets	-
	ROE	Return on equity	PBDIT/Paid-up equity capital + reserves funds	-
	TQ	Adjusted Tobin's Q	Total assets + market capitalization – book value of equity – deferred tax liability)/total assets	-
<i>Panel C: control variables</i>				
	Age	Firm age	No. of years of a firm since its incorporation	Positive
	Lev	Leverage	Borrowings/Total assets	Negative
	Size	Natural log of sales	Sales is deflated using WPI, then natural log is taken and related to accounting performance of the firm	Negative
	Growth		Growth rate in net sales over that of the previous year	Positive

from a normally distributed population (Park, 2002). The Jarque-Bera statistics has an asymptotic χ^2 distribution with two degrees of freedom and was used to test the null hypothesis that the data follow a normal distribution. The Jarque-Bea statistic would not be significant, and p -value should be greater than 5 percent if the residuals are normally distributed (Brooks, 2008). The results in Table IV report a p -value of 0.4166, higher than 0.5, suggesting that normality assumption holds.

Assumption of homoscedasticity test

To test for homoscedasticity, the Breusch-Pagan test and the White test were used, and the results reported in Table V indicate that the null hypothesis cannot be rejected since the p -values of both tests are considerably greater than 0.05. The results conclude that there is homoscedasticity, so no further corrections for the sample are required.

Assumption of autocorrelation test

Owing to the presence of auto correlation in the residuals, statistical inferences can be misleading. Since the Durbin-Watson test is only applicable to test autocorrelation in time

Table IV.
Jarque-Berra test
for normality

Test value	10.8771
(Prob. > χ^2) p -value	0.4166

Table V.
Breusch-pagan test
for homoscedasticity

Breusch-Pagan test – H_0 : constant variance		White test – H_0 : homoscedasticity	
Test value	0.691	Test value	17.521
p -value	0.4016	p -value	0.3809

series, this study also uses Wooldridge (2002) test appropriate in panel-data models where a significant test statistic indicates the presence of serial correlation. The p -value of the test is greater than 5 percent as shown in Table VI, suggesting the presence of no autocorrelation of errors. Drukker (2003) and Maladjian and Khoury (2014) used simulation results to show that the test has good size and power proprieties in reasonably sized samples.

Assumption for the multicollinearity test

Multicollinearity is the undesirable situation where the correlations among the independent variables are strong. Hence, if multicollinearity problem exists among the independent variables, then the regression results will not provide correct results. Lewis-Beck and Michael in their book *Applied Regression: An Introduction* have stated that if the correlation among the independent variables is greater than or equal to 0.80, then multicollinearity problem is assumed to exist. The same logic has been applied in this paper to define high correlation among the independent variables to give rise to multicollinearity problem. The multicollinearity problem is checked through correlation matrix. Correlation matrix is developed through SPSS between “firms’ performance” and other independent variables. It is observed from Table VII (correlation matrix) that none of the independent variables have correlation greater than 0.8, hence we can safely deduce that multicollinearity does not exist among the independent variables.

From Table VII, Pearson correlation for selected explanatory variables shows that the Pearson correlation coefficient between board size and ROA is -0.733 , ROE is -0.764 and Tobin Q is -0.752 , which is found to be significant at 0.05 level. This indicates that board size and firm performance measures have a strong negative and significant association among the manufacturing firms in India. The results are consistent with Alexander *et al.* (1993) and Yermack (1996). The factor of board independence has been found to have a weak negative association among the firms’ performance factors of ROA (-0.110), ROE (-0.101) and Tobins Q (-0.034), and the results are statistically insignificant and consistent with Lipton and Lorsch (1992). It is evident that board meeting has been found to have a moderate negative and significant relationship with firms’ performance indicators such as ROA (-0.491), ROE (-0.551) and Tobins Q (-0.638), and the results are found to be significant at 0.05 level. The factor of CEO duality has been found to have a weak positive relationship among the firms’ performance factors of ROA (0.061), ROE (0.086) and Tobins Q (0.183), and the results are statistically insignificant except for Tobins Q (at 0.05 level). This indicates that market-based performance (TQ) is increased if the positions of the CEO and chairperson are combined. The age of the firm and ROA have a positive and significant relationship at 0.481, and the result is significant at the 0.01 level. The size of the firm and Tobins Q has been found to be positively associated and significant at 0.01 level. The growth of the firm and ROE have a positive and significant association, and the results are statistically significant at 0.01 level. The remaining factors have insignificant association with the firms’ performance factors.

Furthermore, the existence of multicollinearity is tested by calculating the variance inflation factor (VIF), where a VIF coefficient greater than ten indicates the presence of multicollinearity (Chetterjee and Price, 1977). Moreover, the mean of all VIFs is considerably larger than 1. The VIFs for individual variables were also very low, supporting the

Wooldridge test for autocorrelation in panel data
 H_0 : no first-order autocorrelation

Table VI.
Wooldridge test for
autocorrelation

Test value	2.037
Prob. > F	0.2521

	BS	BI	BM	CEO duality	Age	Leverage	Size	Growth
<i>Board size</i>								
R	1							
Sig.								
<i>Board independence</i>								
R	0.801**	1						
Sig.	0.000							
<i>Board meetings</i>								
R	0.785**	0.590**	1					
Sig.	0.000	0.000						
<i>CEO duality</i>								
R	-0.028	-0.072	-0.030	1				
Sig.	0.652	0.238	0.625					
<i>Age</i>								
R	-0.088	-0.083	-0.016	0.124*	1			
Sig.	0.149	0.173	0.791	0.041				
<i>Leverage</i>								
R	0.097	0.106	0.023	-0.183**	-0.059	1		
Sig.	0.111	0.081	0.713	0.003	0.332			
<i>Size</i>								
R	0.079	0.033	0.074	0.045	0.011	0.093	1	
Sig.	0.194	0.593	0.225	0.459	0.858	0.127		
<i>Growth</i>								
R	-0.018	-0.010	-0.019	0.020	-0.004	-0.017	-0.065	1
Sig.	0.768	0.866	0.754	0.748	0.952	0.780	0.288	
<i>Return on assets (ROA)</i>								
R	-0.733*	-0.110	-0.491*	0.061	0.481**	-0.025	0.073	-0.021
Sig.	0.029	0.072	0.034	0.320	0.000	0.683	0.229	0.735
<i>Return on equity (ROE)</i>								
R	-0.764	-0.101	-0.551*	0.086	-0.035	-0.063	0.094	0.449**
Sig.	0.031*	0.098	0.047	0.161	0.569	0.300	0.123	0.000
<i>Tobins Q</i>								
R	-0.752	-0.025	-0.638*	0.183**	0.010	-0.080	0.568**	0.016
Sig.	0.019*	0.685	0.031	0.002	0.868	0.192	0.000	0.799

Note: **, *Significance at 5 and 1 percent levels, respectively

Table VII.
Correlation matrix

previous conclusion that the explanatory variables included in the model are not substantially correlated with each other. The results of VIF among all the cases are shown in Table VIII.

Test to check whether the data are stationary or time series

Before going on with the subject, has to find out if the data have time series influence or are stationary. Durbin-Watson test has been conducted using SPSS to check the nature of the data. Computation of Durbin-Watson test was done taking the dependent variables (ROA, ROE and Tobins Q) and all the independent variables together. The result observed from Table IV reflects that Durbin-Watson test results are 1.946, 1.772 and 1.689 for ROA, ROE and Tobins Q, respectively, which fall within the acceptable range of 1.50-2.00 and satisfy

the assumption of independence of errors. The Durbin-Watson test result is out of the range of -1.5 to $+1.5$, which proves that the data are time series one and are stationary. Moreover, by checking the Durbin-Watson table, it is observed that $d_u < d < 4-d_u$ (d_u is derived from the table and d is the Durbin-Watson test result). The results become closer to 2, which is in acceptable range, which proves that the data are not a time series one and are stationary. Thus, there is no autocorrelation between the dependent and independent variables. It is concluded from the above analysis that the data do not have time series influence and are stationary. Hence, we can utilize regression for the present study.

Regression results

The correlation analysis indicates that there exists a negative relationship between board characteristics such as board size, board independence and board meetings with firms' performance indicators of ROA, ROE and Tobins Q . So as to further analyze these relationships and to test the hypothesis, the OLS regression was run, and to find out the predictors of firms' performance factors as dependent variables and board characteristics as independent variables, controlling for other variables was also done.

Tables IX and X sum up the results of regression analysis. It can be seen from Table IX that in model 1, board variables with ROA is fitted the regression equation and explains 44.6 percent variance in firms performance as shown by R square. The F ratio is 10.653 and is highly significant at less than 1 percent level. The R^2 value of model 2 is 0.438, which means that 43.8 percent of the dependent variable (ROE) is explained by independent variables. The R^2 value of model 3 is 0.570, which means that 57.0 percent of the dependent variable (ROE) is explained by independent variables. It can be observed from it that F statistics of the respective models are 10.653, 10.183 and 19.170, respectively, and the results are highly significant at 0.000. Hence, as the p -value is less 0.05, there can be a linear relationship between the dependent variables (ROA, ROE and Tobins Q) and selected independent variables.

The regression results as shown in Table X indicate that there is a statistically significant correlation between firms' performance and board effectiveness. It is also observed from the regression analysis (Model 1) in Table X that "leverage" has a p -value of 0.960 and the corresponding t -value of 0.150. It signifies that this particular variable is not important in

Table VIII.
Variance inflation factor (VIF) of the explanatory variables

Variable	ROA		ROE		ROA	
	VIF	Toler.	VIF	Toler.	VIF	Toler.
Board size	1.205	0.830	0.339	2.953	1.456	0.687
Board independence	1.651	0.606	0.580	1.725	1.995	0.501
Board meetings	0.374	2.674	0.618	1.618	0.452	2.213
CEO duality	2.942	0.340	1.556	0.643	3.555	0.281
Age	0.969	1.032	1.601	0.625	1.171	0.854
Leverage	1.941	0.515	1.553	0.644	2.345	0.426
Size	0.975	1.026	1.611	0.621	1.178	0.849
Growth	0.995	1.005	1.644	0.608	1.202	0.832
Mean VIF	1.382		1.188		1.669	

Table IX.
Regression model summary

Sl. no.	Dependent variables	Multiple R	R^2	Adjusted R^2	SE of the estimate	Durbin-Watson	F -value	p -value
1	ROA	0.696	0.446	0.493	1.685	1.946	10.653	0.000
2	ROE	0.588	0.438	0.495	3.172	1.772	10.183	0.000
3	Tobins Q	0.608	0.570	0.551	4.170	1.689	19.170	0.000

Model and dependent variable	Independent variables	Unstandardized coefficients		Standardized coefficients		
		<i>B</i>	SE	β	<i>t</i>	Sig.
1 – return on assets	(Constant)	-8.695	7.061		-4.241	0.000
	Board size	-1.371	0.055	-0.081	-2.082	0.046
	Board independence	0.176	0.546	0.010	3.115	0.021
	Board meetings	-1.245	0.372	-0.032	-2.369	0.047
	CEO duality	-4.346	1.311	-0.003	-2.058	0.049
	Age	4.856	0.559	0.474	8.680	0.000
	Leverage	1.191	23.943	0.003	0.150	0.960
	Size	3.683	2.805	0.076	1.389	0.166
	Growth	-1.157	1.727	-0.016	-0.295	0.768
2 – return on equity	(Constant)	-9.930	4.024		-2.468	0.014
	Board size	-2.474	0.099	-0.095	-2.791	0.010
	Board independence	-2.355	0.012	-0.053	-4.580	0.000
	Board meetings	1.047	0.075	0.056	0.631	0.529
	CEO duality	1.923	1.652	0.065	4.164	0.003
	Age	-0.013	0.012	-0.057	-1.041	0.299
	Leverage	-0.436	0.532	-0.046	-0.819	0.413
	Size	1.209	0.507	0.131	2.385	0.018
	Growth	13.363	1.594	0.454	8.383	0.000
3 – Tobins <i>Q</i>	(Constant)	-27.030	17.308		-7.322	0.000
	Board size	-1.071	0.765	-0.199	-2.833	0.045
	Board independence	-4.269	1.012	-0.063	-3.763	0.031
	Board meetings	-2.689	0.101	-0.121	-3.505	0.003
	CEO duality	4.413	1.496	0.145	2.859	0.025
	Age	-0.711	1.178	-0.030	-0.603	0.547
	Leverage	-7.545	4.423	-0.098	-1.935	0.054
	Size	5.485	3.027	0.579	11.629	0.000
	Growth	146.754	151.054	0.048	0.972	0.332

Note: $p < 0.05$

Table X.
Regression result

the model. Similarly, “growth of the firm” (p -value of 0.768 and the corresponding t -value of -0.295) and “size of the firm” (p -value of 0.166 and the corresponding t -value of 1.389) have p -value more than 0.05 and t -values within the range of -2 to $+2$. These variables also seem not to be important enough in the model, so they need to be removed. While it is also observed that “board size,” having a p -value of 0.046 and a t -value of -2.082 ; “board independence,” having a p -value of 0.021 and a t -value of 3.115; “board meetings” having a p -value of 0.047 and a t -value of -2.369 ; “CEO duality,” having a p -value of 0.049 and a t -value of -2.058 ; and “age,” having a p -value of 0.000 and a t -value of 8.680, are highly significant variables in determining the firms performance (ROA) of manufacturing firms in India.

It is also observed from the regression analysis (Model 2) in Table X that “leverage” has a p -value of 0.413 and the corresponding t -value of -0.819 . It signifies that this particular variable is not important in the model. Similarly, “board meetings” (p -value of 0.529 and the corresponding t -value of 0.631) and “age” (p -value of 0.299 and the corresponding t -value of -1.104) have p -values more than 0.05 and t -values within the range of -2 to $+2$. These variables also seem not to be important enough in the model, so they need to be removed. While it is also observed that “board size,” having a p -value of 0.010 and a t -value of -2.791 ; “board independence,” having a p -value of 0.000 and a t -value of -4.580 ; “CEO duality,” having a p -value of 0.003 and a t -value of 4.164; “size,” having a p -value of 0.018 and a t -value of 2.385; and “growth,” having a p -value of 0.000 and a t -value of 8.383 are significant variables in determining the firms’ performance (ROE) of manufacturing firms in India.

It is also observed from the regression analysis (Model 3) in Table X that “leverage” has a *p*-value of 0.054 and the corresponding *t*-value of -1.935. It signifies that this particular variable is not important in the model. Similarly, “age” (*p*-value of 0.547 and the corresponding *t*-value of -0.603) and “growth” (*p*-value of 0.332 and the corresponding *t*-value of 0.972) have *p*-values more than 0.05 and *t*-values within the range of -2 to +2. These variables also seem not to be important enough in the model, so they need to be removed. While it is also observed that “board size,” having a *p*-value of 0.045 and a *t*-value of -2.833; “board independence,” having a *p*-value of 0.031 and a *t*-value of -3.763; “board meetings,” having a *p*-value of 0.003 and a *t*-value of -3.505; “CEO duality,” having a *p*-value of 0.035 and a *t*-value of 2.859; and “size,” having a *p*-value of 0.000 and a *t*-value of 11.629, are significant variables in determining firms’ performance (Tobin’s *Q*) of manufacturing firms in India. This positive sign is a consistent signal of stewardship theory which explain CEO duality positively influences firm performance (Huining, 2014) (Table XI).

Discussion, conclusion and implications

This study has investigated the influence the board characteristics of corporate governance measures has on the financial performance of Indian manufacturing industries. A sample of 275 industries across 18 different sectors was cross-sectionally analyzed with the help of OLS regression method. From the study, it can be said that “leverage,” “age,” “growth” and “board meetings” seem not to be statistically important and they do not influence the profitability of the manufacturing firms in India, whereas “board size, board independence, CEO duality and size of the firm” are important variables for determining the manufacturing firms’ performance (ROA, ROE and Tobins *Q*) in India. It can be inferred from the results derived above that board characteristics and firms’ performance of manufacturing firms in India. Theoretically, the effectiveness of board of directors, a central governance mechanism, is expected to be positively related to corporate governance quality. The study explored this relationship empirically with the use of board size, board independence and board meeting and found contradictory results regarding firms’ performance parameters. These results were consistent and similar to previous studies (Arora and Sharma, 2015; Palaniappan and Rao, 2015; Sarpal and Singh, 2013). The study found that board size of a firm has emerged as an important determinant of firm’s performance but the interesting part is that it is negatively related with firm performance (Gugnani, 2013). The results indicate that among the various factors affecting the corporate governance, board characteristics are strongly and negatively related to firms’ performance

Sl. no.	Hypothesis	Proposed Sign	Hypothesis test result			
			ROA	ROE	Tobins Q	Tools
H1	There is no significant association between board size and firm performance	±	Negative and significant	Negative and significant	Negative and significant	Regression
H2	There is a positive and significant association between firm’s performance and board independence	+	Positive and significant	Negative and significant	Negative and significant	Regression
H3	There is a significant and negative association between attendance of directors in board meetings and firm performance	-	Negative and significant	Positive and insignificant	Negative and significant	Regression
H4	There is a significant negative association between CEO duality and firm performance	-	Negative and significant	Positive and significant	Positive and significant	Regression

Table XI.
Summary of hypothesis testing results

measured with both accounting and market-based performance indicators. This result is as expected and supports the hypothesis that the optimum size of the board leads to the improvement of firm's performance. The use of ROA and ROE as proxies for financial performance has its own limitations. The results suggest that the marketing-based measures of financial performance (Tobin' Q, P/E and P/B) were not able to establish any relationship with corporate governance. It shows that the stock market performance of a firm is not related with its corporate governance measures and indicators (Gugnani, 2013).

The results of the study do indicate that the influence that board characteristics of corporate governance has on firm performance is significant. Hence, this study recommends that corporate entities should promote corporate governance measures effectively to send a positive signal to potential investors. In addition, the regulatory agencies including government should promote and socialize corporate governance regulatory measures and its relationships to firm performance across industries. So when policy makers of a nation within the Indian context decide that manufacturing firms should have the attention of board characteristics on the basis of an improvement in firm performance. The contribution of this study has been to find that board characteristic does have an influence on manufacturing firms' performance in India. The outcome of the study has been learned about the relevance and in line with regards to other developing countries, the board characteristics have strongly influenced in the performance of the firms. Despite these benefits, much can still be said about the ongoing debate between the agency theory and stewardship theory.

Limitations and further research

As with all empirical studies, the current research has several limitations, and overcoming these can be a guide for future research. First, the data are based on board characteristics; therefore, the research is exempt from the board composition, that is, the presence of women director on the board, board meeting attendance of especially by independent directors concern, Annual General Meeting and number of meetings conducted by the firms with beyond the required statutory level. Future research could combine measures of presence of women directors, meeting of independent directors and AGM attendance, which have some effect on firms' performance. Second, the current research explores the effect of some board elements such as audit committee and other committees on overall firm's performance. Further research could extend the model to include additional dimensions of the audit committee-based measures in order to better understand the firms' financial performance. Third, the current study does not include all possible board characteristics such as large shareholders' dominance on the board, promoter's shareholding and institutional shareholding to support their firm's performance. Further research might include the ownership structure on board to improve the firm's performance. Finally, this research is limited to Indian manufacturing firms. Future research should consider different countries, inter-differences with medium- and large-scale firms and private and public undertaking firms. There are certain limitations of this study because it focuses on internal governance mechanisms, ignoring external factors, which can have a more significant impact on corporate financial performance.

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Further reading

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Intrapreneurial competencies: development and validation of a measurement scale

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Abstract

Purpose – Few models have attempted to explain intrapreneurial behavior from the perspective of competencies. Therefore, the purpose of this paper is to contribute along this line by developing and validating a scale to measure intrapreneurial competencies for a Costa Rican organizational context.

Design/methodology/approach – A three stage process was followed. The first stage considered literature review, expert judgment, cognitive interviews, and back-translation. In the second stage, the questionnaire was administered to a sample of 543 university professionals who worked mainly in private organizations in Costa Rica. The third stage led to evaluate of the proposed scale's psychometric properties, including, exploratory factor analysis procedure performing by SPSS 19; confirmatory factor analysis procedures by means of structural equation modeling using EQS 6.2 version and finally, a linear regression model to obtain evidence of external criterion-related validity, performed by SPSS 19.

Findings – This study provides evidence of five sub-dimensions of employee attributes, i.e., “opportunity promoter”, “proactivity”, “flexibility”, “drive”, and “risk taking” that constitute a higher-level construct called intrapreneurial competencies. The scale provided evidence of convergent, discriminant, and criterion-related validity – the latter, using an employee innovative behavior scale.

Originality/value – The model offers a first step to continue studies that aim at developing a robust model of intrapreneurial competencies. This potential predictive capacity of an instrument of this nature would be useful for the business sector, particularly as a diagnostic instrument to strengthen processes of staff development in areas that promote the development of innovation and the creation of new businesses for the company.

Keywords Innovation, Competencies, SEM, Intrapreneurship, Cognitive interview

Paper type Research paper

Introduction

As organizations, industries, and consumers become more dynamic, efforts to boost processes that allow employees – within an organization – to turn opportunities into innovations for the company have gained greater importance (Hisrich and Kearney, 2012). This ability to encourage employee entrepreneurial spirit is within the company; therefore, it is generally called intrapreneurship.

Intrapreneurs possess the ability to create, identify, and exploit new opportunities that allow them to create value for the company (Ma *et al.*, 2016). In fact, it has been observed that intrapreneurial efforts enhance competitive advantage, stimulating company growth

JEL Classification — M1

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and well-being (Hayton and Kelley, 2006). In this sense, explaining the relationship between intrapreneurship and innovation is of great interest, particularly in terms of how the intrapreneurial profile affects innovative performance (Camelo-Ordaz *et al.*, 2012).

However, the literature concerning possible inducers of intrapreneurship has placed more emphasis on the influence of organizational variables than on identifying the characteristics of individuals who make these efforts (Antoncic and Hisrich, 2001; Stull, 2005). Although the influence of these human capital characteristics on the field of intrapreneurship has been acknowledged, a particular gap persists in the current literature with respect to the characteristics that are desirable in an intrapreneur beyond schooling and experience. Similarly, there is also a gap in the identification of these characteristics within a clear and coherent competency framework (Hayton and Kelley, 2006). Nonetheless, the value of developing and sharpening such competencies for more chances of entrepreneurial success has been acknowledged (Jain *et al.*, 2015).

Accordingly, this study proposes to develop and validate a scale for measuring intrapreneurial competencies in the Costa Rican context. Thus, this paper makes several contributions to the topic. First, it heeds the call to contribute to research on understanding intrapreneurial profiles, along the lines of competency analysis, developing a measuring instrument while following best practices for the development of assessment tools. Second, it addresses the weakness or gap indicated by Slavec and Drnovsek (2012) concerning the small emphasis that the field of entrepreneurship has placed on the development of valid measures. Therefore, it may be useful to illustrate that it is feasible to apply the main guidelines identified by these authors in intrapreneurship research, benefiting the development of better explanatory models of the phenomenon. Third, it is an initial contribution that opens space for future research that leads to refining a measuring tool for intrapreneurial competencies that is also likely to be implemented in the field of management and research.

This study begins with a section dedicated to conceptualizing the three main study constructs, i.e., intrapreneurship, competencies, and intrapreneurial competencies, with an overview of the theoretical foundations on which the model is built. The second section presents the stages and phases that compose the methodological design followed in this study for the purposes of scale construction. Then, the obtained results for each of the methods followed in the proposed stages and phases are shown, from the demonstration of the relevance of the content domains and the items that assess them to the statistical tests that verify the compliance of the scale's psychometric properties. The last section closes with a presentation of the conclusions, study limitations, and future lines of research.

Literature review

Intrapreneurship

The literature has suggested a variety of terms to refer to “intrapreneurial” efforts, such as “internal corporate entrepreneurship”, “corporate entrepreneurship”, “intrapreneuring”, and “corporate venturing” (Antoncic and Hisrich, 2001). However, there is still no universally accepted definition (Sharma and Chrisman, 1999). Therefore, this line of study is still under construction and seeking its conceptual identity (Sandberg, 2000). Nonetheless, it is possible to identify three elements in the variety of definitions that, in general, characterize these efforts. One of these is recognizing that the phenomenon concerns the entrepreneurial efforts, orientations, or activities performed within the organization (Burgelman, 1983; Goodale *et al.*, 2011; Ma *et al.*, 2016; Miller, 1983; Schollhammer, 1982). Second, these actions may be undertaken as the result of the interlocking entrepreneurial activities of multiple participants (Burgelman, 1983) at different organizational levels, i.e., management, a unit, or operations (Miller, 1983), including an individual or group of individuals within the company (Sharma and Chrisman, 1999; Stevenson and Jarillo, 1990).

The third indicates that entrepreneurial actions are targeted toward the development of innovation for the company. As stated by Covin and Miles (1999, p. 49) “innovation is at the center of the nomological network that encompasses the construct of corporate entrepreneurship.”

Some authors have asserted that intrapreneurship is synonymous with innovation that is initiated and implemented by employees (Carrier, 1996). In this sense, these entrepreneurial efforts within the company lead to three possible innovative results: organizational renewal, transforming existing businesses that need to be revived or transformed (Schendel, 1990), whether doing so involves renewing the key ideas on which the organization is built – strategic renewal – (Guth and Ginsberg, 1990) or redefining the business concept, reorganizing, and introducing change into the system for innovation (Zahra, 1993); the creation of new businesses, such as the birth of new companies within existing companies (Schendel, 1990); and product and process innovation (Zahra, 1993) as well as organizational innovations (Antoncic and Hisrich, 2001; Zahra, 1993).

Regarding the possible inducers of intrapreneurship, the literature has focused its attention more on the influence of organizational variables than on identifying the characteristics of individuals who make these types of efforts (Antoncic and Hisrich, 2001; Stull, 2005). This last point acknowledges an active role in the intrapreneurial process. Some emphasize the ability to behave as entrepreneurs by recognizing, creating, or pursuing opportunities for organizational change (Easley and Longenecker, 2006; Felicio *et al.*, 2012; Kierulff, 1979; Stevenson and Jarillo, 1990). This is done by securing resources (Kierulff, 1979) or even without considering the resources that they control (Stevenson and Jarillo, 1990), not as simple dreamers but as those who do, in the sense that they can change an idea into a profitable reality (Pinchot and Pellman, 1999). Similarly, they act as individuals or groups of individuals who are willing to take calculated risks, meeting the organization’s needs for growth and improvement (Easley and Longenecker, 2006; Sinha and Srivastava, 2013), or as individuals who possess the entrepreneurial spirit, causing them to begin or push a bottom-up process of change (Block and MacMillan, 1993).

It is for this reason that in this study, we frame intrapreneurship as a process in which an individual or group of individuals, within the framework of an existing organization, identify, pursue, and encourage innovative opportunities and create a new organization, renewing the organization or introducing product and process innovations.

Some empirical contributions and theoretical reviews have suggested possible value, attitude, and personality profiles that are associated with intrapreneurs (Jain *et al.*, 2015; Ma *et al.*, 2016; Martiarena, 2013; Sayeed and Gazdar, 2003; Sinha and Srivastava, 2013; Ulijn *et al.*, 2007). Nonetheless, with the exception of the conceptual contribution by Hayton and Kelley (2006), a limited number of studies attempt to specify intrapreneurial behavior from the perspective of the competencies of these individuals. Given the interest of the present study in proposing a model along this line, we dedicate the following section to the conceptualization of competencies.

Competencies

In his literature review, Hoffmann (1999) notes three main positions on the definition of competencies. One of these defines competencies as an observable performance whose focus is the result or the task to be completed; therefore, particular performances are described as competencies and taken as a basis for the assessment, observation, and measurement of a person’s performance. Second, competencies are considered a quality standard of the outcomes of the person’s performance, in which competencies are associated with the achievement of productivity gains or efficiency in the workplace. Thus, competencies here are defined within the context of organizational performance objectives or standards. Third, competencies are defined as a person’s inherent attributes, i.e., knowledge, skills,

and attitudes for competent performances. Although the first two are focused on the result that the person produces, the last focuses on the individual input that is required to perform competently.

Along this line, Boyatzis (1982) defines job competency as an employee's inherent features relating to effective or superior performance in a job, possessing the advantage of being learned in adulthood (Boyatzis, 2008). Woodruffe (1993) defines competency as a set of behavioral patterns that the incumbent must bring to a position to perform his or her tasks and functions with competence. In this sense, he considers competencies to be a particular dimension of individual behavior that should be appropriate to perform a position. Thus, behavioral repertoires can be conducted much better by some individuals than by others.

This last point is consistent with Hayton and Kelley (2006), who state that for a given context and the performance criteria in which competencies are framed, a person may or may not possess "sufficient amounts" of a given competency (e.g. one person may demonstrate competencies as an effective leader, contrary to another); therefore, they represent extremes within a "continuum." In addition, they stress the attitudinal component, indicating that the capacity and desire to behave competently must underlie this set of behaviors. In a way, they determine that people will produce a competent performance in a situation only if they know how and if they value the consequences of the outcomes that are expected from the action. In their definition, they conceptualize individual competencies as the inherent characteristics of individuals, which involve specific combinations of knowledge, skills, and personality traits that are described in aggregate terms (e.g. skills as a leader, team member, etc.).

The authors also note that empirical evidence shows the influence of human capital on the field on intrapreneurship; one of these is competencies related to individuals. However, they consider that a gap persists in the current literature, on the one hand, relating to the connection between human capital and intrapreneurship, particularly in terms of a clear definition of the characteristics that are desirable in an individual. For this reason, the theoretical competence model is described in the following section, drawing on two major components: knowledge, skills, and attitudes as well as innovative outcomes or roles, i.e., introducing product and process innovations, creating new businesses for the company, and contributing to organizational renewal. This model is the basis for proposing a set of initial hypotheses, which are refined in a first qualitative phase and then submitted to quantitative empirical verification in a subsequent stage.

Theoretical model of intrapreneurial competencies

We have taken some elements of the holistic model of professional competence proposed by Cheetham and Chivers (1996, 1998). This model assumes the existence of three basic components of competencies (cognitive, functional, and behavioral); each of these possesses constituent competencies that form an integral part of these components, with the particularity that they interact with one another; for example, the effective execution of functional competencies requires behavioral competencies or vice versa.

Cognitive competence is defined as the possession of appropriate work-related knowledge and the ability to put this knowledge to effective use. Functional competence is conceptualized as an individual's ability to perform a range of work-based tasks effectively to produce specific outcomes. Behavioral competence is noted as the individual's ability to adopt appropriate, observable behaviors in work-related situations. In this sense, it seems to us that they consider knowing (*savoir*), know how (*savoir-faire*), and knowing how to be (*savoir-etre*), from the French inclusive approach, as mapping onto knowledge, skills, and attitudes from the North American KAS approach (Le Diest and Winterton, 2005).

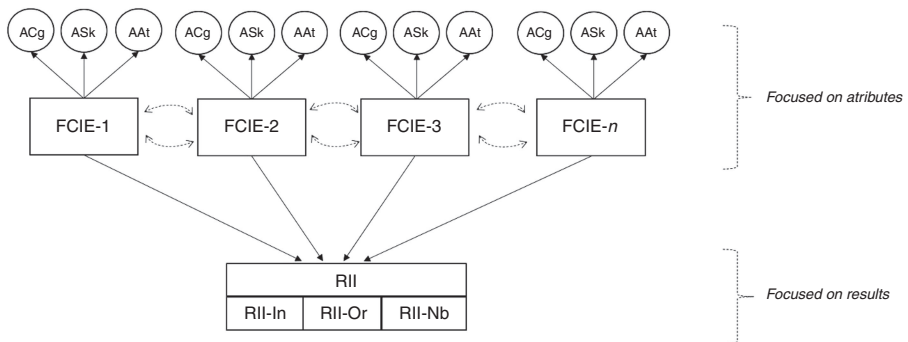
At a higher level, their model proposes that the basic components are influenced by certain – more generic – key competencies that encompass or cover the other competencies,

called meta-competencies. These, the basic components, and their various constituents interact together to produce “outcomes” (or what would amount to corporate entrepreneurial roles, according to Hayton and Kelley, 2006), representing final indicators of professional competence. These outcomes provide feedback so that, in the reflective component, the individual improves his or her competencies. The model foresees the existence of contextual variables for competencies, such as the organizational environment or work context, because an individual may be very competent in a particular context but less competent when this environment changes. This context is defined as the physical, cultural, and social conditions surrounding a person’s work environment.

As stated by Woodruffe (1993), relevant functions, tasks, and competencies can be differentiated using the contribution of Boyatzis (1982), particularly distinguishing between the particular aspects of the job to be performed competently and what a person needs to contribute to the job to perform these particular aspects at the required level of competency. Thus, our model combines the attribute-based competency approach, which begins with the content design of the three basic components, with the observable performance-based approach, which is the outcome required to demonstrate a competent performance (Hoffmann, 1999, pp. 276-277), as shown in Figure 1. At the top, we propose that the attribute combinations of knowledge, skills, and attitudes are explained by different dimensions of intrapreneurial competencies and, on the other hand, that these dimensions are related to employees’ innovative activities for the company. It should be noted that our model does not address the concept of meta-competencies or the organizational contextual factors that affect intrapreneurial competencies. However, we consider the fact that core and constituent competencies influence the intrapreneurial outcome.

Methodology

The process of the development and validation of the scale followed a set of stages, taking the adaptation proposed by Camisón and Cruz (2008) and suggestions from Slavec and Drnovsek (2012) as a reference for new measures in entrepreneurship. The first stage showed the theoretical importance and evidence of the construct to be measured, which



Notes: ACg = cognitive attributes associated to the intrapreneurial competences dimension. ASk = skill attributes associated to the intrapreneurial competences dimension. AAt = attitudinal attributes associated to the intrapreneurial competences dimension. FCIE-n = the infinite number of competences dimensions or factors that explain the entailed attributes, where n equals to 1, 2, 3, ..., n factors. RII = results obtained from the intrapreneurial innovation performance: RII-In = introduce product or process innovations to companies, RII-Or = organizational renovation and RII-Nb = development of new business opportunities for the enterprise
Source: Adapted from Cheetham and Chivers (1996, 1998)

Figure 1.
A conceptual model
of intrapreneurial
competences

involved three phases. The first phase involved two steps: the specification, through a literature review, of the theoretical domain content and the empirical meaning of the three relevant constructs of the study, i.e., competencies, intrapreneurs, and intrapreneurial competencies; and the review of ten entrepreneurial orientation models proposed in the literature to identify possible intrapreneurial attributes of knowledge, skills, and attitudes, which were initially grouped into dimensions of competencies.

In the second phase, expert judgment was used as an assessment strategy (as suggested by Escobar-Pérez and Cuervo-Martínez, 2008) prior to the field study. This strategy sought to confront the theoretical attributes identified in the previous phase from the views and experiences of experts. The expert panel assessed the degree of essentiality of the attributes and the dimensions for innovative outcomes, the perceived degree of interdependence of the dimensions, suggestions for possible dimensions that were not included in the proposal, and finally, their overall impression of the proposed theoretical model. To establish the degree of consensus among the panelists, the Lawshe index (1975), which is considered one of the best for these purposes (Pedrosa *et al.*, 2013), was used.

For panel selection, the recommendations by Slavec and Drnovsek (2012) and Escobar-Pérez and Cuervo-Martínez (2008) in the field of entrepreneurship were considered. The panel was formed by six experts: three entrepreneurs with backgrounds in engineering, of whom two are founders of companies and possess over 15 years of experience in technology-based companies in managerial positions; the other entrepreneur is a manufacturing company manager with over 40 years of experience working in this type of company; two scholars, one of whom is a founder of a spin-off in the field of technology-based companies with a background in engineering and business administration and possesses more than 15 years of experience in academic activities; the other scholar is a university professor who specializes in “competencies” with more than 30 years of academic experience; and finally, an academic with a lead position in a Government Ministry who specializes in the field of science and technology and has over 40 years of experience in the field of public management.

The third phase corresponded to creating items that were in line with the attribute content of the intrapreneurial competency dimensions. General recommendations were followed while drafting these items, for example, avoiding extensive and ambiguous statements, introducing one attribute or aspect at a time, avoiding opposite items, etc. (Colton and Covert, 2007; DeVellis, 2012; Krosnick and Presser, 2010). Three items were drafted for each attribute of the eight dimensions, comprising an initial list of 72 items for the proposed intrapreneurial competency scale. A five-point Likert scale, ranging from 1 = never to 5 = always, was proposed to assess the manner in which the respondent acts for each of the statements expressed in the items (Colton and Covert, 2007).

The second stage corresponded to the representativeness and adequacy of the data collection, consisting of three phases. The first consisted of refining the scale in a pilot test. To that end, the “cognitive interview” (CI) technique, one of the procedures that has been frequently used to adapt scales (Beatty and Willis, 2007), was used. The protocol designed by Smith-Castro and Molina (2011) was used to improve paper and pencil instruments. One of the main features of this process is the verbalization (“thinking aloud”) of ideas evoked by the item; meanwhile, the interviewer asks questions to investigate the cognitive processes that underlie the response process so that the obtained information adjusts the items to the corresponding construct. Six individuals who met the target profile of those who should respond to the instrument were interviewed: university professionals with a background in business administration or engineering who mainly worked in manufacturing or service companies at the time of the interview. The average duration of these interviews was 40 minutes per interviewee. A total of 24 items were assigned to three pairs of interviewees (from 1 to 24, 25 to 48, and 49 to 72) to obtain a more detailed item analysis.

The second phase consisted of completing the preparation of the questionnaire and adding three scales to measure convergent, divergent, and criterion-related validity. To that end, three steps were followed. The first was finding and translating a scale into Spanish that would measure attributes that are similar to intrapreneurial competencies. Champion's behavior scale was chosen; it identifies the behaviors of employees who make a decisive contribution to promoting the successful development of product innovation projects in the company (Howell *et al.*, 2005, p. 644). The "back-translation" technique suggested by Brislin (1986) and particularly the method followed by Beaton and Guillemin (2000) were used. This method proposes that two translators translate the scale from the original language into the target language; subsequently, the translations are synthesized, attempting to seek agreement on the translated items that show significant differences in wording or semantic content, given that it may be technical language. Then, a third translator performs the task of converting the items that were translated into the target language back into the original language ("back-translation"). Finally, the researchers meet with the last translator to identify possible semantic, idiomatic, conceptual, or cultural differences or equivalences between the original items and the target language. Here, they make the final adjustments to the translation in the language in which the tool is to be applied. As a result, the Champion behavior scale was composed of 15 items translated into Spanish, to be evaluated with the same type of Likert scale proposed for intrapreneurs. The pre-test was not performed due to time constraints; however, we sought to compensate for this by turning to translators with expertise in business management.

In the second step, a scale that would allow us to measure attributes that may be different from the intrapreneur was sought. The social desirability (SD) scale by Crowne and Marlowe (1960) was selected; it measures the trend by convening with social norms and more easily reports socially expected behavior than illicit and socially sanctioned behavior. This scale is used in studies as a control variable, particularly when the topics may be evocative of SD. We opted for a version that, composed of 13 items, had previously been adapted to the local context (Smith-Castro *et al.*, 2014). Its items were given the same values as the Likert scale scores proposed for the two previous scales. The third step consisted of designing a scale to measure interviewee performance aimed at proposing innovative initiatives for the organization, considering the four types of innovation suggested by the Oslo Manual (Eurostat and OCDE, 2006) and the creation of new businesses for the company. This step resulted in nine items to be assessed with the same type of Likert scale.

Once the questionnaire was prepared, the third phase began: selecting a non-probabilistic sample of professionals who mainly worked in private companies and who studied in undergraduate and master's programs at public and private universities to apply the questionnaire. Subject quotas were established according to the abovementioned academic degrees and by academic area (business administration and engineering majors). Furthermore, more state than private universities were included, with the purpose of ensuring a sample of professionals with sufficient variability regarding age, years of work experience, and the occupation of different positions or jobs in the company.

Regarding this point, Highhouse and Gillespie (2009) indicate that mechanical assessments, such as "convenience samples are bad", should be avoided (p. 261). These authors pose the following four questions to assess the quality of a sample: Did the research question contain a specific and well-defined population of interest? Is there a characteristic of the convenience sample that may interact with the variables of interest in the study? Is participant motivation relevant to this study? and If the researcher is testing a theory, does the theory apply to this sample? As is evident, the selected sample met all of these criteria.

Finally, the third stage, consisting of five phases, led to the measurement of the proposed scale's psychometric properties. Analysis of the dimensionality of the scales began with an exploratory factor analysis (EFA), reducing the proposed scale of intrapreneurial

competencies down to a smaller number of items in factors that were interpreted in the light of the support from the performed literature review; similarly, an analysis of internal consistency of the scale using Cronbach's α was performed, taking the assessment criteria proposed by DeVellis (2012) as a reference. Both procedures were performed using SPSS version 19.

In the third phase, a confirmatory factor analysis (CFA) was used to assess the general fit of the measurement model and to verify the multidimensional nature of intrapreneurial competencies (first-level analysis) and the establishment of a macro-construct of intrapreneurial competencies (second-level analysis); structural equation modeling was employed. The Mardia index (Álvarez *et al.*, 2006) was used to assess multivariate normality. On the other hand, robust versions of the three indices recommended by Hair *et al.* (2010) were used: a) $SB \chi^2$, b) CFI, and c) RMSEA. Power was calculated by taking the RMSEA as a basis according to the procedure of MacCallum *et al.* (1996); a type II error is defined as the possibility of detecting and rejecting a bad model. An exact fit was used (null hypothesis = 0.00; alternative hypothesis = 0.05) in accordance with Schumacker and Lomax (2010). Similarly, the online tool by Preacher and Coffman (2006) was employed for calculation. In a fourth phase, the global fit measure was calculated for three nested models (variations of those proposed by Byrne (2006) were used because there was only one method and various features), in search of evidence of convergent validity and discriminant validity with the use of parcels as a procedure (Williams *et al.*, 2009). This was done considering the advantages offered by the "pragmatic-liberal" approach (Little *et al.*, 2002), including i) higher reliability, ii) an improved relationship of the number of cases per parameter, iii) a lower possibility of violating the technique assumptions, iv) a better understanding of the relationship among constructs, and v) more stable solutions.

In these two phases, EQS version 6.2 was used. Finally, an assessment of the degree of relationship between the scale of intrapreneurial competencies and the measure of action aimed at innovation for the company was performed to obtain evidence of external criterion-related validity, through a linear regression model, using SPSS version 19.0. In addition, the sensitivity and specificity analysis of the proposed instrument was conducted and was used as a cut-off for the scale scores equivalent to the first and fourth quartile that defined the groups of high and low levels of intrapreneurial competencies and, on the other hand, those of low and high innovative performance for the company. Furthermore, positive and negative value probabilities were considered, in addition to the calculation of sensitivity and specificity (Santisteban, 2009).

Results

Stage 1: theoretical importance and evidence of the construct to be measured

To build the model of intrapreneurial competencies, we proceeded to review each of the following dimensions cited in the literature: entrepreneurial orientation (Lumpkin and Dess, 1996); innovation (Hargadon and Sutton, 1999); strategic renewal (Floyd and Lane, 2000); entrepreneurship (Stevenson and Gumpert, 1985); the innovative champion (Jensen and Jorgensen, 2004); entrepreneurial intensity (Liao *et al.*, 2005); champions of new products (Howell *et al.*, 2005); the creation of new businesses (Baron, 2007); management (Kuratko *et al.*, 2005), and the MCI model of standards (2008).

Based on this review, attributes or characteristics relating to possible intrapreneurial competencies were identified. Subsequently, several grouping sessions of these attributes were performed, and the affinities between them were identified. A generic name was assigned to characterize them – a possible common factor, as proposed in the upper part of Figure 1. Using an iterative process of discussion among researchers, it was possible to agree upon seven possible dimensions that characterize intrapreneurial competencies (see Table I). It is important to note that each of the dimensions of the proposed theoretical

Possible dimension (FCIE-i) ^a	Conceptualization of core competency attributes of FCIE-i ^b	Associated attributes		
		ACg	AHb	AAc
1. Exploiter of opportunities	Knowledge to detect opportunities, acting to take advantage of opportunities, and adopting behaviors to take advantage of opportunities for the company	X	X	X
2. Pro-innovator	Knowledge to create new things, acting to put new things into practice and adopt behaviors, and willingness to create new things for the company		X	X
3. Idea stimulator	Knowledge to create new ideas, acting to put new ideas to the test, and adopting behaviors to promote and support new ideas for the company	X	X	X
4. Planner	Knowledge to plan initiatives, acting to implement a new initiative plan, and adopting behaviors for the new company initiative plan		X	X
5. Resource manager	Knowledge to detect and estimate resources, acting to mobilize resources, and adopting behaviors to commit resources to new initiatives for the company	X	X	X
6. Support network builder	Knowledge to build networks, acting to join forces with others, and adopting behaviors to attract others and negotiate with others to support new initiatives for the company		X	X
7. Builder of interactions with others	Knowledge to involve others, acting to put the knowledge and experiences of others into practice, and the ability to know how to encourage others to support new initiatives for the company		X	X

Table I. Possible dimensions of core intrapreneurial competencies at a conceptual level

Notes: The symbols correspond to those proposed in Figure 1. ^aIn the first theoretical dimension, FCIE-i amounts to FCEI-1 and so on; ^beach dimension (FCIE-i) contains three competency attributes; thus, the seven dimensions of the theoretical model contain 21 attributes

model contains competency attributes, in particular, knowledge, skills, and attitudes. Thus, the dimensions of exploiter of entrepreneurial opportunities, idea stimulator, and resource manager contain the three intrapreneurial attributes; meanwhile, the other dimensions may be more focused on attributes of intrapreneurial skills and attitudes.

The experts were consulted as to how essential, useful, or non-essential they considered the 21 attributes of the seven dimensions proposed for employee innovative behavior in the organization. More than the half of the panelists indicated as essential the three attributes in the dimensions of exploiter of opportunities, pro-innovator, idea stimulator, network constructor, and constructor of interactions with others. In the dimensions of resource planner and manager, there was consensus that attitudinal competencies are essential. Indeed, this was the type of attribute that was most emphasized in their comments, given that cognitive competencies and skills can be learned; however, attitudes hold greater weight for the intrapreneur. Thus, they imply a work philosophy that allows tasks, mainly regarding innovation, to be performed in the organization.

Moreover, three of the panelists declared that the resource planning and management dimensions can be learned; nonetheless, it is not possible to separate them from others, for example, stimulating interactions with others. Most panelists agreed in noting that building networks and interactions with others are very interrelated dimensions, in addition to resource planner and manager.

In addition, four of the six panelists suggested an additional dimension, specifically, risk taking as a promoter of innovative actions in the company, which was included in the model. One aspect that is important to highlight was the agreement among the panelists in regard to the high level of interrelation between the dimensions, which suggests, as a hypothesis, the existence of a higher-level construct that represents intrapreneurship as a macro-competency.

As a result of the literature review, seven dimensions emerged that, in turn, were confirmed by the expert panel, who, moreover, suggested the incorporation of an additional dimension. Therefore, the model was expanded to eight dimensions and 24 attributes. Based on these results, we proceeded to draft three items per dimension for an initial scale of 72 items; this was done while considering the recommended practices for writing and each attribute's content facet.

Stage 2: representativeness and adequacy of data collection

The pre-test of the proposed 72-item scale revealed the need to make the following changes: (a) modifying several words in 24 items; (b) removing or replacing a word to improve the understanding of the item in 16 items; and (c) varying the position of four items. In Table II, we present three examples of modified items to compare them with the items that were finally used as a result of the CI.

Regarding the back-translation, in column 2 of Table III, some of the Champion behavior scale items once two translators agreed on the Spanish version are presented. Below, in the third column, the back-translation of the previous items that was agreed upon by a third translator is presented. Finally, the fourth column shows the final items that the third translator and the researchers agreed upon. Thus, the Spanish version used in this study was obtained. In addition to the two previously presented scales, the final questionnaire included scales of SD and innovative behavior, whereupon the instrument reached 109 items.

Regarding the sample, it was composed of 543 professionals, of whom 71 percent worked in companies, particularly in the financial, telecommunications, and software sectors of large organizations. The remaining 29 percent of the participants worked in governmental organizations. According to job positions, 22.5 percent occupied positions of middle management, 20 percent supervision or leadership, and the remaining 57.5 percent administrative professional positions. The age range was between 19 and 53 years, with an average of 29.7 years and a standard deviation of 6.3 years. Below, the results from the statistical analyses are detailed.

Original item	Final item
I am interested in an in-depth understanding of the ins and outs of the business that this company conducts	I am interested in an in-depth understanding of the business operations that this company conducts
I use pilot prototypes, models, or programs within the company to assess and refine ideas	I use pilot models or programs in the company to assess and refine ideas
I ask questions that challenge the common knowledge of how things are done in the company	I ask questions that challenge how things are done in the company

Table II.
Examples of initial and final items as a result of the pre-test using the cognitive interview

Original item in English	Items with first collaborative translation from original into Spanish	Item with translation from Spanish into English Back-translation	Final item translated collaboratively into Spanish
Enthusiastically promotes the innovation's advantages	Promueve con entusiasmo las ventajas de la innovación	Promotes the advantages to innovation with enthusiasm	Promuevo las ventajas de la innovación con entusiasmo
Keeps pushing enthusiastically	Mantiene el impulso con entusiasmo	Maintains momentum with enthusiasm	Mantengo el impulso de la innovación con entusiasmo
Gets the right people involved	Hace participar a las personas adecuadas	Encourages the right people to participate	Hago participar a los tomadores de decisión clave

Table III.
Examples of items in the Champion behavior scale during the process of translation into Spanish using back-translation

Psychometric properties of the scale

Factorial structure. Regarding the EFA, the KMO = 0.927 indicated sample adequacy. Moreover, Bartlett’s test of sphericity rejected the null hypothesis that the correlation matrix corresponds to an identity matrix (Cea, 2002). We proceeded to perform an extraction using the principal axes and an Oblimin rotation because the experts reaffirmed the high degree of interrelation between the dimensions and it is recommended as the first alternative (Field, 2013). The results supported the oblique procedure, with correlations between factors higher than 0.33, exceeding the minimum criterion of 0.32 suggested by Tabachnick and Fidell (2013). Five factors met the Kaiser criterion of an eigenvalue higher than or equal to one (DeVellis, 2012); therefore, they were retained. This solution explained 63.14 percent of the variance and coincides with what was observed in the sedimentation diagram. Parallel analysis was not used to determine the number of factors because there is no consensus relating to its mode of calculation when an extraction is performed using principal axes (O’Connor, 2015).

Items with loadings ≥ 0.05 were retained because this value explains 25 percent of the item factor (Hair *et al.*, 2014). This value is higher than the minimum loading required for significance, given that, for a sample of 400, quantities of 0.23 ($p < 0.01$) are required (Stevens, 2009). It is important to remember that, in this case, the factors represent different competencies that resulted from the elaboration of the items according to the competency dimensions and attributes. In other words, the dimensionality revealed by the EFA is a first approximation to a model of intrapreneurial competencies.

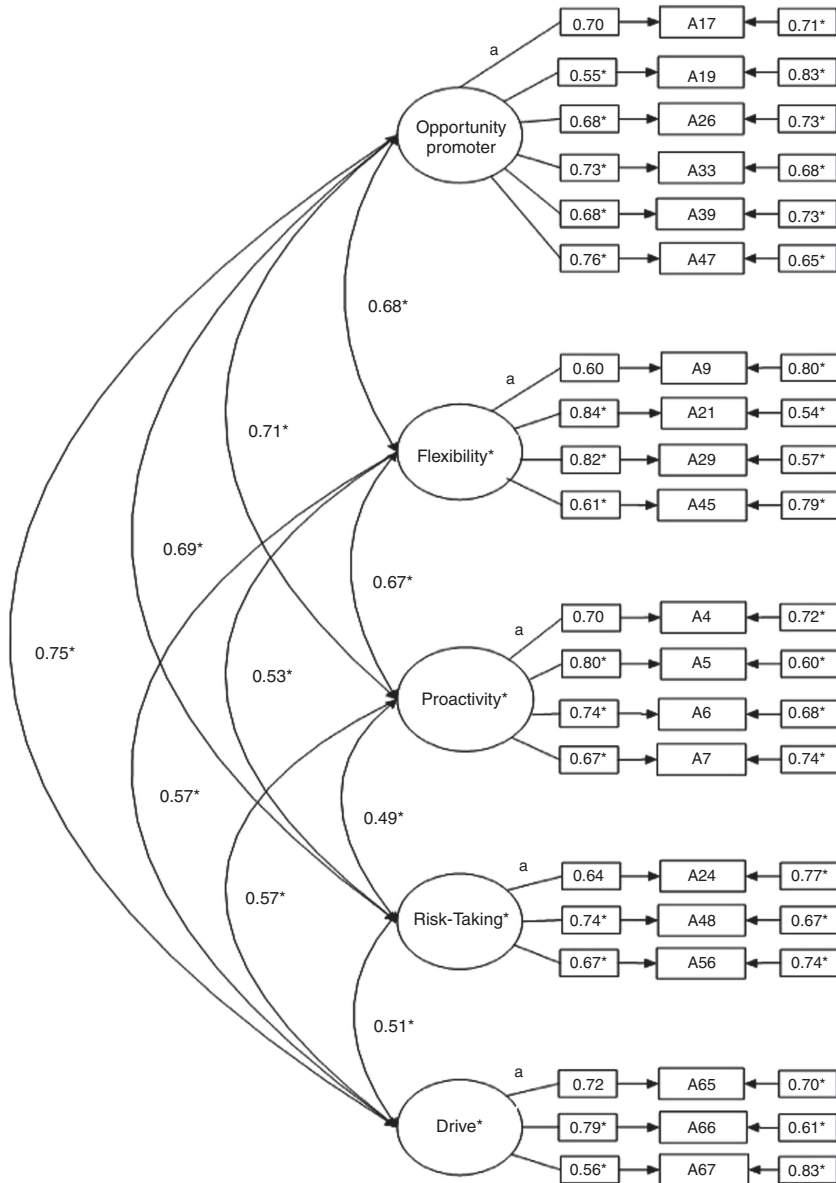
The first factor, known as “opportunity promoter”, is composed of six items related to behavior aimed at identifying, harnessing, convincing others, and being diligent in the face of opportunities for new initiatives in the company. The second factor, called “proactivity”, is composed of three items related to behavior aimed at supporting actions and triggering efforts for new initiatives. The third factor, called “flexibility”, consists of four items related to the flexibility and lack of attachment to schemas and rigid procedures. The fourth factor is called the “drive” competency and includes four items related to an individual’s capacity to become interested in the progress and support of new initiatives and to even perform actions to convince others. Finally, the fifth factor refers to the “risk taking” competency, which comprises three items that denote capabilities oriented toward taking risks on new initiatives for the company. In total, the scale was composed of 20 items, distributed as presented in Table IV.

To corroborate these findings, we proceeded to perform several CFAs, as recommended in the literature (Worthington and Whittaker, 2006). Specifically, a first-level CFA was performed to corroborate the hypothesis of the existence of these five intrapreneurial competencies, i.e., that the selected items, through EFA, effectively load onto the five proposed dimensions. Furthermore, a second-level CFA was conducted to test the hypothesis that these five dimensions represent a macro-competency called intrapreneurship.

The first-level CFA (see Figure 2) showed a Mardia index of 72.19, indicating the absence of multivariate normality (Bentler, 2006). Thus, maximum likelihood with robust indicators

Table IV.
Item total for the scale of intrapreneurship according to dimension as a result of EFA

Dimension	Number of items
Opportunity promoter	6
Proactivity	3
Flexibility	4
Drive	4
Risk taking	3
Total scale items	20



Note: ^aParameters set in 1. Standardized coefficients; those with a statistical significance of $p < 0.005$ are presented with an asterisk

Figure 2. First-level AFC results

was used. The first model obtained a significant Satorra-Bentler χ^2 ($_{SB}\chi^2_{(160)} = 336.37$, $p < 0.001$); however, this statistic is very sensitive to sample size (Byrne, 2010). The robust CFI resulted in 0.943, with the acceptable minimum of 0.90 (Keith, 2015). The RMSEA was 0.046, with a 90 percent CI [0.039, 0.053], in which case, values greater than 0.08 were taken

as indicating a poor fit (Bentler, 2006; Schumacker and Lomax, 2010). Accordingly, it was concluded that the five-factor model obtained an acceptable global fit. The power of the RMSEA with an exact fit was 1, higher than the 0.80 suggested by Ellis (2010). The non-standard parameters freely estimated from the model were shown to be significant ($p < 0.05$). The standardized factor loadings were significant ($p < 0.05$) and higher than 0.50, meeting the established criteria of at least 25 percent s^2 item variance that is to be explained by the factor (Hair *et al.*, 2010). In addition, the correlations between the factors were significant ($p < 0.05$) and ranged between 0.49 and 0.75, indicating relationships between competencies without redundant factors.

The second-level or hierarchical model (see Figure 3) assumes the existence of a macro-competency called intrapreneurship that is formed by the five dimensions or competencies described in the EFA. This model obtained a Mardia index of 72.18; therefore, we continued to use robust statistics. The Satorra-Bentler χ^2 was significant ($_{SB}\chi^2_{(164)} = 333.99$, $p < 0.001$), although slightly less than the first-level model. The CFI was 0.945, and the RMSEA was 0.045, between 90 percent CI [0.038, 0.051]. This finding indicates a good model fit and is slightly higher than the first-level solution. The power of the RMSEA was 0.99.

In terms of the items, the factor loadings of the hierarchical solution were very similar to the first-level model in magnitude and significance. Moreover, the explained variance of each dimension was important, with a range between 0.49 and 0.88 and in all cases significant ($p < 0.001$). Both CFAs provide evidence of validity regarding the internal structure of the proposed scale, according to classical test theory (Martínez *et al.*, 2006; Santisteban, 2009).

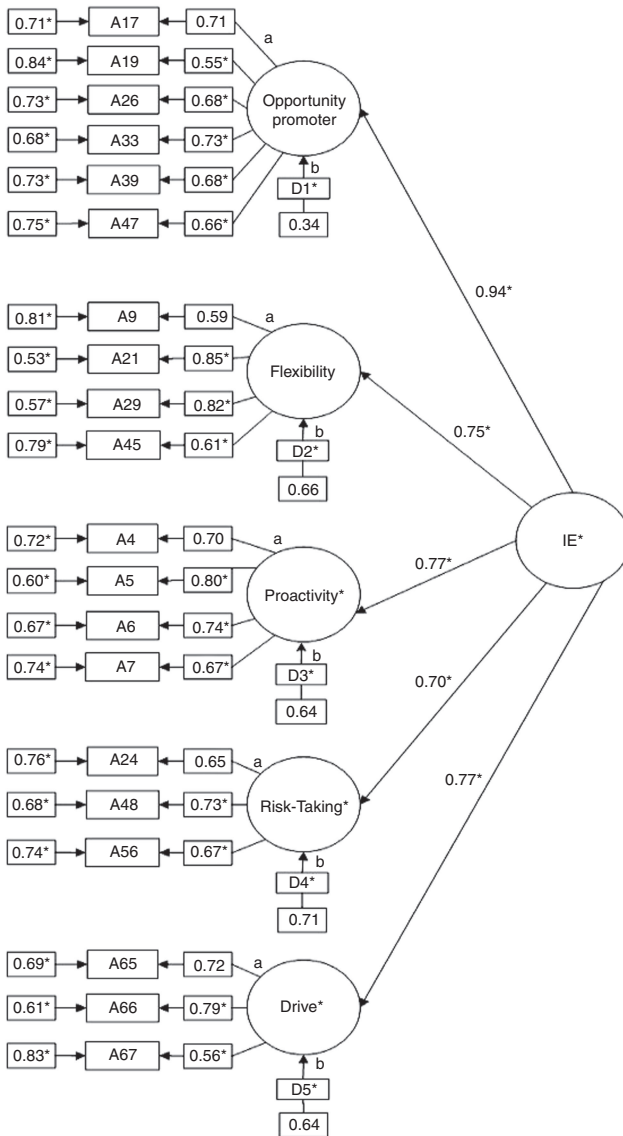
Cronbach's α coefficient was calculated for each dimension and for the total scale to assess the reliability of the developed instrument. As shown in Table V, all scales showed reliabilities between acceptable and very good in accordance with the valuation of DeVellis (2012), which is meritorious due to the small number of items.

Convergent and divergent validity analyses. Convergent validity seeks to measure the confluence between scores of different measures of similar constructs, whereas divergent validity measures the disparity between scores of measures of different constructs. This is the case regardless of the method used (Martínez *et al.*, 2006; Santisteban, 2009). In this study, only one method is used (participant self-report); therefore, the performed assessment is only based on construct content.

To obtain this type of validity evidence, it is common to impose progressive restrictions by setting a parameter simultaneously, i.e., using a nested model (Hoyle, 2012). Similarly, a positive correlation greater than 0.651 between two measures with conceptual correspondence, constituting evidence of convergent validity, was established. Conversely, an association lower than this value was considered to be between theoretically dissimilar constructs and was confirmation of discriminant validity (Mangin and Prado, 2006).

Figure 4 presents the first (base) model in which the three constructs correlate freely, i.e., without any restriction. The Mardia index resulted in 21.57; the Satorra-Bentler χ^2 was significant ($_{SB}\chi^2_{(41)} = 120.408$, $p < 0.001$); the CFI and RMSEA were between the expected values (0.964 and 0.062, respectively, the latter at 90 percent CI [0.049, 0.075]). The correlations between the two measures of intrapreneurship converge, with a significant ($p < 0.001$) correlation of 0.78. The correlations of these two measures with SD were much lower, with magnitudes of 0.36 and 0.41; both are significant ($p < 0.01$). Although these correlations are not negligible, it is important to note that in the case of the proposed scale, it decreases. Clearly, a lower level of correlation with SD is desirable; however, the obtained coefficients are satisfactory as evidence of divergent validity.

The estimated factor loadings were greater than 0.60 and significant ($p < 0.001$) in all parcels of the two measures of intrapreneurship, meaning that both constructs explain a



Notes: ^aParameters set in 1; ^bterm of disturbance for the endogenous latent variables. Standardized coefficients; those with a statistical significance of $p < 0.005$ are presented with an asterisk

Figure 3.
Second-level
AFC results

significant amount of the variance in each scale's sub-dimensions. In this sense, the loading magnitudes and the general fit of the model provide evidence of the convergent and discriminant validity of the scales.

In a second model, the covariances of intrapreneurship and of the Champion behavior scale with SD were set to 0 (see Figure 5). The implication is that the first two do not correlate with SD but that they correlate between themselves. Therefore, if the model fits, then it provides

evidence of convergent validity between intrapreneurship and the Champion behavior scale. In this case, a significant χ^2 was obtained ($_{SB}\chi^2_{(43)} = 185.864, p < 0.01$), with a CFI of 0.935, which is slightly less than the base model but meets the acceptable minimum. Regarding the RMSEA, it increased slightly to 0.081, with 90 percent CI [0.069, 0.093]. Accordingly, the model maintains an acceptable fit, providing evidence of convergent validity.

Table V.
Internal consistency
by competency for
the total scale

	Cronbach's α	Assessment ^a	Number of cases
Creating opportunities	0.838	Very good	537
Motivating	0.728	Acceptable	537
Flexible	0.803	Very good	539
Drive	0.815	Very good	537
Risk taking	0.723	Acceptable	537
Total scale	0.913	Very good ^b	520

Notes: ^aAccording to DeVellis; ^bthe scale could even be reduced

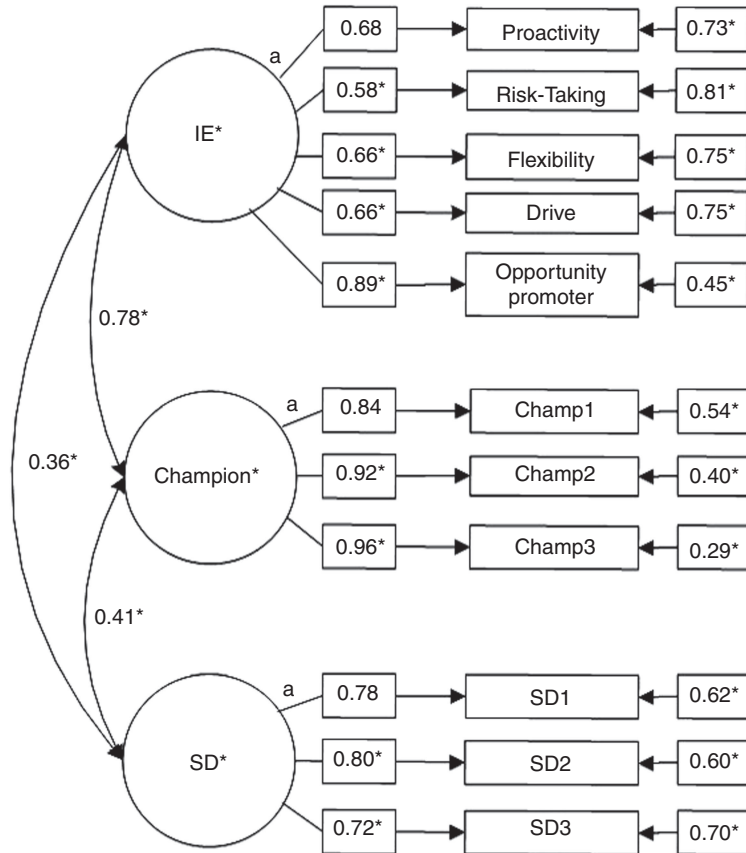
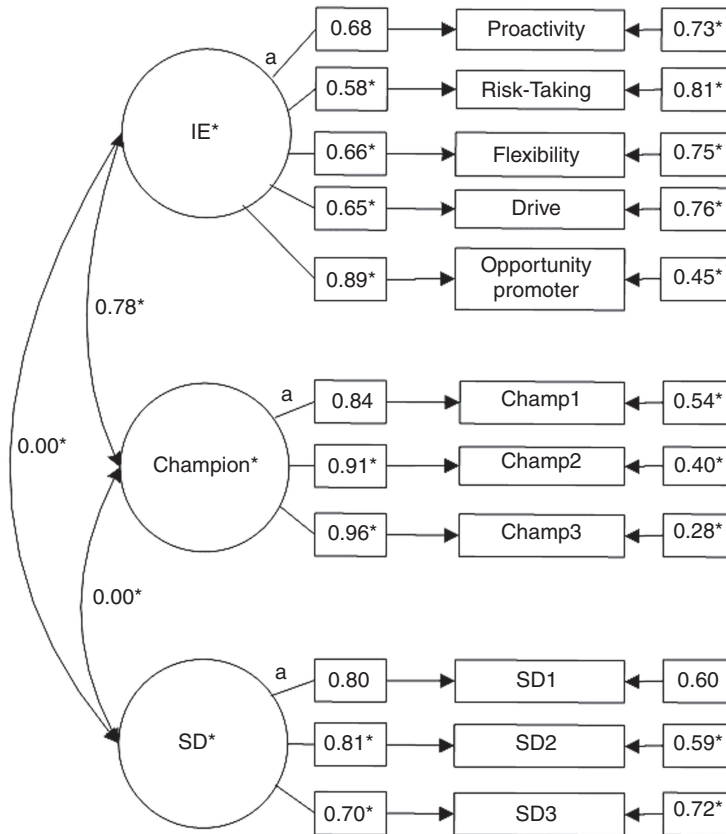


Figure 4.
Model 1: the
three constructs
correlate freely

Notes: ^aParameters set in 1. Standardized coefficients; those with a statistical significance of $p < 0.005$ are presented with an asterisk

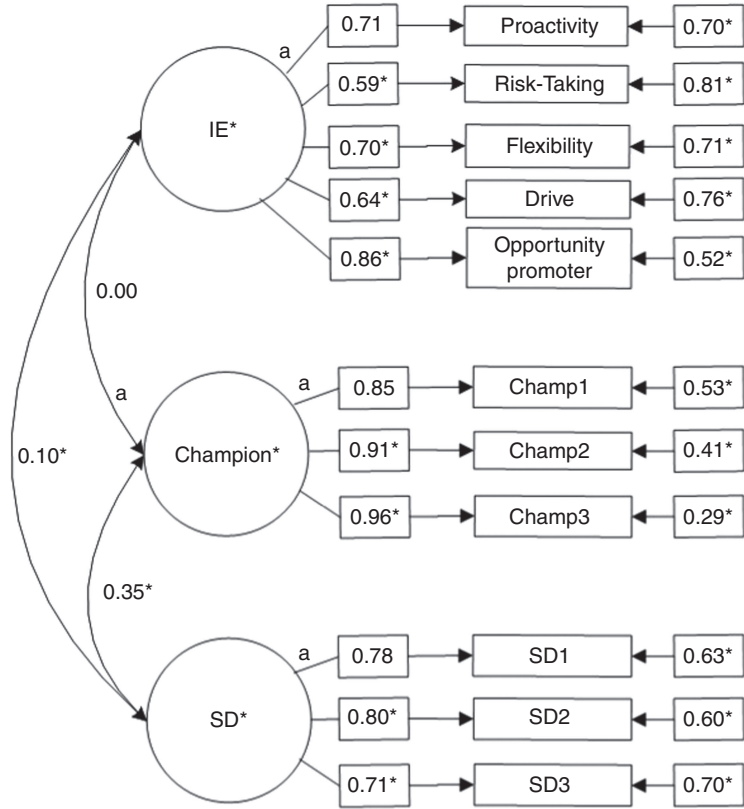


Notes: ^aParameters set in 1. Standardized coefficients; those with a statistical significance of $p < 0.005$ are presented with an asterisk

Figure 5.
Model 2: the two measures of IE do not correlate with SD

The third model set the correlation between the two measures of intrapreneurship to 0 (see Figure 6) and allowed them to correlate freely with SD. In this case, it is assumed that, given the divergence between intrapreneurship and the Champion behavior scale with SD, the model should not fit. This has been used in the field of business management by authors such as Tellis *et al.* (2009, p. 11). Indeed, the χ^2 rose markedly ($_{SB}\chi^2_{(42)} = 441.428, p < 0.01$), the CFI was below the acceptable minimum (0.817), and the RMSEA was outside of the range (0.138 at 90 percent CI [0.126, 0.149]). The difference between the robust Satorra-Bentler χ^2 of the base model and third model ($\Delta_{SB}\chi^2_{(2)} = 143.58$) was significant ($p < 0.01$). The findings above indicate a poor model fit; in this sense, they provides evidence of the discriminant validity of the proposed scale.

To determine the possible SD bias, the procedure suggested by Podsakoff *et al.* (2003) was used. Both Model 4, which does not control SD, as well as Model 5, which does, fit (see Table VI and Figures 7 and 8). In the case of the scale of intrapreneurship, the factor loadings controlling SD varied very little. In fact, this last factor obtained significant saturations, although they were very low. This finding indicates that although there is a SD bias, it is very small. In the case of the Champion behavior scale, the loadings varied to a



Notes: ^aParameters set in 1. Standardized coefficients; those with a statistical significance of $p < 0.005$ are presented with an asterisk

Figure 6. Model 3: the two measures of IE do not correlate

Table VI.

Model fit indices without and with controlling for social desirability

Models Indices	Model 4	Model 5
SB χ^2	64.64* (28) ^a	87.83* (19) ^a
Robust CFI	0.97	0.97
Robust RMSEA	0.068 (0.050, 0.087) ^b	0.055 (0.041, 0.069) ^b

Notes: ^aDegrees of freedom; ^b90 percent confidence intervals. *Statistically significant at the $p < 0.001$

wider extent (see Table VII). SD obtained significant and moderately high saturations, indicating that it is more susceptible to this type of bias than the proposed tool.

Criterion validity analysis. The linear regression model used the sum of the scores from the 20 items in the proposed scale to assess intrapreneurship as an independent variable. As a dependent variable, the sum of the scores of the nine items from the employee innovative behavior scale was employed. These items measure employee participation in the development of product, process, organizational, and marketing innovations in the company (Eurostat and OCDE, 2006) and in the creation of new businesses for the company.

The results showed a relationship between the scores on the intrapreneurship and employee innovative behavior scale, $F(1, 505) = 329.9, p < 0.01$, with a reasonable level of explained variance, $R^2 = 0.394$. Moreover, graphically, the estimate assumptions were verified according to the ordinary least squares method: the normality assumption (histograms of residuals and normal probability plot; and the independence of errors (constant variance and 0 mean, with the use of the residuals vs predicted values plot). All of these results offer evidence of the criterion-related validity of the developed scale.

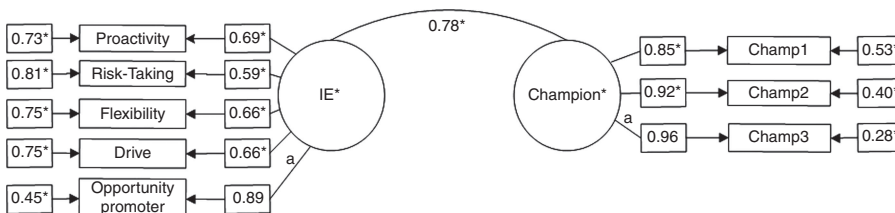
In addition, as shown in Table VI, a sensitivity and specificity analysis was performed. Regarding the former, it can be observed that out of every 100 intrapreneurs in the sample, the instrument detects 90.3 percent. Furthermore, regarding the latter type of analysis, 89.9 percent of the non-intrapreneurial individuals in the sample are identified with the scale. We add to this fact that the probabilities that an intrapreneur will actually correspond to a case of success and that a non-intrapreneur will correspond to a case of success are 91.1 and 89 percent, respectively. As can be observed, these values are very high and balanced, providing evidence of not only the criterion-related validity of the scale but also its usefulness as a diagnostic instrument for the development of competencies (Table VIII).

Conclusions

This study provides evidence of five sub-dimensions of employee attributes that constitute a higher-level construct called intrapreneurial competencies. These sub-dimensions are consistent with what has been indicated in the literature. The first of these contains characteristics relating to the ability to ask questions about the organization’s endeavors because doing so may be an input to detect opportunities that, coupled with the ability to turn them into manageable initiatives, contribute to creating opportunities for the company. Attributes such as diligence are added to the above to take advantage of these opportunities and to promote enthusiasm in their execution. This addition is based on the models by Stevenson and Gumpert (1985) and Baron (2007). It is worth noting that from their conceptualization of the intrapreneur, authors such as Kierulff (1979) and Felicio *et al.* (2012) have highlighted the ability to recognize opportunities. Similarly, Stevenson and Jarillo (1990) emphasize individuals who pursue opportunities, and Pinchot and Pellman (1999) highlight those who make them a reality.

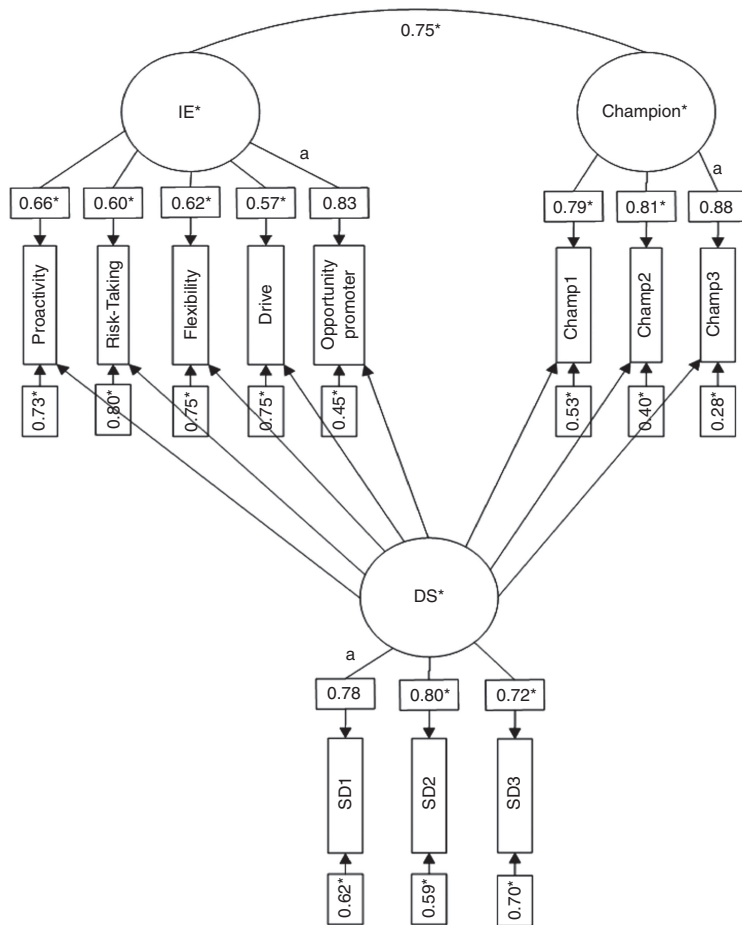
A second element is the proactivity reflected in actions such as the willingness to assess a new initiative with others and to support new ideas, regardless of who suggests them, and the ability to unite efforts to implement innovations for the company. In the literature, authors such as Lumpkin and Dess (1996) have noted proactivity as a component of the entrepreneurial orientation of organizations, and Becherer and Maure (1999) have presented evidence of the relationship between the proactive personality and entrepreneurial behavior.

A third component proposes the absence of structured or methodological schemes (Jensen and Jorgensen, 2004) in different types of knowledge related to the recognition of



Notes: ^aParameters set in 1. Standardized coefficients; those with a statistical significance of $p < 0.005$ are presented with an asterisk

Figure 7.
Model 4: measurement model of the intrapreneurial and champions scales, without controlling the social desirability bias



Notes: ^aParameters set in 1. Standardized coefficients; those with a statistical significance of $p < 0.005$ are presented with an asterisk

Figure 8.
Model 5: measurement model of the intrapreneurial and champions scales by controlling the social desirability bias

opportunities regarding financial resources, specifically, identifying resources, obtaining resources, and assessing the initiative's cost and benefits. This last attribute is consistent with what is proposed by Pinchot and Pellman (1999) in the sense that innovation may lead to a chaotic process. Therefore, innovators must have the courage to do what must be done, even if it means challenging the rules. These authors clearly warn that attempting to bend the rules requires the employee to have the company and its clients' best interests in mind.

The fourth component highlights the importance of attributes such as perseverance, stimulating projects, and being interested in the progress of initiatives for the company and the capacity to identify resources for new initiatives. This is consistent with what is indicated by Hargadon and Sutton (1999), Kuratko *et al.* (2005), and Lumpkin and Dess (1996). In addition, Garud and Van de Ven (1992) emphasize the relevance of employees who endeavor to gain access to the necessary resources and provide advice and guidance for innovative projects.

Finally, a fifth component contains characteristics relating to taking risks on new initiatives for the company, which is in line with Kuratko *et al.* (1990), Lumpkin and Dess (1996), and Stull (2005). It is worth highlighting the contribution by Desouza (2011) in the sense that intrapreneurs are individuals who take calculated risks as a result of their quick learning and from experiencing numerous iterations of learning by trial and error. This allows them to take risks that have the potential for a yield for the organization.

On the other hand, the study has shown that the measurement scale of the intrapreneurial competency construct is related to the employee's disposition to contribute to the development of innovations and to the creation of new businesses for the company. This potential predictive capacity of an instrument of this nature would be useful for the business sector, particularly as a diagnostic instrument to strengthen processes of staff development in areas that promote the development of innovation and the creation of new businesses for the company.

Despite the exploratory nature of this study, the model offers a first firm step to continue studies that aim at developing a robust model of intrapreneurial competencies. It is clear that the proposed scale requires further research. The need to access employees working in companies, through advanced academic programs (undergraduate and master's) in universities, limits the ability to infer the results. According to this deficiency, we propose the development of future studies to replicate the results in different samples. Such studies would help to refine the proposed competency model, verifying the item behavior and including new items to explore other possible dimensions of intrapreneurship. This improvement in the scale would help build performance criteria with respect to the

Models	IE Model 4 ^a	IE Model 5 ^b	CH Model 4 ^c	CH Model 5 ^d	SD Model 5 ^e
Observed variables					
Implementer	0.69	0.66			0.19
Risk	0.59	0.60			0.08*
Flexibility	0.66	0.62			0.24
Change	0.66	0.57			0.34
Opportunity	0.89	0.83			0.33
Parcel 1			0.85	0.79	0.31
Parcel 2			0.92	0.81	0.43
Parcel 3			0.96	0.88	0.38
Factor correlation	0.78	0.75	0.78	0.75	

Notes: ^aFactor loadings of the scale of intrapreneurship in the model without bias control; ^bfactor loadings of the scale of intrapreneurship in the model with bias control; ^cfactor loadings of the Champion behavior scale in the model without bias control; ^dfactor loadings of the Champion behavior scale in the model with bias control; ^efactor loadings of the social desirability scale in the model with bias control. *ns ($p > 0.05$)

Table VII.
Model saturations without and with controlling for social desirability

Scale cut-off criterion	Innovative behavior cut-off point		Total
	> 28 points	< 20 points	
> 78 points IE scale	102	10	112
< 65 points IE scale	11	89	100
Total	113	99	212
Sensitivity	102/103 = 0.903		
Specificity	89/99 = 0.899		
Positive prob. value	102/112 = 0.911		
Negative Prob. Value	89/100 = 0.890		

Table VIII.
Sensitivity and specificity analysis of the measuring instrument

market (e.g. percentiles), offering much more objective criteria for assessing the degree of development of intrapreneurial competencies and supporting the practical use of the tool.

In the future, it would be useful to complement these findings with the study of intrapreneurial competencies in governmental organizations. The reason is that professionals working in private companies predominated in this study sample.

It is important to note that basing the development of a tool on 10 models of entrepreneurial orientation that were developed in contexts different from Costa Rica constitutes a limitation. Thus, it is necessary to extend the exploration of intrapreneurial attributes in the ecosystem of companies because the models studied in the literature have been developed in cultural and economic contexts that are very different from the local context. We attempted to mitigate this limitation with expert judgment. However, for future studies, we propose accompanying the intrapreneurial competency analysis with other inputs provided by employees situated at a higher or intermediate level of the organizations, using techniques such as the frequency concept of disposition proposed by Buss and Craik (1980).

The academic environment of the study addresses the weakness or gap indicated by Slavec and Drnovsek (2012) regarding the little emphasis that valid measure development has been given in the field of entrepreneurship. Specifically, this study is a first effort toward defining a competency model and its respective measurement scale for intrapreneurship in the Costa Rican business context.

Moreover, the possibility of performing studies with the tools of classical test theory in the field of intrapreneurship is demonstrated. Having done so allows other researchers not only to emulate the effort but also to improve it. The advancement of a scientific discipline is not feasible without good measures (Bearden *et al.*, 2011). Furthermore, in the social sciences, instrument validity is linked to the context in which the instrument is used. In accordance with the above, the scale aims to make a contribution to the community of researchers in the field to create a tool that possesses validity evidence in the Costa Rican context. Clearly, as with any measuring instrument in the field, the scale requires further studies not only to corroborate its validity and reliability but also aimed at obtaining more robust versions. Appropriate measuring instruments clearly reduce measuring error. Thus, researchers can better manage the development of causal models in which intrapreneurship constitutes an important factor.

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Financing public transport: a spatial model based on city size

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Abstract

Purpose – The purpose of this paper is to investigate the relationships between public transport services and the financial needs. Cities require to be equipped with public transport networks as they are primarily responsible for creation of wealth for countries and to ensure sustainability of urbanization. Once decisions have been taken to design, build and operate such networks, it is equally important to set rules for urban transport financing. Depending on the city size and other factors, authorities allocate resources. Nonetheless, is there a relationship between the size of the city and its public transport financial needs? This paper develops a model to explain such relationships.

Design/methodology/approach – The study develops a spatial model, while providing intuition through the use of graphs, to solve the question of the amount of resources allocated for financing the transport services.

Findings – It is verified that those financial needs are more than proportional to the size of the city; when a city grows in its number of boroughs, economic funds needed to support public transport have to increase in a greater proportion in comparison to the growth of boroughs growth. The model states a formula valid for explaining the financial needs.

Originality/value – The model is interesting as it explains why large metropolitan areas need special financial aid from authorities. Real life shows that big cities like Paris, Berlin or Madrid need extraordinary funds for this purpose, and in most of the cases, specific national laws are required for financing public transport networks in these large metropolitan areas.

Keywords Public transport, Finance, Subsidies, Transport infrastructures, Spatial model

Paper type Research paper

1. Introduction

There is no doubt cities require to be equipped with public transport networks as they are primarily responsible for creation of wealth for countries. Public transport improvements in any city enable the growth and densification of urban spaces. Therefore, it is necessary to develop infrastructures and urban transport services to solve mobility problems, especially to ensure sustainability (Banister, 2005), and in line with this principle, it is essential to include sustainability as a first-class variable in the planning and development of transport infrastructures (TRB, 2004). Once decisions have been taken to design, build and operate such networks, it is equally important to set rules for urban transport financing and make it likewise sustainable in the economic sphere, as financial sustainability has often been neglected (Buehler and Pucher, 2011). However, the following questions may arise: how many public transport services do cities require for them to be considered well connected? Are urban transport services' financial needs proportional to the number of cities' inhabitants? Is there any relationship between those financial needs and the size of the city?

Clearly the need to finance urban public transport is not alien to any country, including the developing countries. Among other reasons to finance it, one is citizens' demand it as a



high priority, and as one of basic public services, authorities are compelled to provide. It is true that depending on the country, region or even city, public transport is financed in one way or another. There are countries where mobility policy consists in the provision of a very high percentage of the total cost towards transport network services. Contrary to that, other countries show little interest in financing buses, subways and trams using part of their public budget. But in every or almost every big city and metropolitan areas worldwide, there is to a greater or lesser extent a clear commitment towards modern transport systems, and accordingly, to cover part of the operating costs through subsidies. Moreover, the question that always arises is what percentage of urban transport costs should be subsidised or if those subsidies should be increased (Tscharaktschiew and Hirte, 2011).

The reason is simple: urban mobility has special social connotations, especially redistributing wealth, but it is also important that authorities be aware that the competitiveness of cities depends on the movement of number of inhabitants in the best possible way. In fact, the cities that do not anticipate urban growth and do not endow municipalities of the necessary transport infrastructures end up suffering traffic crashes that result in noticeable loss of productivity. Therefore, in one way or another, public authorities end up implementing certain approaches: first, setting up enough transport networks for providing services to the citizenship, and second, those networks to be financed in a certain way, i.e., a specific percentage of the cost subsidized by public funds, supplemented with fares paid by users.

Studies and research related to public transport subsidies have traditionally been focussed on two main aspects: the spatial network model the authorities have decided to implement and the effect subsidies exercise (Mohring, 1972; Martin, 2001; Parry and Small, 2009), or models which, in addition to taking into account the network concept, focus on aspects such as the social impact derived from transport subsidies in terms of its benefits to society and its impact on urban development (Vickrey, 1980; Zenou, 2000; Van Dender, 2003; Brueckner, 2005; Borck and Wrede, 2005, 2009; Su and DeSalvo, 2008). In summary, the bibliography regarding the effect of subsidies on public transport and financing is very diverse. Congestion is, undoubtedly, the externality caused by urban transportation and has attracted the attention of engineers and economists. Obviously, in most cities, people have a choice between using a car or public transportation, but authorities try to reduce the use of private cars by promoting and expanding the public transport networks, and consequently, financing them.

The objectives of this paper are the following. First, to propose a simple tractable way to study analytically how the level of resources grows when a city increases the number of boroughs. When that happens, authorities are obliged to provide more transport services, bus lines, for example, and then, economic funds needed to support those public transport lines have to be increased. For that purpose, a model is proposed and solved analytically, while providing intuition through the use of graphs. The second objective of this paper is to obtain explanations about a real fact: those economic funds for public transport grow in a greater proportion in comparison to the growth of boroughs. This evidence is well known in the sector and can be verified by simple comparison between budgets allocated for financing the subsidies in different cities. However, in the literature, this topic has not been considered in depth.

In conclusion, all these objectives are interesting to explain the way in which countries allocate public resources in the budget to finance the public transport, in terms of city size, especially for big cities. The results could be motivating as a topic of discussion not only academically but also professionally. Certainly, the scientific literature is not abundant at a time when the authorities and transport operators need to understand the mechanism for public subsidies in a theoretical way.

2. Financing public transport in terms of city size

Over the past two decades, most of the large cities worldwide have improved the quality of their public transport services. Bus lines, bus rapid transit, trams and undergrounds are now very popular, even in developing countries, where authorities try to reduce congestion and increase productivity. Engineering has provided multiple methods to guarantee that the needs of the people are met. However, when a city continues to grow, one of the most interesting issues is from view of economy, i.e., the financial sustainability.

The analysis of how and why public transport systems increased their financial needs is something that can be observed simply by reading the budgets of major cities. Certainly the complex interaction of government policies, agencies measures or simply the trend towards more financial efficiency is changing. For example, in countries like Germany, the approach to a transport system that is financially sustainable is certainly different (Buehler and Pucher, 2011). In any case, the costs to operate the transport networks have increased in the last years, and authorities are interested to understand such increases. Probably we are facing a new social phenomenon, and the financial sustainability of urban transport must be at the same level as city planning. As a matter of fact, it could be thought that the level of resources to finance city urban transport depends directly on the number of its inhabitants: the fewer the less and vice versa.

All this matter is especially interesting in big cities, due to the complexity of the networks, reaching extremely high levels of financing resources. For example, in Spain, the two big cities, Madrid and Barcelona, due to the increase of transport services and the global amount of financial resources to be allocated, authorities decided to provide them with a special status (Ruiz, 2014). By means of that agreement, those cities receive from the state an impressive sum, that is four times bigger than the total amount assigned for the rest of the country (Table I).

According to the system established by the Ministry of Economy, the subsidies provided by the State for the public transport in Spain are mainly assigned to the two main cities, while the rest, 89 cities, receives only 17.3 per cent of the total budget. As it is shown, there is no relationship between the subsidy per inhabitant and the size of the city.

Another example is France, where the “Ile de France”, the Parisian region, through different methods and taxes, like the versement transport, receives impressive figures for financing the public transport, undoubtedly higher than other areas in the country[1]. In general terms, the financial resources for the French cities, excluding the capital of the country and its metropolitan area, reach up to 7,591 million euro, as it is shown in Figure 1 (loans not included). That budget, coming from at least four main sources – the French state,

	Number of cities	Inhabitants (millions)	Total subsidies (millions €)	Subsidy/inhabitant
<i>Big cities</i>				
Madrid		6.3	167.5	26.7
Barcelona		4.9	152.0	30.9
Total		11.2	319.5	
<i>Rest of the Spanish cities</i>				
500,000-1 million inhabitants	4	2.7	28.6	10.5
100,000-500,000 inhabitants	36	7.3	31.5	4.3
50,000-100,000 inhabitants	40	2.8	6.1	2.2
20,000-50,000 inhabitants	9	0.3	0.7	2.3
Total	89	13.2	66.9	

Table I.
State subsidies for public transport in Spain

Source: Ministry of Economy (2008)

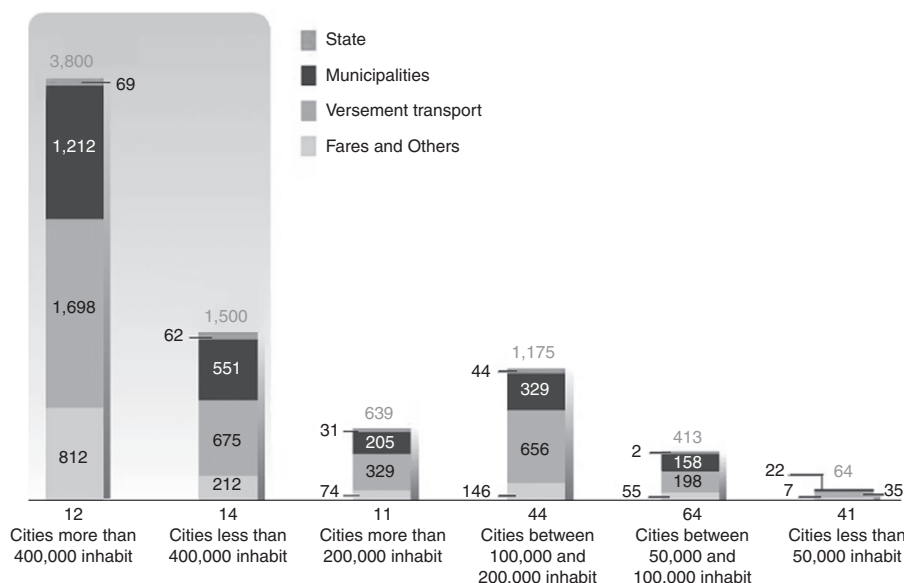


Figure 1. Financial resources for public transport in French cities, excluding Paris (2013)

the local governments, the versement transport tax and the fares and others commercial incomes – is distributed among 186 cities.

On the other side, the Parisian region receives almost 9,000 million euro. This metropolitan area includes the city of Paris, the region and seven departments (Figure 2).

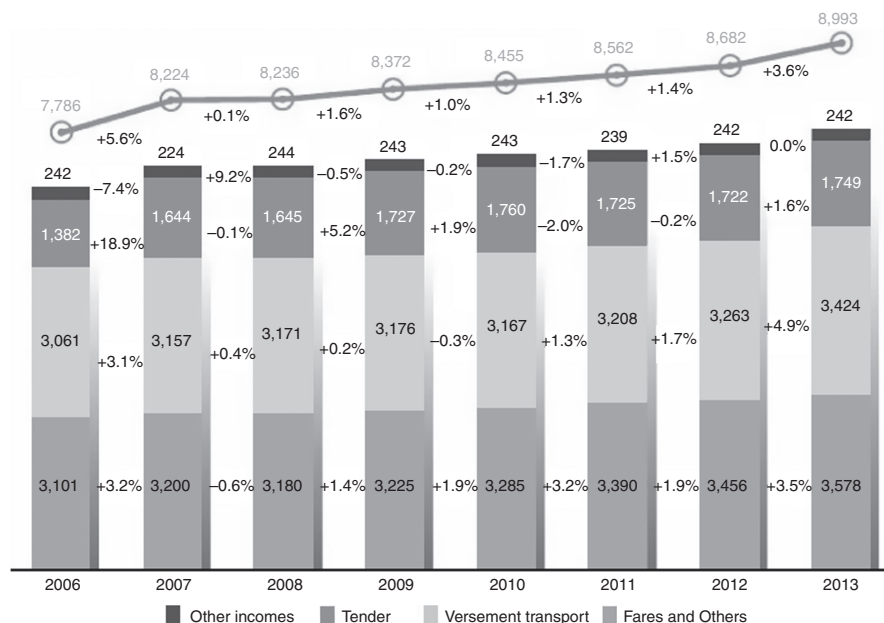


Figure 2. Financial resources for public transport in the île-de-France (Paris metropolitan area)

As result of these figures, it is easily understood the huge difference when financing the public transport in the Paris metropolitan area and the rest of cities in the country (Table II).

Consequently, the interest of this paper is to analyse why big cities demand such large financial resources, in comparison with medium and small urban places. For that purpose, a simple method is proposed, based on graphs, in order to determine the transport lines needed. The city model, either monocentric or polycentric, could affect the result of studies, but in the model described in this paper, a principle of interconnection is established between all neighbourhoods or districts chosen for the purpose of the calculation of the financing required, as the maximum number of public transport lines a city needs to implement.

Regardless, in agreement with the articles consulted and provided, each city is different; the urban spatial structure studies (Anas *et al.*, 1998) determine that cities are strongly shaped by agglomeration economies, especially external scale economies. Cities teem with positive and negative externalities, all acting with different strengths, among different agents, at different distances. Particularly interesting is debate about transport in monocentric and policentric cities. Subsidies in monocentric small towns could be non-effective because they distort the rational use of land. In fact, in a great number of cities, transport networks may have contributed in making citizens choose the outskirts (suburbs) as an alternative to living in the city centre. However, it should be the opposite. As a city grows it becomes polycentric, with different nuclei of interest citizens wish to visit such as large shopping centres, etc. That is the reason why in this study the question alluding to the maximum number of public transport lines possible among cities interesting points is simplified. Of course, the study can be completed with more inputs that appear in cities. Faster and cheaper travel may change where firms locate, and where people could decide to live. Cities or neighbourhoods that gain higher accessibility may also increase in size and productivity. Thus, a transportation investment can cause a spatial concentration of firms seeking larger market areas that enable the realization of internal economies of scale in production (Chatman and Noland, 2011). Moreover, for households, reduced transport costs could make job searching easier and commuting cheaper, increasing employment participation and hours worked, and again, increasing productivity. Consequently, good transportation may also help cities grow and diversify. Whether improvement in transport does any of these things depends on its spatial, modal, and temporal characteristics, in addition to a number of other economic factors. For example, transportation might increase employment in cities, by increasing firm access to labour and by increasing links between companies (Venables, 2007). There is a substantial empirical literature quantifying the relationship between city size and productivity, but for the purposes of this paper, and for the model proposed, the matter considering the maximum number of transport lines that can operate in a city will be simplified. So, it is possible to determine the upper limit of

France: global financial resources for public transport (million euro)	Paris	Rest of French cities (186)
Paris (Île de France)	8,993	–
12 cities with more than 400,000 inhabitants	–	3,800
14 cities with less than 400,000 inhabitants	–	1,500
11 cities with more than 200,000 inhabitants	–	639
44 cities between 100,000 and 200,000 inhabitants	–	1,175
64 cities between 50,000 and 100,000 inhabitants	–	413
41 cities with less than 50,000 inhabitants	–	64
Total	8,993	7,591

Table II.
Global financing
resources in
France 2013

transport infrastructures operating in a city, and consequently, the financial needs, in order to propose a simple tractable way to study analytically how the level of resources grows when a city increases the number of boroughs. Unquestionably, authorities are obliged to provide more and more transport services, and the economic funds needed to support those services have to increase.

3. The proposed spatial model

All transport systems in cities operate as networks. Although we could use more complex theories about networks, the proposed spatial model can explain, while providing intuition through the use of graphs, the question of the amount of resources allocated for financing the services.

To draw conclusions valid to the model proposed, we can begin by assuming that we operate urban transport in a small town with only two districts or boroughs: districts 1 and 2. Considering this, the city should be run only by one urban transport line, with little buses and regular two-way service between the two: districts 1 and 2. This system obviously shows itself as not expensive because it requires little resources and also because of the little demand expected. Rail services such as trams or similar are not to be considered (Figure 3).

If we move to a medium-sized city with six districts, citizens' mobility is very different. As more districts get involved, new needs develop in moving terms among them, all in such a way that citizens in district 1 would like to travel to district 2 or 3, or 4, or 5, or 6. Regarding the other districts, the same will happen considering all possible combinations. Therefore, urban transport network supply becomes more complex with this kind of city. Obviously, we should have more bus lines, at least one per possible combination so districts keep connected in the best way with a network of relationships. It is even possible to sequentially run a circle line among the districts establishing bilateral relations between districts because it is not necessary to go through a third district when travelling between the other two, especially the one considered as central, city centre or down town.

If we consider a medium-sized city with development prospects it is possible to incorporate a sort of tram system or light rail transit besides buses that could add an ability to move for people in those areas with greater flow. This new rail mode would increase financing needs bearing in mind that it is more expensive than those transport systems based on buses. In fact, this is a recently common phenomenon in most cities over 300,000 inhabitants in Spain and Europe. These growth tendency cities due to a dispersed urbanism and with many residential neighbourhoods have chosen trams to provide services between population centres. Curiously, the implementation of these tram systems has increased the financial needs of transport systems as their technical rates and passengers total (real) transport costs are higher than those based on buses.

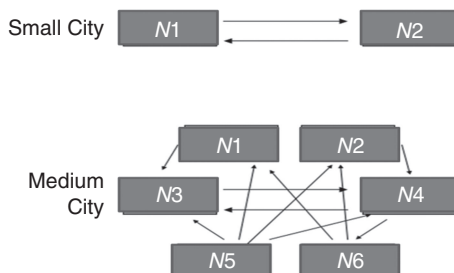


Figure 3.
Sketch map of
transport lines
in towns

Variations of different transport lines from one district to another would be mathematically expressed in the following way:

$$P(n, r) = {}^n P_r = \frac{n!}{(n-r)!}$$

To transport people from one neighbourhood to another, we choose the number of districts in the city (n) and mobility possible choices (r). Of course, this last variable is always $r=2$, because between two districts, transport lines have two choices: one-way ticket and return.

This simple formula would give the variations related to the number of lines a city would require to fully meet the needs of mobility of its inhabitants from one neighbourhood to another. For example, in small towns as mentioned above, with only two districts: $P(2, 2) = 2!/(2-2)! = 2$. Logically, to communicate two neighbourhoods, there are two transport streams that meet: "district 1" to "2", and neighbourhood "2" to "1". This is accomplished using a single back and forth bus line. For that reason, the result should always be divided by 2. Total number of lines between two neighbourhoods $L(2) = P(2, 2)/2 = 2/2 = 1$. In the following six districts city example, $P(6, 2) = 6!/(6-2)! = 6!/4! = 6 \times 5 = 30$, and the number of lines among six neighbourhoods: $L(6) = P(6, 2) = 30/2 = 15$.

That is to say, in a six districts city, if there is a wish to connect all districts among them, 15 bus lines are necessary, as can be seen in Figure 4. If we now find ourselves in a large design city, these characteristics would be represented in Figure 5.

In this figure, we now represent a 24 districts big city with a centre of town that behaves as main point of trips' attraction. Using the formula shown above this "big-sized city", implementation would yield the following results: $P(25, 2) = 25!/(25-2)! = 600$. Then, the number of lines would reach a theoretical dimension to serve all districts would be

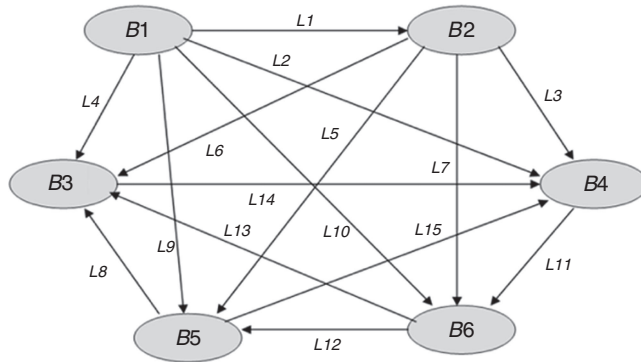


Figure 4.
Public transport
lines for a city
with six boroughs

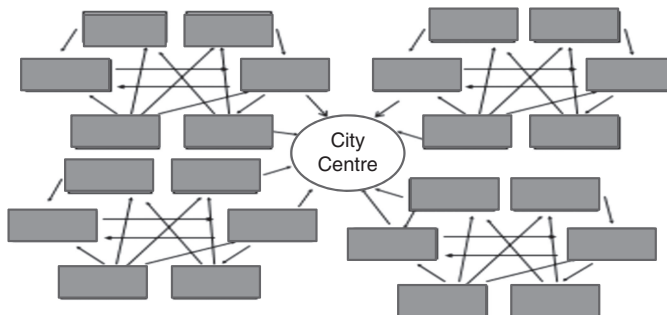


Figure 5.
Public transport
lines for a large city

$L(25) = 600/2 = 300$. To express it clearly, this great city of 25 nodes needs 300 public transport lines to cover in full 100 per cent of mobility needs of its inhabitants, being able to transport them directly from one district to another with no transfers. Evidently, with the above formula we have tried to draw an overall conclusion in the mathematical field but far from the usual practice of most municipalities for several reasons. First, because transport operators size is very different from one city to another. That is to say, not all cities of the same size have equal public transport fleets (number of buses, underground lines, trams, etc.). Second, relations between districts develop in an uneven way in those cities with a strong monocentric character in which citizens prefer to go mostly to the same point which is usually the city centre. However, the current trend in developed countries is the “polycentric” model, with new points citizens wish to move to (e.g. macro shopping centres and multimodal transport nodes). Finally, cities solve mobility problems with public transport lines that meet citizens’ demands but in most cases with transfer requirements to other lines. In the foregoing theoretical model it has been considered that all boroughs or districts have direct lines to move to the others, but in reality, it is very different. In most big cities, transfer from one line to another is necessary to reach the chosen destination. Furthermore, transfer is not only necessary in railway systems (undergrounds, trams etc.) but also in city buses. Therefore, most transport networks include transfer free of charge, so that citizens do not have to pay for taking two buses, provided you do so during a certain period of time.

The conclusion we can draw from what has been theoretically considered is that as cities grow public transport systems’ needs become more and more expensive. Financing needs will grow vertiginously as the city grows. It is possible to calculate the sequence as shown in Table III.

Considering the number of transport lines necessary depending on the number of districts the sequence would be as shown in Table IV.

This is a sequence using the terms: $a_1 = 1, a_2 = 3, a_3 = 6, a_4 = 10, a_5 = 15, a_6 = 21$. As shown, these series respond to the following pattern: each term is equal to the previous adding the order number. The formula of the sequence that corresponds to the number of lines to be implanted in a city based on the number of districts is as follows:

$$a_n = a_{n-1} + n$$

Number of neighbourhoods	Variations	Number of public transport lines needed
1	No need for public transport	0
2	$P(2, 2) = 2$	$L(2) = 1$
3	$P(3, 2) = 6$	$L(3) = 3$
4	$P(4, 2) = 12$	$L(4) = 6$
5	$P(5, 2) = 20$	$L(5) = 10$
6	$P(6, 2) = 30$	$L(6) = 15$
7	$P(7, 2) = 42$	$L(7) = 21$
8

Table III.
Transport lines in terms of the number of neighbourhoods

Public transport lines	Term of the sequence
$L(2) = 1$	a_1
$L(3) = 3$	a_2
$L(4) = 6$	a_3
$L(5) = 10$	a_4
$L(6) = 15$	a_5

Table IV.
Terms of the sequence depending on the number of transport lines

From this, it can be concluded that when in a city the number of districts in need of urban transport services increases, the number of lines to be implemented grows in a greater proportion than the number of districts. It is clear that having a greater number of transport lines funding needs will grow even more. Consequently, financing needs of public transport in cities grow at a higher rate than that of their own neighbourhoods or districts. This makes the funding of transport in large cities reach considerably higher values in comparison to those of medium and small cities.

All this can be represented graphically, as shown in Figure 6. For example, if a city has three districts, we have seen that it needs six transport lines. If a district grows up to four districts, then it will need $a_n = a_{n-1} + n$, that is, ten public transport lines. Going from three to four districts, public transport increases from six to ten lines.

In short, large cities require greater financing needs, and they do it at a rate that grows according to the formula shown above.

4. Conclusions

It is certain that public transport improvements lead to benefits to the economy of a country. Although the potential impacts will depend on the specific projects, authorities allocate funds in their budgets for financing the public transport networks. Each country has specific rules for estimating, allocating and distributing the total amount of money for public transport, including different methods for the income of such funds, for example, the case of France, with the *versement transport* tax, or Germany, with the *Mineralölsteuer*. But in all cases, the cost benefits analysis shows that it is expected large effects of investments in big cities, and virtually no effects in smaller cities. Although in fact most of the cities demand public transport services, the result is that buses, trams and metros provide such services to the population in almost all medium and big cities. At the end, authorities dedicate more and more resources, and the financial sustainability of public transport is an important omission in several countries.

In this paper, a model has been formulated to explain why big cities require huge amounts of money for financing public transport, compared to medium or small cities. Although the method is simple, real life shows that big cities like Paris, Berlin or Madrid need extraordinary funds for this purpose, and in most of the cases, specific national laws are required for financing public transport networks in those large metropolitan areas.

The simple tractable way studied analytically in this paper shows that the level of resources grows more than proportionally when a city increases the number of boroughs. When that happens, authorities are obliged to provide more transport services, and then, economic funds needed to support those public transport lines have to increase. As a result,

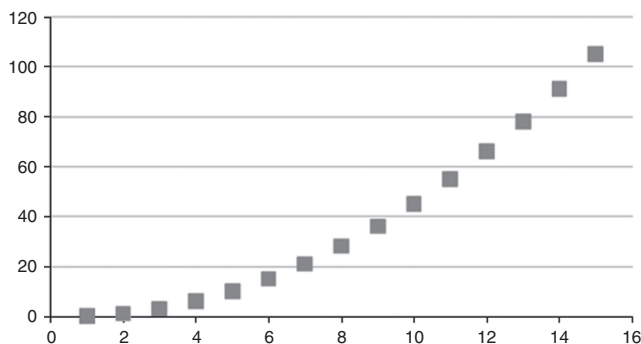


Figure 6.
Transport lines
in terms of
number of boroughs

it is obtained that those economic funds grow in a greater proportion in comparison to boroughs growth itself.

Finally, in the opinion of the author, this analysis opens ways for future research, for several reasons, and at least, two main. First, this is a topic deeply treated in the relationships between transport operators and public authorities. The services required by citizens have no limits, although the public money for paying those services is strictly limited. As an example, in this paper, the cases of Spanish and French cities have been studied. These results are interesting to understand the enormous budgets countries allocate to finance the public transport in big cities that sometimes, like the case of Madrid or Paris, are huge, really higher than the budget for the rest of the country. As this is a matter still not solved, the inquisitiveness of the sector, sometimes large companies operating in several European cities, will attract the attention of universities and academics to study more in deep this issue.

Precisely, the second reason to motivate future research, academically, is the following. There is interest to develop theories in the field of sustainability, and specifically, in the financial sustainability, which is a major topic today, not only in Europe, but worldwide. Increasing public transport's financial sustainability provides great opportunity to employ funds more efficiently. Obviously, sustainable mobility has a central role to play in the future of sustainable cities.

Note

1. Figures content in the Annual report by GART: L'année 2013 des transport urbains. GART: Groupement des autorités responsables de transport.

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Cooperation in R&D, firm size and type of partnership

Evidence for the Spanish automotive industry

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Cooperation in
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Abstract

Purpose – The purpose of this paper is to analyse cooperation in R&D in the automobile industry in Spain. It first examines to what extent firms cooperate with external actors in the field of technological innovation, and if so, with what type of cooperation partner, paying special attention to the differentiation according to the size of the firms. Second, it aims to study how the firm's size may affect not only the decision of cooperating but also with which type of partner.

Design/methodology/approach – The data in this study came from the surveys done in 2010 and 2013 by the Technological Innovation Panel (PITEC) for firms in the automotive industry. The paper estimates a bivariate probit model that takes into account the two types of cooperation mostly present in such an industry, vertical and institutional, explicitly considering the interdependencies that may arise in their simultaneous choice.

Findings – The empirical study confirms that small firms cooperate less frequently than big firms and that giving more importance to information publicly available and having public financial support from local and national governments are important determinants of collaboration agreements, mainly in the case of customers and suppliers.

Originality/value – This paper contributes to the understanding of the motivations of the automotive industry for engaging in R&D cooperation agreements. The authors study how the firm's size may affect not only the decision of cooperating but also with which type of partner.

Keywords Innovation, Partnership, Automotive industry, Firm size, Cooperation in R&D

Paper type Research paper

1. Introduction

A firm may increase its technological capabilities through either internal efforts in R&D or external activities such as cooperating in technological agreements. Firms seek to blend external sources of innovation with company-level competences and assets to incorporate new ideas (Chesbrough, 2006), allowing firms to gain greater technological innovation (Ili *et al.*, 2010) and improve efficiency (Montoro, 2005). In particular, R&D cooperation is a strategy of knowledge sharing and diffusion across firms that has increased in importance in recent decades. R&D cooperation allows knowledge to flow among different firms to increase their competitive advantage (Frels *et al.*, 2003)[1]. Cooperation partners can be of

JEL Classification — D22, O32, L24, L62

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different types (customers, suppliers, competitors, firms in the group, universities and research institutes), and it is the case that firms collaborate with different types of partners at a time, as they bring in different sets of knowledge or complementary capabilities (Belderbos *et al.*, 2004).

Cooperation agreements are particularly important in the automobile industry. The diffusion of lean production has implied that original equipment manufacturers (OEMs) move away from vertical integration so that suppliers assume more design tasks (MacDuffie and Helper, 2006). A car is a technologically complex system where various process and product technologies converge (Lara *et al.*, 2005)[2]. In recent years, the innovation strategies of the firms are characterized by an increasing importance attached to external sources of knowledge, thus establishing cooperation agreements in the field of R&D with external agents (Martínez and Pérez, 2003; Wyman, 2007).

Many automakers located in Spain do not perform R&D activities or they do it so scarcely. There are exceptions, such as SEAT, the only OEM in Spain capable of designing and creating on their own, followed by Nissan MI and the subsidiary of Fiat (Iveco Pegaso), and to a lesser extent Renault (R&D in motors). The other assembly factories in Spain only develop process innovations, receiving product innovations from other technical centres in the group[3]. In the automobile industry, multinationals do not tend to conduct research in Spain but development in order to adapt their products to the local condition of the market (Berger *et al.*, 2011).

Given the complexity of the automotive sector and the various challenges it faces, it is often no longer sufficient to rely only on in-house innovation, and firms are forced to improve their innovation capability through interactions with other economic agents. Through cooperation with different actors, firms may enable to acquire required information from a variety of sources which could lead to more synergies and intake of complementary knowledge (Belderbos *et al.*, 2006; Laursen and Salter, 2006; Nieto and Santamaría, 2007; Van Beers and Zand, 2014; Badillo and Moreno, 2015). Despite its relevance for firms and that it constitutes an important goal of innovation policy (López, 2008; Boardman and Gray, 2010), the studies on R&D cooperation of the Spanish automotive industry are scarce.

In this context, this study contributes to the understanding of the motivations of the automotive industry for engaging in R&D cooperation agreements in two ways. First, we examine to what extent firms cooperate with external actors in the field of technological innovation, and if so, with what type of cooperation partner, paying special attention to the role that the size of the firms may be playing. Second, we analyse the factors that turn out to have a determining effect on the decision of firms to carry out such collaborative activities in R&D. Specifically, we study how the firm's size may affect not only the decision of cooperating but also with which type of partner, while controlling for other determinants that have been considered in the literature as the main drivers of collaborative activities in R&D.

To this end, we use data provided by the Technological Innovation Panel (PITEC), using the surveys of 2010 and 2013 for firms in the automotive industry. We estimate a bivariate probit model that takes into account the two types of cooperation mostly used in such an industry, vertical and institutional, explicitly considering the interdependencies that may arise in the simultaneous choice of both. With regard to theoretical approach, we follow the most important lines of thinking examining the determining factors on the decision of firms to establish R&D cooperation agreements: the resource-based view, transaction cost theory and industrial organization theory.

The paper is organized as follows: after introduction, Section 2 provides a review of the literature on the theories that justify the firms' choice of performing R&D cooperation activities and exposes the main hypotheses of the paper. Section 3 describes the data and

provides a descriptive analysis of this phenomenon, while Section 4 presents the results of the regressions on the determinants of R&D cooperation agreements for the different types of partnership. Section 5 offers the main conclusions.

2. Literature review and hypothesis

2.1 Cooperation with external agents

When a firm in the automobile industry decides to cooperate to carry out R&D activities, it can be either with customers and suppliers (vertical cooperation), with firms of the same group, with universities and technology centres (institutional cooperation) or with competitors (horizontal cooperation). The motivation for choosing to cooperate in R&D may be different in each case and also in relation to the size of the firm.

In the case of vertical cooperation, the customer knows what he wants and needs, giving information to their suppliers to ease product innovations (Tether, 2002). Their mutual collaboration helps to identify market opportunities for technological development, reduces the risk of uncertainty associated with market introduction of new products from new ideas due to collaboration with clients and facilitates identifying new market trends (Tsai, 2009; Von Hippel *et al.*, 1999). Cooperation with suppliers in new product development often allows improvements in the quality and cost reduction through process innovation (Hagedoorn, 1993) and reduces project development lead times (Clark, 1989). In the automotive industry, outsourced components can be classified as supplier proprietary parts, detail-controlled parts or black-box parts (Clark, 1989; Mikkola, 2003; Koufteros *et al.*, 2007). Automakers have outsourced most of the R&D activities formerly done in-house to external suppliers (Clark and Fujimoto, 1991; Takeishi, 2001; Womack *et al.*, 2007) because they have more technical knowledge about the components, systems and modules.

The adjusted production model incorporates a close relationship between the manufacturer and its suppliers, which is a long-term one (Sako and Helper, 1998; Womack *et al.*, 2007). The first-tier suppliers cooperate with the OEMs in the design (Volpato, 2004) and co-development of new product development process (Liker *et al.*, 1996). Even some suppliers involve themselves in the early phase of development of new concepts (Langner and Seidel, 2009; Kamath and Liker, 1994), although some automakers use the strategic segmentation across suppliers (Dyer, 1996). In any case, only some suppliers maintain relationship with the automakers, whereas others keep competitive relationships (Sako and Helper, 1998). The trend in this century is to converge towards a hybrid “close but adversarial” model (Ro *et al.*, 2008), from the models “Exit” and “Voice” to Hybrid Collaborative (MacDuffie and Helper, 2006).

The first-level suppliers tend to be large multinationals that are very often strategic partners of the assemblers; while when descending in the pyramid of suppliers, business size decreases and firms tend to carry out less R&D activities, since they have fewer resources (human, technological and financial resources). They usually provide products with lower technological content which, as a consequence, reduce the interdependence between customers and suppliers giving place to more competitive relationships (Mahapatra *et al.*, 2010).

In the case of the automotive industry, cooperation with firms within the group arises in some cases as a result of the fact that subsidiaries of foreign multinationals often have relevant technical centres located in the matrix or in subsidiaries in other countries (Llorente, 2011). In these cases, a competitive advantage of the group is the successful transfer of tacit knowledge from headquarters to subsidiaries (Rugraff, 2012).

With respect to institutional cooperation, universities and R&D centres are the main public research infrastructure which is incorporated in the system of innovation (Nelson, 1993), and one of the most important sources of technological spillovers (Benavides and Quintana, 2000)[4]. On the one hand, universities and firms have increasingly been encouraged to collaborate

in R&D activities on the basis of the triple-helix model (Etzkowitz and Leydesdorff, 2000). The need for basic research requires cooperation with public science institutions (Tether, 2002; Van Beers *et al.*, 2008), and it has been said that automotive firms depend on universities and public laboratories to undertake curiosity-driven basic research (Rutherford and Holmes, 2008). Universities provide access to new knowledge and research that enable the development of novel products (Hagedoorn *et al.*, 2000; Lee, 2000). Along with R&D centres, they bring new ideas and complex innovations (Fontana *et al.*, 2006), creating new scientific and technological knowledge (Lundvall, 1992), which complement the applied research made by the firm (Chastenet *et al.*, 1990).

In recent years, demand at university for applied research has increased (Miller *et al.*, 2014). The collaboration with universities increases the probability of the introduction of innovations that are new to the market (Monjon and Waelbroeck, 2003), and such collaborations are very useful in the development of high-tech technologies and research located at the technological frontier (Van Looy *et al.*, 2003; Miotti and Sachwald, 2003). Universities prefer to work with large firms, as they have higher financial resources for R&D and higher technological capabilities, giving them more prestige and greater opportunities for new research initiatives (Shapira *et al.*, 1995; Beise and Stahl, 1999). On the other hand, technological centres focus their activity towards the generation, transfer and diffusion of technological innovation to firms. Among their activities, we find the generation of R&D projects, consulting and technical assistance, technology diffusion and promotion of international cooperation. According to Santamaria (2001) and Bayona *et al.* (2002), technological centres seek knowledge which is more related to solving design problems and develop new products, whereas Gracia and Segura (2003) consider that they allow focusing on the basic research carried out in universities and other research centres towards the improvement of businesses[5]. Globally, universities and technology centres also allow firms to access specialized equipment and infrastructure (Callejón *et al.*, 2008), to make tests and trials, offering highly qualified researchers (Dooley and Kirk, 2007).

It is interesting to note that when taking into account institutional cooperation, the role of the firm's size turns out to be different if we refer to universities or to technological centres. Barge-Gil *et al.* (2011) show that firms that collaborate with technological centres tend to be smaller, probably due to its lower internal capacity for innovation as well as the main orientation towards technological development, and not basic research, of technological centres. By contrast, large firms tend to collaborate more frequently with universities, thanks to their greater internal capabilities and the fact of being more oriented towards the basic research carried out in universities. The same is observed in Japan, with large firms collaborating more with universities than small firms (Motohashi, 2004). Rasiah and Govindaraju (2009) verified the importance of university as a source of knowledge in the automotive industry of Malaysia. Size was inversely correlated with university-industry collaboration alliances. Closer examination showed higher university-industry collaboration means among medium-size firms.

Horizontal cooperation is based on maintained cooperative relations between a firm and its competitors. The strategy of combining competition and cooperation deliberately with certain competitors is called co-opetition (Brandenburger and Nalebuff, 1997), and the objective is to obtain a game of positive sum and a better outcome both individually and collectively (Bengtsson and Kock, 1999; Czakon, 2010). Firms can use collaboration with competitors to develop new technology for prospective markets and the need of to share risk (Miotti and Sachwald, 2003). However, co-opetition can also be considered a risk because some competitors may have greater capacity to absorb external knowledge and thus access relevant information that can be used to their advantage in future research made individually. Cassiman and Veugelers (2002) show, for the case of Belgian firms, that

cooperation with competitors is used scarcely, probably because it is more difficult to manage and also for the risk it entails (Röller *et al.*, 2007). Nieto and Santamaría (2007) verified, in the case of Spanish firms that collaborating with suppliers, customers and research centres has a positive impact on innovation novelty, while the effect is negative when collaborating with competitors.

2.2 *The effect of firm size on cooperative R&D*

In the literature, there is no consensus regarding the effect of firm size on the probability of collaborating with external agents. Theoretically, according to Robertson and Gatignon (1998), to conduct R&D, it is necessary to have sufficient amount of financial, technical and human resources, which is more often the case in large firms (Rothwell and Dogson, 1991; Narula, 2004). In addition, to absorb the external knowledge offered by other agents, firms need to have an internal knowledge base and conduct internal R&D activities (Cohen and Levinthal, 1989; Veugelers and Cassiman, 2005), which tend to be higher in large firms (Tether, 2002). However, small firms are characterized by having lower economies of scale in R&D, reduced funding and scarce staff to carry out innovative activities as well as other innovation critical resources such as management skills to create and maintain innovation projects (Narula, 2004; Chun and Mun, 2012). Therefore, one could think that cooperation should enable them to overcome this reduced availability of funds (Hewitt-Dundas, 2006) and share with others the fixed costs associated with such projects (Busom and Fernández-Ribas, 2008).

According to Forrest and Martin (1992), when SMEs collaborate in R&D projects, they seek a quick scanning of new technologies, sharing the risks of developing new products and accessing new funding. In contrast, for large firms, the advantage of cooperation is to access the experience of the partner in R&D activities, have a window open to new technologies and develop products for specific market niches. It seems to follow, therefore, that although with different motivations, both large and small firms have incentives to embark on cooperation agreements for carrying out innovation activities, and from that point of view, firm size should not influence the propensity of firms to establish cooperation agreements in innovation. Is this conclusion corroborated at the empirical level? A large number of empirical studies conclude that large firms cooperate to a greater extent (e.g. Cassiman and Veugelers, 2002; Becker and Dietz, 2004; Miotti and Sachwald, 2003; Negassi, 2004), benefit more from cooperation (Veugelers, 1998) and innovate more openly than SMEs (De Backer, 2008). A clear exception is the study of Abramovsky *et al.* (2009), which in the case of a sample of firms from four European countries did not find that the size effect was significant in explaining innovation cooperation.

For the Spanish case, it has also been found that there is a greater propensity to cooperate in the case of large firms (Bayona *et al.*, 2001; López, 2008). In the Spanish automotive supplier industry, Martínez and Pérez (2002) verified the existence of a positive relationship between the size of the firm and cooperation with customers. Also, for the Catalan case and in relation to cooperation with the direct suppliers of OEMs, Llorente (2012) obtained that large firms cooperate in R&D at a higher rate than smaller ones. Therefore, although there are theoretical arguments that motivate both large and small firms to take partnerships in innovation activities with external agents, evidence seems to suggest that large firms tend to do it more frequently, although this relation can vary according to the type of partnership. These arguments lead to our first hypothesis:

H1. Large automotive firms are more likely to engage in cooperative R&D agreements.

2.3 *Other determinants of cooperative R&D*

Among the main factors influencing the decision of firms to participate in cooperation R&D agreements, on the one hand, economic literature highlights knowledge spillovers and the

firms' absorptive capacity[6], while on the other hand, it focuses on the importance of the costs, risks and complementarities present in the innovation process[7].

On the side of knowledge spillovers, it is argued that both incoming and outgoing spillovers operate as determinants of cooperation strategies in R&D. Incoming spillovers are external knowledge flows that a firm is able to capture, and the information sources for them are usually situated in the public domain, whereas outgoing spillovers refer to the ability of the firm to control knowledge flowing beyond its borders. The idea is that in order to internalize the information flows that may occur in the processes of innovation and to manage more effectively these flows, firms decide to participate in cooperative agreements. To measure these factors, we followed Cassiman and Veugelers (2002) and defined incoming spillovers as the importance attributed by the firm to publicly available information for carrying out innovation activities (public information from conferences, trade fairs, exhibitions, scientific journals and trade/technical publications and professional and industry associations), and legal protection as a proxy of outgoing spillovers, which considers if the firm used at least one legal method for protecting innovations (patents, registered an industrial design, trademark or copyright).

At the empirical level, papers obtain predominantly positive results of incoming spillovers as determinants of cooperation agreements (Cassiman and Veugelers, 2002; Veugelers and Cassiman, 2005; Serrano-Bedia *et al.*, 2010, Chun and Mun, 2012). This way, firms that place a higher value on incoming spillovers and externally generated knowledge in their innovative activity might have a greater scope for learning and gaining from knowledge exchange through cooperative agreements. In addition, when taking into account the type of partner, this relationship would be expected to be stronger in collaborations with research institutions and universities. As signaled by Abramovsky *et al.* (2009), it might be expected that firms which are able to get more benefits from external knowledge might be more likely to engage in cooperation agreements with the research base.

Meanwhile, in the literature on outgoing spillovers, the effect of appropriability problems on firms' probability to engage in R&D cooperation agreements is ambiguous. On the one hand, a better appropriability of the results of innovation through protection may have a positive effect on cooperation in R&D, as firms can control outgoing information flows and there are less incentives for others to become a free rider on other firms' investments (Cassiman and Veugelers, 2002). However, excessive legal protection may hinder the internalization of the flows shared by the partners and may thus have a negative effect on R&D cooperation (Hernán *et al.*, 1995; López, 2008). This result must be smoothed according to the partner, since Cassiman and Veugelers (2002) obtained that a better appropriability would increase the probability of cooperating with customers or suppliers whereas it is unrelated with research institutes. Among other reasons, it is sensible to think that the information which is commercially sensitive, as a result of more applied research projects, often leaks out to competitors through common suppliers or customers. Therefore, only those firms with enough protection of their information would be willing to engage in cooperation agreements at the vertical level.

Based on the above-mentioned arguments, we can pose the next hypothesis:

H2. Automotive firms that rate available external information sources as more important inputs to their innovation process are more likely to engage in cooperative R&D agreements.

And the following two competing hypotheses:

H3. Automotive firms that use at least one method to protect the results of their innovations are more likely to engage in cooperative R&D agreements.

H4. The use of methods to protect the results of innovations decreases the probability to engage in cooperative R&D agreements.

The absorptive capacity of the firm is another determinant of cooperation alliances in R&D. According to Cohen and Levinthal (1989), certain absorptive capacity is necessary to assimilate and exploit knowledge from the environment, so that a firm with more absorptive capacity is able to access a greater amount of knowledge than another with less capacity. Consequently, the first firm may draw greater benefits from cooperative innovation agreements. The absorptive capacity, approximated in the literature either as the ratio of internal expenditure on R&D, the number of employees in R&D or permanent R&D, has been found in many studies as an important feature of the firms with greater probability of cooperation (Bayona *et al.*, 2001; Miotti and Sachwald, 2003; López, 2008; Arranz and Arroyabe, 2008). However, one could also think that a greater absorptive capacity allows the firm to easily access external knowledge as well as get benefit from it for free, thus having a lower incentive to cooperate. These arguments would be equally valid for any type of partner. Miotti and Sachwald (2003), for example, find a positive and significant impact of absorptive capacity on the probability of agreements with research institutions and with suppliers and customers. In line with these ideas, the following hypothesis arises:

- H5.* Automotive firms with high levels of R&D intensity have a higher probability to engage in R&D cooperation with research institutions and with suppliers and customers.

Public funding encourages R&D cooperation (Peterson, 1993). Firms obtaining public R&D subsidies may be more likely to establish cooperation agreements with another firm or with institutions given that this way they have the resources to do the research (Arranz and Arroyabe, 2008; Busom and Fernández-Ribas, 2008; Abramovsky *et al.*, 2009). Also, many times public support programmes for R&D activities aim to ease cooperative innovation agreements by firms that would otherwise not engage in such activity. Thus, we put forward our final hypothesis:

- H6.* Automotive firms that receive public financial support for their innovation activities have a higher probability to engage in R&D cooperation agreements.

3. Descriptive analysis

The database used is the Technological Innovation Panel (PITEC)[8], from which we selected the firms available for the automotive industry. Specifically, the variables for R&D cooperation (dependent variables) are taken from the 2013 survey (wave 2013-2010), while the explanatory variables correspond to the 2010 survey (wave 2010-2008)[9]. This results in a sample of 148 firms. Next, we try to describe the cooperation activities carried out in the Spanish automotive industry paying special attention to the type of agents cooperating as well as to the firms' size.

To characterize the sample across firms' sizes and the type of capital, Table I shows that most firms have only domestic capital (64.9 per cent) and are mainly SMEs (64.9 per cent have less than 250 employees). Specifically, half of firms (50.3 per cent) are SMEs (< 250 employees) with only national capital. In contrast, large firms (> 500 employees) are characterized by having clear superior foreign capital participation, with 16.2 per cent of firms in the automotive industry being large, and 12.9 per cent out of the total are big and have foreign capital.

In relation to the innovative activity carried out by Spanish automotive firms, figures in Table II offer the distribution of the internal R&D staff as a proxy of the innovation made by the firm. This gives a median of only 6 people devoted to research activities, with 25 per cent of firms with at least 18 people and only 10 per cent with more than 48 people. Indeed, these figures suggest, by and large, the existence of a very limited staff on innovation activities, with large firms (over 500 employees) having the best figures in this respect: a median of 42 persons, with around 10 per cent of these firms having over 400 employees dedicated to innovation.

Table I.
Number of firms
by size and type
of capital

	Public	Private without foreign capital	Private with participation of foreign capital < 10%	Private with participation of foreign capital 10-50%	Private with participation of foreign capital > 50%	Total
< 50	0 (0.0%)	27 (18.2%)	0 (0.0%)	0 (0.0%)	1 (0.7%)	28 (18.9%)
50-249	1 (0.7%)	48 (32.4%)	2 (1.4%)	0 (0.0%)	17 (11.5%)	68 (45.9%)
250-499	1 (0.7%)	16 (10.8%)	1 (0.7%)	0 (0.0%)	10 (6.8%)	28 (18.9%)
≥ 500	0 (0.0%)	3 (2.0%)	2 (1.4%)	2 (1.4%)	17 (11.5%)	24 (16.2%)
Total	2 (1.4%)	94 (63.5%)	5 (3.4%)	2 (1.4%)	45 (30.4%)	148 (100.0%)

Note: Percentages are calculated over the number of total firms

Source: PITEC and own calculations

Table II.
Internal staff
dedicated to R&D

	<i>n</i>	Mean	Var. coef. (%)	First quartile	Median	Third quartile	Ninth decile
Total firms	148	26.6	276.5	0	6.5	18.75	48.2
< 50 employees	28	4.0	139.6	0	2	5	12.6
50-249 employees	68	7.6	128.9	0	4	12.0	21.1
250-499 employees	28	14.6	130.3	0	12.5	21.5	34.4
≥ 500 employees	24	121	125.0	19.25	42.5	247.5	403
With innovation in products	95	36.9	240.6	1	10.0	24.5	57.6
With internal expenditure on R&D	100	39.4	220.1	6.0	13.5	26.25	59.6

Source: PITEC and own calculations

Since firm size is a key aspect in this research, Table III summarizes the output of the innovation made by Spanish automotive firms according to their size. From this table, we draw the following insights. Most large firms present product (83.3 per cent) and process innovations (78.9 per cent) as well as both simultaneously (62.5 per cent). This is in considerable contrast to small firms, which innovate much less frequently (57.1, 70.0 and 42.9 per cent, respectively). When considering only process innovation, the proportion is higher for firms with at least 250 employees. Even more, the proportion of firms that

Table III.
Type of technological
innovation by
firm size

	< 50	50-249	250-499	≥ 500	χ^2	<i>p</i> -value	Cramer's <i>V</i>
Product innovation	57.1%	58.8%	67.9%	83.3%	5.447	0.142	0.182
Process innovation	64.3%	61.8%	71.4%	62.5%	2.654	0.448	0.116
Innovation in manufacturing methods	46.4%	50.0%	64.3%	62.5%	2.975	0.395	0.142
Innovation in logistics systems	3.6%	17.6	42.9%	41.7%	17.644	0.001**	0.345
Innovation of support in processes	32.1%	25.0%	42.9%	33.3%	3.058	0.383	0.144
Product and process innovation	42.9%	35.3%	53.6%	62.5%	6.442	0.092***	0.209
Total firms	28 (100%)	68 (100%)	28 (100%)	24 (100%)			

Notes: Relative frequencies. Association between type of technological innovation and firm size. Percentages are calculated with respect to the size group. **p* < 0.05; ***p* < 0.01; ****p* < 0.1

Source: PITEC and own calculations

perform logistics innovation increases directly with firm size in spectacular proportions (3.6 per cent of small firms vs 42 per cent of large). A potential explanation is that large suppliers often have to supply OEMs through arranged in sequences, with daily deliveries, so that manufacturers search for logistics integration with module suppliers, sharing the technological systems that allow for this (Bennet and Klug, 2012). Furthermore, in this group of large firms, full service suppliers who design their supply chain have increased in number. Instead, small firms in auxiliary industries use JIT less frequently and assume more costs of inventory of their parts.

Focusing on innovation cooperation activities (Table IV), firms with more than 250 employees collaborate to a greater extent than small firms. This is probably a result of the latter having less technologically complex products and that some small firms work according to design specifications, being the manufacturer or the supplier of a higher level the one that designs the product that must be manufactured and delivered afterwards. In addition and regardless of the size, the most common partner in the Spanish automotive industry are firms in the same group, followed by suppliers, with competitors being the least frequent. This is hardly surprising given that collaborating with competitors seems to be considered by firms in the automotive industry more of a risk than an opportunity.

Collaboration agreements with universities, research centres, consultants and commercial laboratories are not numerous. They are mainly performed by medium and large enterprises, since they perform more research and product development[10]. Cooperation with private or public research centres is higher than with universities in all sizes, probably because those research centres focuses more on applied research, more interesting for firms developing new products. Overall, 35.7 per cent of firms with at least 250 workers collaborate with private or public research centres, followed by 33.3 per cent of firms with more than 500 workers. Indeed, there is a clear association between firm size and each type of partnership, rejecting the null hypothesis of independence in all cases.

Finally, Table V provides summary statistics for the variables used in the regression analysis. We observe that automotive firms that engage in cooperation agreements are more

	< 50	50-249	250-500	≥ 500	Total	χ^2	p-value	φ
Customers	2 (7.1%)	10 (14.7%)	6 (21.4%)	4 (16.7%)	22 (14.9%)	2.335	0.506	0.125
Suppliers	2 (7.1%)	15 (22.1%)	9 (32.1%)	11 (45.8%)	37 (25.0%)	11.230	0.011*	0.257
Firms in the same group	1 (3.6%)	22 (32.4%)	13 (46.4%)	17 (70.8%)	53 (35.8%)	27.194	0.000**	0.429
Universities or other higher education institutions	1 (3.6%)	8 (11.8%)	4 (14.3%)	4 (16.7%)	17 (11.5%)	2.580	0.461	0.132
Private or public research centres	0 (0.0%)	10 (14.7%)	10 (35.7%)	8 (33.3%)	28 (18.9%)	15.721	0.029*	0.328
Consultants or commercial laboratories	2 (7.1%)	5 (7.4%)	3 (10.7%)	5 (20.8%)	15 (10.1%)	3.979	0.275	0.162
Competitors	2 (7.1%)	6 (8.8%)	0 (0.0%)	6 (25.0%)	14 (9.5%)	9.900	0.019**	0.260
Vertical cooperation	2 (7.1%)	16 (23.5%)	10 (35.7%)	11 (45.8%)	39 (26.4%)	11.581	0.009**	0.279
Institutional cooperation	2 (7.1%)	13 (19.1%)	11 (39.3%)	10 (41.7%)	36 (24.3%)	12.818	0.005**	0.294
Size of each sub-sample or sample	28 (100%)	68 (100%)	28 (100%)	24 (100%)	148			

Notes: Relative frequencies. Association between type of partner and firm size. Percentages are calculated with respect to the size of all the firms (in the sample, cooperative and non-cooperative firms included). * $p < 0.05$; ** $p < 0.01$; *** $p < 0.1$

Source: PITEC and own calculations

Table IV. Partners of R&D cooperation activities by firm size

Table V.
Descriptive statistics
of the variables
used in the
regression analysis^a
(mean values)

Variables	Total sample	Cooperative	Non-cooperative	Type of cooperation	
				Vertical	Institutional
Incoming spillovers	0.266	0.316	0.219	0.368	0.370
Legal protection	18.9%	23.9%	14.3%	23.1%	30.6%
R&D intensity	0.107	0.183	0.036	0.022	0.021
Risks	0.477	0.493	0.463	0.521	0.444
Costs	0.583	0.609	0.560	0.664	0.617
Public funding	38.5%	52.1%	26.0%	56.4%	55.6%
Less than 50 employees	18.9%	5.6%	31.2%	5.1%	5.6%
50-249 employees	45.9%	43.7%	48.1%	41.0%	36.1%
250-499 employees	18.9%	23.9%	14.3%	25.6%	30.6%
500 or more employees	16.2%	26.8%	6.5%	28.2%	27.8%

Note: ^aThe definition of the variables is presented in Table AI
Source: PITEC and own calculations

likely to place higher importance on incoming spillovers and to use some form of legal protection than those which do not cooperate (for instance, around 24 per cent of firms that cooperate use at least one method of legal protection to protect their innovation returns vs 14 per cent in the group of firms that do not cooperate); they also tend to have a higher mean of internal R&D intensity, and receive public funding for innovation. Related to size, Table V shows that big firms show a greater propensity to cooperate than smaller firms.

4. Determinants of partnership agreements in the automotive industry

4.1 Methodological issues

We plan now to analyse whether the determinants of R&D cooperation in the automotive firms are different according to the different types of partners. To do so, we estimate a bivariate probit model with two binary equations, each one for the main types of cooperation: vertical and institutional. Vertical cooperation includes cooperation with suppliers and/or customers whilst institutional cooperation includes cooperation with consultants, commercial laboratories or private R&D institutes, universities or other higher education institutions, public research organizations and technology centres. Cooperation with competitors is excluded from the analysis because very few automotive firms carry out this type of cooperation agreements (only 11 firms, representing 5.6 per cent of the total). We also exclude cooperation with firms within the same group because only firms belonging to a group can have such kind of alliances, while all other types of cooperation may be chosen by all firms[11].

4.2 Determinants of cooperative R&D: definition of variables

In our model, we include the main factors that have traditionally been considered in the literature as influencing the decisions to engage in innovation alliances. In this paper, we focus on firm size, the roles of incoming spillovers, legal protection and cooperation as a means of overcoming constraints (i.e. risks and costs). We also control for some firm's characteristics such as absorptive capacity and the receipt of public funding for innovation. The variables used in the regression analysis as well as their construction are mainly based on previous studies on the topic of R&D cooperation such as Cassiman and Veugelers (2002), López (2008), Arranz and Arroyabe (2008) and Badillo and Moreno (2016).

Incoming spillovers are measured by the importance that the firm attributed, on a four-point scale, to publicly available information for the innovation process of the firm. The information sources asked in PITEC were conferences, trade fairs, exhibitions, scientific journals and trade/technical publications and professional and industry associations.

To generate a firm-specific measure of incoming spillovers, we aggregated these answers by summing the scores on each of these questions and then the variable was rescaled from 0 (unimportant) to 1 (crucial). With the same survey data, we also computed the variable proxying for legal protection, which considers whether the firm used at least one legal method for protecting inventions or innovations (patents, registered an industrial design, trademark or copyright), taking a value of 1 if used, and 0 otherwise. Although we could have considered other proxies for these spillover variables, we have followed Cassiman and Veugelers (2002) who pointed that the advantage of the ones suggested here is that they are direct and firm specific, allowing for heterogeneity among firms.

In this paper, internal R&D intensity is captured through the ratio between the intramural R&D expenditure and turnover. Risk and cost sharing are proxied through the rates that the firm attributed to the uncertain demand for innovative goods or services and the score of the importance of the lack of funds or the consideration of innovation costs too high, as factors hampering their innovation activities, respectively.

Firm size (< 50 employees, 50-249, 250-499 and > 500) and public funding of innovation are included taking the value 1 if the firm belongs to the corresponding size range and has received any kind of public funding (local, regional or national), respectively, and 0 otherwise. Table AI shows the matrix of correlation between variables used in the regression analysis, and Table AII summarizes the construction of these variables.

4.3 Main results

The results of the estimation of the binomial probit model are provided in Table VI. As shown in the bottom of the table, the assumption that ρ is 0 is rejected, showing that the binomial probit is more suitable than the estimation of the equations separately, providing evidence that there are interdependencies between the different cooperation strategies. The positive and significant estimated coefficient of correlation of the error terms (ρ) may be due to complementarities in R&D cooperation strategies but also to the existence of unobserved firm-specific factors affecting the decision regarding the different types of cooperation.

With respect to the traditional determinants of cooperation, the estimates show a positive and significant relationship between incoming spillovers and the probability of cooperating in the two types of partnership, giving full statistical support to our second hypothesis.

	Vertical cooperation	Institutional cooperation
Incoming spillovers	1.491*** (0.505)	1.117** (0.463)
Legal protection	0.122 (0.250)	0.427 (0.266)
Internal R&D intensity	-2.996 (4.528)	-1.468 (4.259)
Risks	0.082 (0.407)	-0.077 (0.382)
Costs	0.394 (0.453)	0.062 (0.444)
Public funding	0.514** (0.259)	0.315 (0.263)
<i>Firm size (base < 50 employees)</i>		
50-249 employees	0.577 (0.432)	0.114 (0.420)
250-499 employees	0.928* (0.483)	0.790* (0.459)
500 or more employees	1.246*** (0.476)	0.782* (0.470)
Constant	-2.423*** (0.610)	-1.729*** (0.496)
ρ	0.898*** (0.048)	
n		148
Log L		-113.34
Wald test		$\chi^2(18) = 42.18$
H_0 : the coefficients are jointly = 0		Prob. > $\chi^2 = 0.000$

Notes: Heteroskedasticity-robust standard errors. * $p < 0.1$; ** $p < 0.05$; *** $p < 0.01$

Table VI. Binomial probit model of R&D cooperation in the automotive sector

In line with some previous empirical studies, we obtain that if the firm gives more importance to information publicly available and useful for innovation processes, the firm tends to be more able to exploit spillovers in order to increase the productivity of its innovation activities and consequently obtain higher profits through cooperation agreements (Cassiman and Veugelers, 2002; López, 2008). This way, it seems fair to conclude that automotive firms benefit greatly from the information coming from external sources, especially when it comes through cooperation.

We also find that the ability to appropriate the results of innovation do not affect the probability to cooperate with any type of partners considered. This variable proxies for the possibility of the firm of appropriating the results of the innovation, known in the literature as outgoing spillovers or outgoing information flows. Our results show that making use of protection methods of the benefits of innovations, i.e. reducing the transmission of unintended information flows, do not affect the probability to cooperate with suppliers and customers or with universities or research institutions, in such a case we do not obtain sufficient evidence to support our fourth or fifth hypothesis. This can be probably due to the ambiguity of the impact of appropriability and due to the fact this variable may be more closely related to cooperation with competitors, where free-rider concerns might be the most likely to come into play.

For the automobile firms in Spain, the effect of the intensity of R&D activities is not relevant in the decision to participate in neither vertical nor institutional cooperative agreements. This could be a consequence of the existence of arguments in favour and against the positive impact of R&D intensity on cooperation. As pointed out in the previous section, a certain absorptive capacity is required to assimilate and exploit knowledge in the environment. However, a greater absorptive capacity allows the firm to easily access external knowledge as well as getting benefit from it for free, thus having a lower incentive to cooperate. Additionally, another possible explanation for this non-significant result might be that the magnitude of internal R&D expenditure over turnover is not very high in the Spanish automotive firms. We can also conclude that the problem associated to cost and risks constraints to carry out innovation activities seems not to be relevant in the decision to participate in cooperation agreements.

The estimation results also show that public financial support from local and national government is one of the main determinants of vertical R&D collaboration, while it does not affect the probability to cooperate with universities or research institutions.

On the other hand, according to the literature of strategic management, firms use research partnerships with the idea of accessing complementary knowledge, or in order to share risks or costs (Hagedoorn, 1993). In the Spanish automobile case, we do not find any significant impact of such risks and costs. Indeed, existing empirical studies show mixed results regarding the effects of these factors on R&D cooperation. Bayona *et al.* (2001) signal both risk- and cost-sharing factors are significant determinants of cooperation, whereas Miotti and Sachwald (2003) found that none of these factors influence the likelihood of cooperation. Distinguishing cooperative R&D by type of partner, Belderbos *et al.* (2004) find that the risks that firms experience as an obstacle to innovation positively affect the likelihood of cooperation with competitors and suppliers, while cost sharing is only relevant for the decision to cooperate with research institutions.

The size of firms has a positive and significant effect on the probability of carrying out cooperation agreements in both types of partnerships. Thus, in the case of vertical cooperation, firms with more than 500 workers are most likely to make cooperative agreements in R&D. While in the case of institutional cooperation, firms with more than 250 employees are the ones having a higher probability of cooperating, other things equal. This evidence gives support to our first hypothesis. This higher propensity to cooperate of large firms can be explained by the fact that they are more able to face the commitment required in partnerships and to better reap

the returns of cooperation agreements, thanks to the availability of a greater structure and greater resources. Despite small firms may need cooperation with other firms or institutions in order to manage innovation activities which otherwise could not carry out because of their limited resources, it seems that the evidence provided in our study also gives more support to the former theoretical argument, being big firms more likely to enter in R&D cooperation agreements, irrespectively of the type of partner.

5. Conclusions

This paper provides evidence on the determinants of cooperation in R&D in the automotive sector in Spain.

First, we analyse to what extent firms in the sector cooperate with various external actors in the field of technological innovation, and if so, with what type of cooperation partner, paying special attention to the role the size of the firms may play in this type of activities. In particular, we see that suppliers and firms in the group are the external agents with whom automotive firms cooperate the most. Instead, competitors are the least frequent, that is, the co-opetition strategy is poorly implemented in the Spanish automobile case. The low collaboration with universities and research centres can be a result of the little awareness of SMEs about the real possibilities offered by the research groups at the universities. This can also be a consequence of the fact that most foreign capital multinationals that innovate in product in Spain only carry out the product development phase in its Spanish subsidiaries, making significantly few research and design of their products.

Small firms cooperate less frequently than big firms, despite having fewer resources to conduct R&D, which one would think as an incentive in favour of cooperation. In addition, we observe that large firms are those that offer higher rates of institutional cooperation. Simultaneous cooperation with different agents is very low in medium and large firms, being null in small firms.

In relation to the factors that have a determining effect on the decision of firms to carry out collaborative activities in R&D, we estimated a bivariate probit model that takes into account the two most common types of cooperation in the automotive industry, vertical and institutional cooperation, explicitly considering the interdependencies that may arise in their simultaneous choice. According to the literature, we obtain that when firms give more importance to information publicly available and useful for innovation processes, they are better able to exploit spillovers in order to increase the productivity of their innovation activities and consequently obtain higher benefits through cooperation agreements: as a result, they do cooperate, being this determinant, in the automotive industry, more clear in vertical cooperation agreements. Also, it seems that having public financial support from local and national governments is an important determinant of collaboration agreements, especially for the case of customers and suppliers. By contrast, in the case of automobile firms in Spain, the effect of the intensity of R&D activities is not relevant in the firms' decision to participate in vertical or institutional cooperation agreements, nor is the existence of cost or risk constraints to carry out innovation activities.

The results in this study are of considerable interest for public policy in their efforts to promote R&D cooperation activities. According our results, the effectiveness of such policies, in the case of automotive firms, could be enhanced if there are technological spillovers that can be internalized by cooperating firms. According to Cohen and Levinthal (1989), firms can improved their capacity to use information which is available externally by investing in own R&D. However, in this study, we have noted that the automotive firms' R&D intensity is very low. Besides, our results suggest that automotive firms need certain resources and abilities that small firms do not have in order to establish a cooperation agreement with other agents. As a consequence, policy measures need to be more addressed at smaller firms.

Our study is not without limitations. The principal limitation of this study derives from the data available. In PITEC, certain firms that are part of the value chain in the automotive industry are not classified as belonging to this sector. They may be incorporated in diverse sectors such as textiles, chemistry or plastic; however, the majority of its sales volume focuses on the automotive sector. It also conditioned the way in which we constructed some of our variables, for instance, the variables on cooperation are dummies or we cannot include a measure of the location of this sector in industrial parks. In terms of future research, it would be interesting to know the intensity of collaboration or to know if the firms are OEM, tier one, tier two, and so on. On the other hand, it would be interesting to analyse the impact of R&D cooperation with different partners on innovation performance of automotive firms, in order to get a better understanding about the role of this strategy for promoting innovation in the automotive industry.

Notes

1. Nevertheless, it has also been pointed that there may be potential disadvantages of cooperation agreements, to a large extent resulting from opportunistic behaviours by partners (Williamson, 1985; Gulati, 1995). Cooperation may also lead to a loss of autonomy and control of research results, as well as a loss of know-how as a company relies more on other partners (Quélin and Duhamel, 2003; Hoecht and Trott, 2006; Kremic *et al.*, 2006).
2. The automotive sector comprises manufacture of motor vehicles, manufacture of bodies and manufacture of components, parts and accessories. This sector presents a typical pyramidal structure with the automakers at the top. The first-tier suppliers supply modules and systems to the OEMs, which are becoming increasingly more technologically complex and have assumed more responsibility for R&D in the development of new models.
3. In Spain, most first-tier suppliers are of foreign capital, and the R&D incorporated in their products tend to be developed out of Spain. Only few subsidiaries make product design and carry out part of its R&D in Spain (Lear, TRW, Valeo and Bosch). There are also some national capital groups that perform R&D themselves (e.g. Antolín Irausa, Ficosa International, Gestamp, CIE Automotive and Mondragón Automotive).
4. In Spain, it encompasses Public Innovation Organizations (OPIs) along with universities, which are the core of the Spanish public research system, running most of the activities planned in the National Plan for Scientific Research, Development and Technological Innovation. At the Spanish level, the Scientific Research Center (CSIC), Centre for Energy, Environment and Technology (CIEMAT) and the National Institute for Aerospace Technology (INTA) work with the automotive industry.
5. In the Spanish case, in 2006, the CENIT projects were introduced to encourage public-private partnerships in industrial research, establishing technological alliances between companies located in Spain and Spanish universities and technological centers.
6. Some of the main references in this approach are Katz (1986) and Kamien *et al.* (1992).
7. The main ideas of such theories can be found in Pisano (1990), Das and Teng (2000) and Hagedoorn *et al.* (2000).
8. PITEC is a panel developed jointly by the Institute of National Statistics of Spain (INE), the Spanish Foundation for Science and Technology (FECYT) and the Cotec Foundation.
9. We lagged explanatory variables in order to limit the simultaneity bias inherent to this kind of studies.
10. Note that universities or other higher education institutions provide firms with technological personnel and resources which are not available internally. So, a priori, one would think that small firms are those that could take higher advantage, although the results say the opposite.

In this regard, some universities, as it is the case of the University of Barcelona (Llorente, 2012), offer the possibility for SMEs to incorporate a graduate student during six months at a reduced cost, with the aim of driving innovation in the firm, helping to understand the available supply of technological innovations in universities and reaching further agreements of collaboration.

11. Note that, although PITEC has a panel structure, we carried out a cross-sectional analysis because of the complexity of the estimation strategy. More details of the estimation method can be found in Badillo and Moreno (2016).

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(The Appendix follows overleaf.)

Table AI.
Association between variables used in the regression analysis

	1	2	3	4	5	6	7	8	9
1 Incoming spillovers	1.00	0.064	0.128	0.396***	0.059	1,586.3***	1,940.5***	1,321.5***	1,381.0
2 Risks		1.00	0.413***	0.111	-0.133	2,093.0	2,642.0	8,114.0	2,011.0
3 Costs			1.00	0.153	-0.189	2,221.5	2,430.0	7,943.5	1,872.0
4 R&D intensity				1.00	-0.089	0.140	0.086	0.052	0.055
5 Size					1.00	0.213	0.004	0.214	0.118
6 Legal protection						1.00	0.258***	0.134	0.202
7 Public funding							1.00	0.282***	0.214***
8 Vertical cooperation								1.00	0.698***
9 Institutional cooperation									1.00

Notes: To test the degree of association between variables we estimated the more appropriate coefficient in each case, depending on the types of variables. Correlations between continuous variables (4, 5) and continuous variables versus ordinal variables (1, 2, 3) are calculated with the Spearman's rank correlation method. Values in bold are computed with the φ coefficient in order to test correlation between dichotomous variables (6, 7, 8, 9). While values in italics, obtained with the η correlation method, correspond to correlations between dichotomous versus continuous variables. To test the association of ordinal variables versus dichotomous variables we used the Mann-Whitney U coefficient, whose values are provided in the box. Although this latter test is a statistical comparison of the mean, it is assumed that if there are no differences in the media there is no significant relationship between these two variables. *** $p < 0.01$

Source: PITTEC and own calculations

Variables	Definitions
<i>Dependent</i>	
Cooperation with suppliers or customers (vertical)	1 if the firm cooperated in some of their innovation activities with suppliers of equipment, materials, components or software, or customers in the period 2013-2010 0 otherwise
Cooperation with research institutions (institutional)	1 if the firm cooperated in some of their innovation activities with consultants, commercial laboratories or private institutes R&D, universities or other higher education institutions, government or public research organizations (OPIs), and technology centres in the period 2013-2010 0 otherwise
<i>Independent</i>	
Incoming spillovers	1 minus sum of the score of importance that the firm attributed [number between 1 (high) and 4 (Not relevant/not employed)] to the source of information from conferences, trade fairs, exhibitions, scientific journals and trade/technical publications and professional and industry associations. Rescaled between 0 (unimportant) and 1 (crucial)
Legal protection of innovation	1 if the firm applied for a patent, registered an industrial design, registered a trademark, and/or claimed copyright 0 otherwise
Internal R&D intensity	Ratio between internal R&D expenditure and turnover of the firm
Risks	1 minus the score of importance that the firm attributed [number between 1 (high) and 4 (Not relevant/not employed)] to the uncertain demand for innovative goods or services as a factor hampering their innovation activities. Rescaled between 0 (unimportant) and 1 (crucial)
Costs	1 minus sum of the score of importance that the firm attributed [number between 1 (high) and 4 (Not relevant/not employed)] to the lack of funds within the group of firms, lack of funding from sources outside the firm, innovation cost too high as factors hampering their innovation activities. Rescaled between 0 (unimportant) and 1 (crucial)
Public funding of innovation	1 if the firm received public financial support from local or regional government and/or central government for their innovation activities 0 otherwise
Firm size	< 50 employees: 1 if the firm has less than 50 employees 0 otherwise 50-249 employees: 1 if the firm has between 50 and 249 employees 0 otherwise 250-499 employees: 1 if the firm has between 250 and 499 employees 0 otherwise 500 or more employees: 1 if the firm has 500 or more employees 0 otherwise

Table AII.
Definition of the variables included in the regression analysis

Note: All explanatory variables come from PITEC 2010

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