A discriminant analysis of high and low-innovative firms: the role of IT, human resources, innovation strategy, intellectual capital and environmental dynamism

Simona Popa, Pedro Soto-Acosta and Daniel Palacios-Marqués

Abstract
Purpose – This paper aims to examine the effect of technological, organizational and environmental factors on the level of innovation outcomes in manufacturing small- and medium-sized enterprises (SMEs).
Design/methodology/approach – Drawing on the technology-organization-environment theory this paper conducts a discriminant analysis of firms’ innovation level based on a data set of manufacturing SMEs.
Findings – The results show that low- and high-innovative firms can be distinguished in terms of information technology (IT) knowledge and infrastructure, commitment-based human resources (HR) selection practices, exploitative innovation and organizational capital.
Practical implications – The study findings support the idea that innovation is a complex phenomenon explained by multiple factors. As a consequence, firms need to devote extra efforts to develop IT knowledge and infrastructure, commitment-based HR selection practices and organizational capital because these are crucial for obtaining greater innovation outcomes. In addition, the identification of exploitative innovation as a strong discriminant variable highlights that the most effective way to be a highly innovative SME is through incremental innovation, which permits the firm to capitalize as much as possible on previous exploratory efforts.
Originality/value – Although many studies have highlighted that innovation is more challenging for SMEs than for their larger counterparts, the vast majority of studies has been conducted in large companies. This paper extends prior literature by analyzing the discriminant variables that may distinguish between low- and high-innovative manufacturing SMEs.

Keywords IT, Human resources, Innovation strategy, Intellectual capital, Environmental dynamism, Innovation management

1. Introduction

Today, companies all over the world are facing the challenges derived from the COVID-19 crisis. Innovation and business transformation have been suggested confirmed as key to give response to disruptive changes caused by global phenomenon such as the current pandemic, the economic crisis caused by the pandemic and the ongoing climate crisis (Brem et al., 2021; Soto-Acosta, 2020). Extensive research indicates that the innovative capacity of firms is crucial for current and future competitiveness, especially in uncertain environments (Martín-de Castro et al., 2013; Meseguer-Martinez, et al., 2021; Soto-Acosta et al., 2016a). At the same time, it has been largely acknowledged that innovation is not only critical for obtaining sustainable competitive advantages but also for companies’ survival, in particular small- and medium-sized enterprises (SMEs) (Akbari et al., 2020).
Although extant literature provides sufficient arguments that emphasize on the difficulties of smaller firms in achieving innovation, there are few studies analyzing this phenomenon in the specific context of SMEs (Cao et al., 2009; Chang and Hughes, 2012; Chang et al., 2011). There is a consensus about the fact that SMEs have more stringent resource limitations than their larger counterparts, which make it more challenging for SMEs to pursue innovation (Cao et al., 2009; Ebben and Johnson, 2005). In addition, SMEs are expected to face more problems in achieving high levels of innovation as they have restricted managerial expertise, less structured procedures and fewer formalized innovation systems to transform new ideas into innovation outcomes (Agostini and Nosella, 2017). Accordingly, prescriptions for large firms could result either inappropriate or inconvenient when applied to SMEs (Chang and Hughes, 2012). Therefore, it is important to advance the knowledge on the antecedents that determine the level of innovation in SMEs.

There is a common agreement in previous literature on describing innovation as a complex phenomenon that is developed along the following three dimensions:

(1) products and services;

(2) processes; and

(3) management or administrative practices (Cabrilo and Dahms, 2018; Kim et al., 2012).

Following Cabrilo et al. (2020) innovation cannot be associated to a unique cause, but rather to a series of factors. Accordingly, previous research has identified a great diversity of factors that may influence on the level of innovation. In this regard, although the research on the antecedents of innovation is extensive, there is a need to further enrich the understanding on innovation antecedents from a more integrative perspective.

Existing research offers extensive theoretical argumentation about the potential of the information technology (IT) capability to drive significant innovations in business processes, products and services of firms (Del Giudice and Della Peruta, 2016; Soto-Acosta et al., 2016b; Popa et al., 2018; Vendrell-Herrero et al., 2020). In this sense, Arvanitis et al. (2013) suggested that “soft” IT capital related to IT knowledge and skills as well as “hard” IT capital, which is mainly related to IT infrastructure, leverage the communication and exchange of knowledge which, in turn, may result in higher innovation outcomes.

Besides technological factors, the organizational context has been suggested in literature as relevant for distinguishing between low- and high-innovative firms. For instance, Enkel et al. (2017) identify individuals as the frontline that permits firms to pursue innovation. As a consequence, human resources (HR) practices may result crucial for creating a positive social climate for innovation (Cabello-Medina et al., 2011; Soto-Acosta et al., 2016b). Furthermore, to extrapolate this climate for innovation from an individual level to a firm level, the innovation strategy pursued by companies play a pivotal role. In this sense, highly innovative firms are expected to be capable of both exploiting existing competencies to take advantage of existing market opportunities and of exploring new opportunities to meet the challenges of emerging markets. In addition, literature suggests that the competitive advantage of SMEs is usually derived from another key organizational factor: intellectual capital. Yet, how intellectual capital influences specific performance indicators of SMEs such as innovation outcomes remains an under-investigated research area (Agostini and Nosella, 2017). In addition, most studies have focused on the individual impact of single components on innovation (Carmona-Lavado, et al., 2013; Hsu and Fang, 2009; Wu et al., 2007; Beltramino et al., 2020), while fewer have considered the three-dimensional conceptual framework of intellectual capital (Agostini et al., 2017; Agostini and Nosella, 2017; Buenechea-Elberdin et al., 2018). Nonetheless, isolating these components may contradict the fair presentation of intellectual capital as there is a close relationship between these components (Leitner, 2014). To address this issue, this study adopts the second approach by considering the effect of the three intellectual capital components on innovation.
Furthermore, prior studies suggest that innovation is contingent on environmental factors (Jansen et al., 2006, 2009; Popa et al., 2017). Environmental forces create a great pressure in the establishment of innovation strategies and their outcomes (Jansen et al., 2009). In the same venue, firms’ ability to innovate may depend on the development of multiple internal capabilities, combining IT, innovation strategy, intellectual capital, but also on the quick response to external pressures such as environmental dynamism.

Consistent with technology-organization-environment (TOE) framework, the objective of this study is to assess the effect of technological, organizational and environmental factors on the level of innovation in the specific context of SMEs. To address these issues, this paper conducts a discriminant analysis of firms’ innovation level based on a data set of manufacturing SMEs. The remainder of the paper is organized as follows. Section 2 presents the theoretical background and the justification of hypotheses. Following that, the research methods drawing from a large sample of manufacturing SMEs are described. Then, data analysis and results are presented. Finally, the paper ends with a discussion of research findings, limitations and concluding remarks.

2. Theoretical framework and hypotheses

The TOE framework conceives the context of adoption and implementation of technological innovations as consisting of three factors: the technological context, the organizational context and the environmental context. The technological context refers to the characteristics of the technological innovation, the organizational context describes characteristics of the organizations and the environmental context implies characteristics of the environment in which the adopting organizations operate (Thong, 1999; Tornatzky and Fleischer, 1990). The TOE framework has been extensively used as the theoretical framework to analyze factors which affect the adoption and use of different technological innovations (Chan et al., 2012; Hsu et al., 2014; Lian et al., 2014; Palacios-Marqués et al., 2015; Soto-Acosta et al., 2016a, 2016b).

2.1 Technological antecedents and innovation

Previous literature suggests that achieving innovation in SMEs depends on key resources and capabilities such as IT (Hadjimanolis, 2000). In fact, IT has been identified in previous literature as a fundamental component for improving firms’ overall business success (Yunis et al., 2018). For instance, some researchers argue that IT improves information flows within and beyond companies’ boundaries by eliminating communication barriers while increasing the interconnectedness of business networks and, consequently, improving innovation (Giannakis and Papadopoulos, 2016; Gonzalvez-Gallego et al., 2010). Still other investigations suggest that IT has the potential to boost innovation through the improvement of integration, design, execution and control of operational processes (Soto-Acosta et al., 2016b). Therefore, IT has been recognized in previous literature as an innovation catalyst owing to its potential to enhance companies’ innovation speed, quality as well as flexibility (Vendrell-Herrero et al., 2020).

Technology competence depends on both tangible and intangible resources, though the latter are more likely to generate competitive advantages (Soto-Acosta and Meroño-Cerdán, 2008, 2009; O’Sullivan and Dooley, 2010). Previous studies suggest that, when used appropriately, tangible resources such as IT infrastructure may enhance the speed of knowledge exploration and exploitation, from individuals to organizational members (Chan et al., 2012; Gonzalvez-Gallego et al., 2010; Sher and Lee, 2004). However, IT infrastructure by itself is typically imitable and, thus, should not be considered by firms a source of competitive advantage (Kmieciak et al., 2012; Popa et al., 2016; Soto-Acosta and Meroño-Cerdán, 2008, 2009). Regarding intangible resources, several authors highlight that “soft” IT capital related to IT knowledge and skills improves the positive impact on innovation of
“hard” IT capital, which is mainly related to IT infrastructure (Arvanitis et al., 2013; Colombo-Palacios et al., 2018). With other words, intangible IT resources are crucial for the effective exploitation of the tangible ones. In this sense, firms with a higher IT expertise have been found to be more likely to adopt IT innovations because they can better adapt IT solutions to their own organizations’ needs (Palacios-Marqués et al., 2015; Soto-Acosta, 2014). Thus, we propose the following hypotheses:

\[ H1a. \] IT knowledge is predominant in highly innovative firms compared to their low-innovative counterparts.

\[ H1b. \] IT infrastructure is predominant in highly innovative firms compared to their low-innovative counterparts.

### 2.2 Organizational antecedents and innovation

With respect to the organizational context, there are several factors that influence the level of innovation. Previous studies suggest that individuals are the frontline, which permits firms to widen its knowledge base through learning, contributing to innovation (Enkel et al., 2017). Innovation essentially results from collaboration between employees (Subramaniam and Youndt, 2005). Thus, innovation largely depends on both employees’ individual knowledge and the creation of a suitable climate for exchanging and sharing insights and experiences (Cabello-Medina et al., 2011). Consistent with the social exchange theory, previous literature suggests that commitment-based HR practices may create a positive social climate that encourage employees to act in line with firm’s objectives by being enablers of a positive social climate for innovation (Soto-Acosta et al., 2016b). Commitment-based HR practices are long-term oriented and encourage flexibility, teamwork, cooperation and knowledge exchange (Collins and Smith, 2006). In this sense, Çakar and Ertürk (2010) provide empirical evidence for the positive effect of employee empowerment on the innovation capability of SMEs. Instead, the lack of employee empowerment in the process of decision-making may hinder their innovativeness and, consequently, may reduce the overall firm innovativeness. However, these positive effects might not be achieved unless there is a coherence among these practices (Cabello-Medina et al., 2011). Accordingly, high-innovative firms are more likely to use commitment-based HR selection, incentive and training and development practices than their low-innovation counterparts. Based on these arguments, the following hypotheses are proposed:

\[ H2a. \] Commitment-based HR selection practices are predominant in highly innovative firms compared to their low-innovative counterparts.

\[ H2b. \] Commitment-based HR incentive and training and development practices are predominant in highly innovative firms compared to their low-innovative counterparts.

Furthermore, to extrapolate this climate for innovation from an individual level to a firm level, the innovation strategy pursued by the company plays a pivotal role. Innovation strategy has been extensively described in previous literature in terms of exploration and exploitation (Enkel et al., 2017). Explorative innovation encompasses activities that are oriented toward selection, improvement and efficiency, while exploratory innovation builds upon search, discovery and experimentation. Accordingly, exploration involves “experimentation with new alternatives” with returns that are “uncertain, and distant,” and exploitation is the “refinement and extension of existing competencies, technologies and paradigms” with returns that are “proximate and predictable” (March, 1991, p. 85).

When March (1991) introduced the concepts of exploration and exploitation in the management literature, he argued that they should be viewed as two ends of a single continuum. In March’s characterization, trade-offs between exploration and exploitation are seen as unavoidable. However, a dominant approach in ambidexterity literature is to conceptualize exploration and exploitation as distinct and separable modes of activity such
that firms can choose to engage in high levels of both activities at the same time (Gibson and Birkinshaw, 2004). Proponents of this approach consider exploration and exploitation as independent variables, orthogonal to each other (Gibson and Birkinshaw, 2004; Hill and Birkinshaw, 2014; Kang and Snell, 2009; Menguc and Auh, 2008; Nemanich and Vera, 2009). In this sense, those companies that are able to synchronize efforts of exploratory and exploitative innovation are labeled as ambidextrous organizations (Enkel et al., 2017; Li, 2013).

Both activities are seen as critical to create firm sustainable competitive advantage, as they enable to enhance firm performance and competitiveness. Firms’ ability to compete successfully in the long run may, thus, be rooted in their capacity to jointly pursue short-term efficiency and long-term innovation (Gibson and Birkinshaw, 2004; Smith and Tushman, 2005). More specifically, to remain competitive in dynamic environments, firms should pursue exploitation activities and develop new products and services as the existing ones become rapidly obsolete (Jansen et al., 2006; Teece, 2007). At the same time, firms need to develop exploitative innovations to cope with the threat of obsolescence and capitalize on previous exploratory efforts (Yang and Li, 2011). Thus, a highly innovative firm is one that is capable of both exploiting existing competencies to take advantage of existing market opportunities and, at the same time, exploring new opportunities to meet the challenges of emerging markets. Hence, we propose the following hypothesis:

\[ H3a \] Exploitative innovation is likely to be more predominant in highly innovative firms compared to their low-innovative counterparts.

\[ H3b \] Exploratory innovation is likely to be more predominant in highly innovative firms compared to their low-innovative counterparts.

From a more integrative perspective, intellectual capital has been identified as a critical antecedent of innovation (Agostini and Nosella, 2017; Colomo-Palacios et al., 2011; Dost et al., 2016). Intellectual capital can be defined as a set of human, organizational and social intangible resources that the company owns or has access to (Agostini and Nosella, 2017; Buenechea-Elberdin, 2017). This view of Intellectual capital highlights the three dimensions that encompass the concept: the knowledge, skills, experiences and capabilities of the employees that compose the human capital; explicit knowledge captured in organizational routines, procedures and systems that determine the structural or organizational capital; and the knowledge derived from external relationships and networks of the enterprise that constitute the relational or social capital.

There is extensive literature that highlight the role of human capital as the primary antecedent of creativity and innovation, with the latter being treated as the development of new products and capabilities based on the knowledge and skills of the personnel (Cabello-Medina, 2011; Lopez-Cabrales et al., 2006). In this sense, the value and uniqueness of human capital are the characteristics that most contribute to the exploration of new market opportunities and new procedures, enhancing the innovativeness of the firm (Subramaniam and Youndt, 2005). These attributes are associated to the so-called “intellectual agility” of employees which draws on the ability to view challenges and problems from different perspectives and to propose innovative solutions and renewed practices (Roos et al., 2001). Thus, human capital is considered a necessary prerequisite for innovation, gathering this knowledge into organizational procedures and protocols is particularly relevant for SMEs as talent retention is more challenging because of resource scarcity. In this sense, previous studies identify organizational capital as the infrastructure that allows companies to transform individual knowledge into collective know-how, which remains within the company even when employees leave (Kalkan et al., 2014). This infrastructure consists of databases, manuals, routines, strategies and other organizational structures that integrate institutionalized knowledge and experiences (Beltramino et al., 2020). Similarly, it is not less true that accumulated expertise tends to become obsolete over time and continuous renewal is required. In this sense, previous studies suggest that
social capital enhances the knowledge and capabilities of individuals and companies by improving information access, quality, relevance and timeliness (Adler and Kwon, 2002). Therefore, drawing on the establishment, development and maintenance of external relations and networks, companies are able to foster strategic alliances, brand awareness and innovation performance (Agostini and Nosella, 2017). Based on these arguments, the following hypotheses are posited:

\[ \text{H4a. Human capital is superior in highly innovative firms compared to their low-innovative counterparts.} \]

\[ \text{H4b. Organizational capital is superior in highly innovative firms compared to their low-innovative counterparts.} \]

\[ \text{H4c. Social capital is superior in highly innovative firms compared to their low-innovative counterparts.} \]

2.3 External factors and innovation

Consistent with the TOE framework and the contingency theory, prior studies suggest that firms’ innovation strategies and performance are contingent on both internal and external factors (Gibson and Birkinshaw, 2004; Jansen et al., 2006; Messeni Petruzzelli et al., 2009). Moreover, the literature agrees on the fact that capabilities development and evolutionary processes are dependent on the external business context (Teece, 2007; Messeni Petruzzelli et al., 2009). In this regard, firms’ ability to deploy innovations may depend not only on the development of diverse internal capabilities but also on the quick response to external pressures such as the dynamism of the business environment. Environmental dynamism is characterized by technological changes, variations in customer preferences, changes in product demand and the unpredictability of change (Chan et al., 2016). In this sense, environmental dynamism is a source of both challenges and opportunities for innovation (Prasad and Junni, 2016). To remain competitive companies operating in rapidly changing and unpredictable environments are forced towards continuous renewal because current products, practices and technologies rapidly become obsolete (Baron and Tang, 2011; Jansen et al., 2006). At the same time, new markets and business opportunities are rising more often in dynamic environments, so companies that are able to give a prompt response by developing new products and processes or by upgrading the existing ones benefit from the advantages of being first movers. Accordingly, from both perspectives environmental dynamisms may be considered a driving force of innovation. Hence, the following hypothesis is proposed:

\[ \text{H5. Environmental dynamism is predominant in highly innovative firms compared to their low-innovative counterparts.} \]

3. Method

3.1 Data and sample

The target population of our study is formed by manufacturing SMEs from Spain. Selected companies will meet the following criteria: 20 ≤ employees < 250, turnover ≤ €50m; and a balance sheet total ≤ €43m. Previous studies on the subject have used SMEs with at least 20 employees for their research to ensure a minimum firm complexity (Carmeli and Shteigman, 2010; Lubatkin et al., 2006; Simsek et al., 2005). The study used a sample of 2,000 firms selected randomly from a list of 8,938 manufacturing SMEs with at least 20 employees included in the Sistema de Análisis de Balances Ibéricos (SABI) database. The sample drawn was a random sample of companies from the respective sector population with the objective of fulfilling strata with respect to business size and business subsectors. In administering our survey, the questionnaire was assigned to senior and middle managers whose primary responsibilities are related to strategic innovation activities of the firms.
Data were collected in two stages. First, a pilot study was performed and, following that, a questionnaire was conducted. A total of 15 SMEs were randomly selected from the SABI database to perform the pilot study. Based on their responses and subsequent interviews with participants in the pretest, minor modifications were made to the questionnaire. Responses from the firms that participated in the pilot study were not included in the final sample. The survey was administrated between May and June 2018 by using computer-assisted telephone interviewing software. In total, a final data set of 306 valid cases was obtained, yielding a response rate of 15.3%, which was comparable to other studies of similar scale. Data was examined for non-response bias by comparing the characteristics of early and late participants in the study. The results of this comparison revealed that non-response bias does not represent a threat for the results obtained and their interpretation.

3.2 Measurement

Measurement items were selected on the basis of a careful literature review. The research instrument was pretested with 15 different researchers and managers. Our primary objective was to detect inadequate wording and facilitate the ease of administering the instrument. The results from the pretest showed no particular bias. A description of the constructs and the associated indicators is provided in Appendix.

All the variables used in the study were operationalized using multi-item instruments (seven-point Likert scales). Based on the scales developed by Tippins and Sohi (2003) and Soto-Acosta et al. (2018) three items were adapted to measure IT knowledge and four to assess IT infrastructure. Using the scales established by Collins and Smith (2006) and Ceylan (2013), a second-order construct was drawn up to reflect commitment-based HR practices. Overall, ten items were adapted to measure the extent of use of different commitment-based long-term-oriented practices along two dimensions: selection policies and incentive and training and development policies. In measuring innovation strategy, the scales from Jansen et al. (2006) and Chang and Hughes (2012) were adapted to develop two different approaches to innovation: exploratory innovation and exploitative innovation. Exploratory innovation dimension focuses on innovation activities that are oriented toward selection, improvement and efficiency, whereas the exploratory innovation dimension captures innovation activities that build upon search, discovery and experimentation. Drawing on Subramaniam and Youndt (2005), 14 items were used to measure the three dimensions of intellectual capital (human capital, organizational capital and social capital). Based on the previous work of Jansen et al. (2006) a three-item scale was used to measure environmental dynamism. Finally, drawing on Kim et al. (2012), Ritala et al. (2015); and Yang et al. (2009), 11 items were used to evaluate innovation performance relative to its main competitors along three key areas: product innovation, process innovation and administrative innovation performance.

3.3 Instrument validation

The unidimensionality and reliability of the data set were assessed by different procedures. First an initial exploration of unidimensionality was done using principal component factor analyses. In each analysis, the eigenvalues were greater than 1 and all factor loadings greater than 0.50 (with no substantial cross-loadings), lending preliminary support to a claim of unidimensionality in the constructs. Then, confirmatory factor analysis was performed to establish the required convergent validity, discriminant validity and reliability of the constructs. After dropping insignificant items, all estimated standard loadings were significant ($p < 0.01$) and of acceptable magnitude, suggesting good convergent validity (Sethi and King, 1994). To assess the discriminant validity – the extent to which different constructs diverge from one another – Forell and Larcker’s (1981) criterion, that the square root of average variance extracted for each construct (diagonal elements of the correlation matrix in Table 1) should be greater than the absolute value of interconstruct correlations
(off-diagonal elements), was used. All constructs met this criterion, suggesting that the items share more variance with their respective constructs than with other constructs. Table 1 also provides an overview of the means, standard deviations and correlations of the constructs.

Most researchers agree that common method variance is a potentially serious bias threat in behavioral research, especially with single informant surveys. Several steps to control for common method bias were adopted before data collection, such as assuring the participants that there were no right or wrong answers and that their responses would remain anonymous (Podsakoff et al., 2003). In addition, the extent of common method bias was assessed after data collection by using two distinct methods. First, the Harman’s one-factor test was used by entering all the indicators into a Maximum Likelihood factor analysis (Podsakoff and Organ, 1986). Evidence for common method bias exists when a general factor accounts for the majority of the covariance among all factors. With all indicators entered, ten factors were extracted. The variance explained ranged from 16.1% to 3%, indicating no substantial common method bias. Second, the correlation matrix (Table 1) did not indicate any highly correlated variables, while evidence of common method bias usually results in extremely high correlations ($r > 0.90$) (Bagozzi et al., 1991). In summary, these tests suggest that common method bias is not a serious threat in our study.

### 4. Data analysis

The two-step cluster analysis was chosen to reveal groupings based on the following constructs: product innovation, process innovation and administrative innovation. This statistical technique has been extensively used to report not readily identifiable groupings and because it allows the importance of each input variable to be identified (Brown et al., 2016). Before starting the cluster analysis, the specific assumptions of the two-step clustering algorithm were assessed. First, the independence of the respondents was supported by the random sampling plan. Second, to assess the normality of each continuous variable, both skewness and kurtosis tests were determined: in neither test did any of the calculated $z$-values exceed a critical value $\pm 1.96$, indicating the normality of the distribution at $P < 0.05$. With all this in mind, the Two-step cluster analysis was conducted for the 306 firms in this study. The log-likelihood criterion and the silhouette coefficient were used for distance measure and compare cluster solutions, respectively. Silhouette measure of less than 0.2 are classified as poor; between 0.2 and 0.5 as fair; greater than 0.5 as good solution quality, with fair or higher considered acceptable clustering (Sarstedt and Moos, 2014; Tabachnick and Fidell, 2013). In our study, the silhouette coefficient was 0.6. The importance of the main predictors in decreasing order was: process innovation 1.0, administrative innovation 0.86 and product innovation 0.62. Two clusters were identified, with 148 firms classified as highly innovative and 158 as low-innovative firms. Differences between the two clusters by the variables of classification (process

<table>
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<tr>
<th>Constructs</th>
<th>Ave.</th>
<th>SD</th>
<th>(1)</th>
<th>(2)</th>
<th>(3)</th>
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<th>(7)</th>
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<tbody>
<tr>
<td>1. IT know</td>
<td>4.35</td>
<td>1.48</td>
<td>0.83</td>
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<td>2. IT infras</td>
<td>4.04</td>
<td>1.42</td>
<td>0.69</td>
<td>0.81</td>
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<td>3. CHR sel</td>
<td>5.44</td>
<td>1.14</td>
<td>0.39</td>
<td>0.40</td>
<td>0.82</td>
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<td>4. CHR inc</td>
<td>4.74</td>
<td>1.23</td>
<td>0.46</td>
<td>0.48</td>
<td>0.66</td>
<td>0.79</td>
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<td>5. Exploit. innov</td>
<td>4.94</td>
<td>1.19</td>
<td>0.41</td>
<td>0.35</td>
<td>0.34</td>
<td>0.38</td>
<td>0.75</td>
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<td>6. Explor. innov</td>
<td>4.12</td>
<td>1.49</td>
<td>0.38</td>
<td>0.33</td>
<td>0.35</td>
<td>0.37</td>
<td>0.60</td>
<td>0.78</td>
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<td>7. Human cap</td>
<td>4.94</td>
<td>1.15</td>
<td>0.51</td>
<td>0.46</td>
<td>0.49</td>
<td>0.57</td>
<td>0.43</td>
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<td>8. Organiz. cap</td>
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<td>1.53</td>
<td>0.49</td>
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<td>0.43</td>
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<td>0.49</td>
<td>0.51</td>
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<td>9. Social cap</td>
<td>5.43</td>
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<td>10. Env. dynam</td>
<td>4.15</td>
<td>1.57</td>
<td>0.24</td>
<td>0.24</td>
<td>0.25</td>
<td>0.30</td>
<td>0.39</td>
<td>0.42</td>
<td>0.31</td>
<td>0.24</td>
<td>0.28</td>
<td>0.85</td>
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**Note:** Diagonal values in italic represent the square root of the AVE
innovation, administrative innovation and product innovation) were confirmed through the subsequently conducted ANOVA analyses.

Next, the multivariate technique of discriminant analysis was used. To suit this type of statistical analysis, a dummy dependent variable composed of the two groups (highly innovative and low-innovative firms) from the cluster analysis was created. Table 2 shows the descriptive statistics of the respondents. Results for four important statistics showed the strength of the discriminant function. First, the eigenvalue as measure of the total variance in the discriminant variables totaled 0.728. Second, the canonical correlation (which is similar to Pearson’s correlation \( r \)) was 0.649, whereby the value reflects the closeness of the relationship between the discriminant function and the dependent variable. Third, the squared canonical correlation of 0.421 can be interpreted as the proportion of the variance in the discriminant function explained by the two subgroups and serves as a good indicator of the fairly strong explanatory ability of the discriminant function. Table 3 presents the significant differences between highly innovative and low-innovative firms in terms of the predictor variables that best discriminate between the two groups. These specific predictor variables are: exploitative innovation, IT knowledge, IT infrastructure, organizational capital and commitment-based HR selection practices. Table 4 supplements Table 3 by depicting the strength of the discriminant function in classifying highly innovative and low-innovative firms. In total, 79.7% of the grouped cases were correctly classified, further supporting the power of the discriminant function. Through these analyses, \( H_1a \), \( H_1b \), \( H_2a \), \( H_3a \) and \( H_4b \) were confirmed, whereas \( H_2b \), \( H_3b \), \( H_4a \), \( H_4c \) and \( H_5 \) did not find support.

5. Conclusions, limitations and future research

Innovation has attracted great attention of both academics and practitioners as benefits are largely acknowledged. Innovations in products and services may permit firms to open new

### Table 2 Descriptive statistics

<table>
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<th>Variable</th>
<th>Highly innovative (( N = 148 ))</th>
<th>Low-innovative (( N = 158 ))</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>SD</td>
</tr>
<tr>
<td>IT knowledge</td>
<td>5.02</td>
<td>1.214</td>
</tr>
<tr>
<td>IT infrastructure</td>
<td>4.70</td>
<td>1.194</td>
</tr>
<tr>
<td>CHR selection</td>
<td>5.92</td>
<td>0.775</td>
</tr>
<tr>
<td>CHR incentive/develop.</td>
<td>5.27</td>
<td>0.949</td>
</tr>
<tr>
<td>Exploitative innovation</td>
<td>5.49</td>
<td>0.881</td>
</tr>
<tr>
<td>Exploratory innovation</td>
<td>4.58</td>
<td>1.427</td>
</tr>
<tr>
<td>Human capital</td>
<td>5.43</td>
<td>0.906</td>
</tr>
<tr>
<td>Organizational capital</td>
<td>4.94</td>
<td>1.245</td>
</tr>
<tr>
<td>Social capital</td>
<td>5.87</td>
<td>0.841</td>
</tr>
<tr>
<td>Environmental dynamism</td>
<td>4.55</td>
<td>1.497</td>
</tr>
</tbody>
</table>

### Table 3 Standardized canonical discriminant coefficients and tests of significant differences between groups

<table>
<thead>
<tr>
<th>Variable</th>
<th>Discriminant function coefficients</th>
<th>Classified function coefficients</th>
<th>Test of equality of group means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Highly innovative</td>
<td>Low-innovative</td>
<td>Wilks’ lambda</td>
</tr>
<tr>
<td>Exploitative innovation</td>
<td>0.474</td>
<td>3.764</td>
<td>3.023</td>
</tr>
<tr>
<td>IT knowledge</td>
<td>0.239</td>
<td>0.895</td>
<td>0.603</td>
</tr>
<tr>
<td>IT infrastructure</td>
<td>0.226</td>
<td>0.694</td>
<td>0.405</td>
</tr>
<tr>
<td>Organizational capital</td>
<td>0.301</td>
<td>0.495</td>
<td>0.127</td>
</tr>
<tr>
<td>CHR selection</td>
<td>0.310</td>
<td>4.619</td>
<td>4.110</td>
</tr>
<tr>
<td>Constant</td>
<td>–</td>
<td>–29.792</td>
<td>–19.426</td>
</tr>
</tbody>
</table>
markets, enter already established industries as well as achieving differentiation over competitors. At the same time, innovation in processes may enable firms to achieve higher efficiency and profitability through the redesign or creation of new methods of performing activities that lower costs or generate new revenues (Arvanitis et al., 2013; Colomo-Palacios et al., 2018). In addition, administrative innovation is associated with increased efficiency and effectiveness of management structures, systems, policies and processes based on a top-down approach (Kim et al., 2012). However, achieving high innovation outcomes is still challenging, in particular for SMEs, as innovation cannot be associated to a unique cause, but rather to a series of factors (Cabrilo et al., 2020). Accordingly, there is a need to further enrich the understanding on innovation antecedents from a more integrative perspective.

This paper builds on the TOE framework to develop an integrative conceptual model that sheds light on the antecedents that may explain the differences between low- and high-innovative manufacturing SMEs. The empirical results reveal that factors have differential effects. With regard to the technological context, the results indicate that low- and high-innovative firms can be distinguished in terms of IT knowledge and IT infrastructure. It is important to note that the effect of IT knowledge as discriminant variable is stronger than that of IT infrastructure. These findings provide empirical support for studies suggesting that although both tangible and intangible IT resources are positively associated with innovation performance, the latter are more likely to generate competitive advantages (Arvanitis et al., 2013; Popa et al., 2016; Soto-Acosta and Meroño-Cerdan, 2008, 2009).

Regarding organizational factors, the results suggest that high-innovative firms are more focused toward commitment-based HR selection practices, while the differences between low and high-innovative firms are not significant in terms of other commitment-based HR practices. A possible explanation of this partial consensus with previous studies is that the effect of some commitment-based HR practices on innovation is not direct. In this sense, some authors suggest that commitment-based HR practices have a positive effect on other factors such as social capital (Cabello-Medina et al., 2011), e-business use (Soto-Acosta et al., 2016b), innovation climate (Popa et al., 2017) or social web knowledge sharing (Soto-Acosta et al., 2018), which subsequently have a significant influence on innovation. With regard to innovation strategy, only exploitative innovation is found to distinguish between low- and high-innovative firms, being exploitative innovation the strongest discriminant variable in our model. Although previous studies argue that both exploitation and exploration are seen as critical to sustainable competitive advantage, SMEs are more oriented toward developing exploitative innovations to capitalize on previous exploratory efforts because of their resource constrains. For the three discriminant variables related to intellectual capital, our results show that only organizational capital distinguishes between low- and high-innovative firms. These findings are contrary to previous studies that show that radical and incremental innovation outcomes are higher in SMEs displaying a higher strength of human capital and relational capital (Agostini et al., 2017). However, our findings may be framed within the stream of research suggesting that, among the three components of intellectual capital, organizational capital is considered to give the greatest benefits for a company (Beltramino et al., 2020) and that organizational capital mediates the effects of

<table>
<thead>
<tr>
<th>Actual group in sample</th>
<th>Highly innovative</th>
<th>Low-innovative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Highly innovative firms</td>
<td>122 (82.4%)</td>
<td>26 (17.6%)</td>
</tr>
<tr>
<td>Low-innovative firms</td>
<td>36 (22.8%)</td>
<td>122 (77.2%)</td>
</tr>
</tbody>
</table>

Note: 79.7% of groups correctly classified
human capital (Agostini and Nosella, 2017; Chen et al., 2014; Costa et al., 2014) and social capital (Agostini and Nosella, 2017; Costa et al., 2014; Elsetouhi et al., 2015) on innovation.

With respect to the environmental context, our findings show that the discriminant effect of environmental dynamism is not significant. A possible explanation of this result is that although dynamic environments may push enterprises to engage in both exploitative and exploratory innovations (Chang et al., 2011; Soto-Acosta et al., 2018), there is no direct effect on innovation performance. With other words, environmental dynamism may have a direct and significant influence on enhancing the process of innovation but not on the outcomes of innovation. However, such boost of the innovation process is expected to contribute by extension to innovation performance.

The present study provides several important implications for managers. First, the study findings support the idea that innovation is a complex phenomenon explained by multiple factors. In this sense, firms should devote extra efforts to develop IT knowledge and infrastructure, commitment-based HR selection practices and organizational capital because these are crucial for obtaining greater innovation outcomes. Second, our results show that the ability to deploy exploitative innovations is a crucial factor for discriminating low- and high-innovative SMEs. The identification of exploitative innovation as a strong discriminant variable highlights that pursuing exploitation has a greater effectiveness than focusing on exploratory innovation in the case of SMEs. Third, although SMEs have to compete within dynamic environments, these firms are not so influenced by the challenges and opportunities posed by the business contexts as their primary focus is on exploitation. Accordingly, rather than introducing radical innovation, the most effective way to be a highly innovative SMEs is though exploitation and incremental innovation, which permits the firm to capitalize as much as possible on previous exploratory efforts.

While the contributions of the present study are significant, it has some aspects which can be addressed in future research. First, the sample used was from Spain. It may be possible that the findings could be extrapolated to other countries, as economic and technological development in Spain is similar to other Organization for Economic Co-operation and Development member countries. However, in future research, a sampling frame that combines firms from different countries could be used to provide a more international perspective on the subject. Second, the key informant method was used for data collection. With this method the data reflects the opinions of only one person. Future studies could consider research designs that allow data collection from multiple respondents within an organization. Third, while IT, commitment-based HR selection practices, exploitative innovation and organizational capital are found to be important factors affecting the level of innovativeness of SMEs, future research could consider other potential factors such as organizational culture, leadership and open innovation (Martinez-Conesa et al., 2017). Fourth, firm performance measures are subjective in the sense that they were based on seven-point Likert-scale responses provided by managers. Thus, it could also be interesting to include objective indictors for measuring innovation performance. Fifth, this research takes a static, cross-sectional picture of factors affecting innovation, which makes it difficult to address the issue of how these antecedents and their importance may change over time. A longitudinal study could enrich the findings. These suggestions should be considered in future studies to increase the validity of our findings.

References


Appendix. Measures

Technology

Information technology (IT). Regarding IT in your firm, to what extent do you agree with the following statements? (1–7):

1. IT knowledge:
   - ITC1. Our firm possesses a high degree of ICT expertise.
   - ITC2. We are very knowledgeable about new ICT innovations.
   - ITC3. Our firm possesses a high degree of expertise for the development and maintenance of new IT (Web 2.0, wiki, extranets, etc.).

2. IT infrastructure. With regard to IT infrastructure and staff in your firm, to what extent do you agree with the following statements? (1–7):
   - ITC4. We budget a significant amount of funds for new ICT implementation and maintenance (technical staff, hardware, software, etc.).
   - ITC5. Our firm use customized software applications.
   - ITC6. We use computer-based systems that allow our employees to communicate and develop collaborative tasks.
   - ITC7. We routinely use computer-based systems that are integrated with our external stakeholders IT systems (clients, suppliers, etc.).

Organization

Commitment-based HR practices (CHR). In relation to HR practices in your firm, to what extent do you agree with the following statements? (1–7):

1. CHR selection practices (CHR selection):
   - CHR1. Internal candidates are given consideration over external candidates.
   - CHR2. We select employees based on an overall fit to the company.
   - CHR3. Our selection system focuses on the candidate’s potential to learn and grow with the firm.
   - CHR4. We ensure that all employees are made aware of internal promotion opportunities.

2. CHR incentive and training and development practices (CHR incentive/develop):
   - CHR5. Employee bonuses or incentive plans are based primarily on the performance of the firm.
   - CHR6. Goals for incentive plans are based on business unit or company performance.
CHR7. Salaries for employees in these positions are higher than those of our competitors.
CHR8. Performance appraisals are used to plan skill development and training for future advancement within the company.
CHR9. We provide multiple career path opportunities for employees to move across multiple functional areas of the company.
CHR10. We provide training focused on team-building and teamwork skills.

Innovation strategies

With regard to innovation in your firm, to what extent do you agree with the following statements? (1–7):

1. Exploitative innovation:
   - ET1. We regularly implement small adaptations to our existing products.
   - ET2. We introduce improved, but existing, products in our market.
   - ET3. We improve our provision's efficiency of products and services.
   - ET4. We increase economies of scales in existing markets.
   - ET5. Our company expands services for existing clients.

2. Exploratory innovation:
   - ER1. Our firm accepts demands that go beyond our existing products and services.
   - ER2. We invent new products and services.
   - ER3. We experiment with new products and services in our market.
   - ER4. We commercialize products and services that are completely new to our company.

Intellectual capital

Concerning intellectual capital in your firm, to what extent do you agree with the following statements? (1–7):

1. Human capital:
   - HC1. Our employees are highly skilled.
   - HC2. Our employees are widely considered the best in our industry.
   - HC3. Our employees are creative and bright.
   - HC4. Our employees are experts in their particular jobs and functions.
   - HC5. Our employees develop new ideas and knowledge.

2. Organizational capital:
   - OC1. Our organization uses patents and licenses to store knowledge.
   - OC2. Much of our knowledge is contained in manuals, databases, etc.
   - OC3. Our organization's culture (stories, rituals) contains valuable ideas, ways of doing business, etc.
   - OC4. Our organization embeds much of its knowledge and information in structures, systems and processes.

3. Social capital:
   - SC1. Our employees are skilled at collaborating with each other to diagnose and solve problems.
   - SC2. Our employees share information and learn from one another.
- SC3. Our employees interact and exchange ideas with people from different areas of the company.
- SC4. Our employees partner with customers, suppliers, alliance partners, etc., to develop solutions.
- SC5. Our employees apply knowledge from one area of the company to problems and opportunities that arise in another.

**Environment**

Regarding your firm, to what extent do you agree with the following statements? (1–7):

1. Environmental dynamism:
   - ED1. In a year, our market has changed a lot.
   - ED2. Our clients regularly ask for new products and services.
   - ED3. In our market, the volumes of products and services to be delivered change fast and often.

**Innovation performance**

How would you compare your performance over the past three years to that of other firms operating in the same industry in the following areas? (1–7):

1. Product innovation:
   - IP1. The level of newness (novelty) of our firm’s new products.
   - IP2. The use of latest technological innovations in our new products.
   - IP3. The speed of our new product development.
   - IP4. The number of new products our firm has introduced to the market.

2. Process innovation:
   - IP5. The speed with which we adopt the latest technological innovations in our processes.
   - IP6. The updatedness or novelty of the technology used in our processes.
   - IP7. The rate of change in our processes, techniques and technology.

3. Administrative innovation:
   - IP8. The use of new or improved computer-based administrative applications.
   - IP9. The use of new or improved employee reward/training schemes.
   - IP10. The use of new or improved structures such as project team or departmental structures.
   - IP11. The use of new or improved marketing practices.

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