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Antecedents, moderators, and outcomes of innovation climate and open innovation: An empirical study in SMEs

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ABSTRACT

In recent years, open innovation (OI) has attracted much attention in innovation management research. Although showing signs of advance, most of the existing literature still relies, to a great extent, on case studies and conceptual frameworks, with little empirical research in the specific context of small and medium enterprises (SMEs). This paper adds to the literature by empirically assessing the effects of organizational antecedents and innovation climate on OI as well as its consequences on firm performance in SMEs. In addition, the moderating roles of environmental dynamisms and competitiveness in the relationships between innovation climate and inbound and outbound OI are analyzed. To achieve these goals, this paper develops an integrative research model, which analyses the network relations using covariance-based structural equation modeling (SEM) on a data set of 429 Spanish SMEs. Results revealed that organizational factors such as commitment-based human resources practices have a positive influence on innovation climate and that innovation climate contributes to both inbound and outbound OI. Another important finding is that contingent factors such as environmental dynamism strengthen the positive effect of innovation climate on outbound OI. The main conclusions of this research can be valuable to SMEs that implement or intend to implement OI.

1. Introduction

In today's dynamic and globalized business environment, academics and practitioners agree on an emergent trend toward opening up the innovation strategy (Lichtenthaler and Lichtenthaler, 2009; Spithoven et al., 2013). Thus, an increasing number of firms, especially SMEs, are relying more on external information and research collaborations in order to innovate and gain competitive advantages. This new way of conducting the innovation process has been recently coined as "open innovation" (OI) (Chesbrough, 2003). However, this topic builds upon previous work on well-established concepts such as absorptive capacity, complementary assets or the exploitation versus exploration dyad. In fact, previous literature admits that OI practices, such as looking beyond organizational boundaries for opportunities to grow or using external knowledge to improve internal innovation processes, are not new to companies. The establishment of this new concept and its coincidence in time with the growing interest for outsourcing, collaboration, organizational agility and flexibility permitted researchers to reconsider innovation strategies in the light of an increasingly networked world (Huggins and Thompson, 2015; Huizingh, 2011). As a consequence, OI has become one of the topics that gained most attention in innovation management research over the last decade (Carayannis and Campbell, 2011; Spithoven et al., 2013).

Previous research on OI has focused mainly on high-tech large enterprises, whereas it is widely accepted in literature that OI practices and consequences depend heavily on firm size. Nonetheless, only a few and recent studies have analyzed OI in the specific context of SMEs (Laursen and Salter, 2006; Lee et al., 2010; Spithoven et al., 2013; Van de Vrande et al., 2009), with most of them contributing to the discussion about the differences between OI in small and large firms. Although previous research showed that OI practices have a significant impact on different measures of performance, the relationship between OI and firm performance of SMEs has received little attention. At the same time, there is a lack of research on the antecedents that stimulate or detract SMEs from pursuing OI practices. In addition, a great part of the studies on OI are descriptive by nature and based upon case studies and in-depth interviews (Chesbrough, 2003; Dodgson et al., 2006; Huston and Sakkab, 2006).

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Firms' migration toward OI has been driven by a confluence of social, economical and technological changes, such as globalization, increased labor division or the rise of collaborative technologies (Huizingh, 2011). Despite the great pressure of business environment trends, some authors found that many firms are still reluctant to open up their innovation strategy through the use of OI practices (de Wit et al., 2007; Lichtenthaler and Ernst, 2009). Previous literature suggests that besides firm demographics (size, age, market share, location or ownership), organizational culture and employees' characteristics have a significant impact on the adoption of OI practices (Harison and Koski, 2010; Huizingh, 2011). For instance, the resistance of employees and lack of internal commitment have been pointed out as strong barriers to SMEs adoption of OI practices (Chesbrough and Crowther, 2006; Lichtenthaler and Lichtenthaler, 2009; Van de Vrande et al., 2009). This draws attention on the importance of innovation climate and employees' commitment for the adoption of OI in SMEs. At the same time, the extent of use of OI practices is contingent on environmental factors. For instance, in a dynamic technological environment firms tend to acquire more external technology as their current technological knowledge and infrastructures rapidly become obsolete (Jansen et al., 2006; Soto-Acosta and Cegarra-Navarro, 2016; Teece, 2007).

There is therefore a need for further research on the antecedents and consequences of OI in the specific context of SMEs. To address these issues, this paper develops and tests a research model by considering literature that covers organizational antecedents of innovation, the crucial role of innovation climate, environmental moderators and the impact of OI on firm performance. The remainder of the article is organized as follows: The next section presents the literature review and hypotheses. Following that, the research methods drawing from a sample of 429 manufacturing SMEs are described. Then, data analysis and results are examined. Finally, the paper ends with a discussion of research findings, limitations and concluding remarks.

2. Theoretical background and hypotheses

2.1. Open innovation

OI has been defined as "the use of purposive inflows and outflows of knowledge to accelerate internal innovation and to expand the markets for external use of innovation, respectively" (Chesbrough et al., 2006, p. 1). This view of OI suggests that openness is relevant for both internal innovation and its external exploitation. Although OI has been initially presented as the opposite of a closed innovation strategy, recent literature considers OI more on a continuum than on an open versus closed innovation dichotomy (Huizingh, 2011).

Drawing on Chesbrough's view of OI, most OI researchers decompose OI in terms of inbound and outbound practices (Bianchi et al., 2010; Cheng and Shiu, 2015; Tranekjer and Knudsen, 2012). The inbound dimension encompasses purposive inflows of knowledge that permit firms to explore and capture new knowledge and technologies from external sources such as customers, suppliers, competitors, governments, consultants, universities or research organizations (Cheng and Shiu, 2015; Meissner, 2015). Inbound OI involves an exploratory learning behavior that enables a firm to look beyond its boundaries, enriching its own knowledge pool. In this vein, firms that perform inbound practices may benefit from new ideas and combinations of knowledge, new market opportunities and renewed problem-solving capabilities (Hung and Chou, 2013; Zahra et al., 2006). In contrast, outbound practices refer to the exploitation of internal ideas or technological knowledge that flow out of the company trough licensing, patenting or contractual agreements in order to gain monetary of non-monetary benefits (Hung and Chou, 2013, Lichtenthaler, 2009). Previous studies found that firms are prone to perform more frequently inbound than outbound practices (Bianchi et al., 2011; Chesbrough and Crowther, 2006). However, these two types of practices are not mutually exclusive (Cheng and Shiu, 2015; Tranekjer and Knudsen, 2012). Moreover, firms that adopt inbound practices are more likely to identify new innovation opportunities, reinforcing their ability to effectively adopt outbound practices (Hung and Chou, 2013; Laursen and Salter, 2006). Similarly, firms that pursue both inbound and outbound practices are more likely to obtain greater value from their knowledge and technological capabilities (Lichtenthaler, 2008; Van de Vrande et al., 2009).

Despite the wide consensus on the benefits of opening up the innovation strategy, empirical studies show that many firms are still reluctant to open up their innovation strategy (de Wit et al., 2007; Lichtenthaler and Ernst, 2009). In this sense, the Not-Invented-Here (NIH) syndrome has been pointed out as one of the main factors that may detract SMEs from adopting OI practices (Chesbrough and Crowther, 2006; Lichtenthaler and Lichtenthaler, 2009; Spithoven et al., 2013). The NIH syndrome reflects the internal resistance from the members of a company (especially its technical staff), which detracts firms from taking advantage of outside knowledge (Laursen and Salter, 2006). This barrier consists of a behavioral response of project groups of stable composition that reject outside knowledge due to a conviction of possessing a monopoly of knowledge in their field. Accordingly, the principal focus of the NIH syndrome is on inflows of knowledge. However, resistance could also descend from the Only-Used-Here (OUH) syndrome which results into barriers to purposive knowledge outflows beyond firms' boundaries (Lichtenthaler and Ernst, 2009). These barriers draw attention on the importance of organizational factors such as innovation climate and employees' commitment for the adoption of OI practices.

The extent of use of OI practices is also contingent on environmental factors. For instance, in a dynamic technological environment firms rely more external technology as their current technological knowledge and infrastructures rapidly become obsolete (Jansen et al., 2006; Teece, 2007). Furthermore, market turbulence requires firms to seek constantly for new knowledge and technologies to satisfy customers' new demands and preferences (Hung and Chou, 2013). This perspective is consistent with the Contingency Theory. According to this theory, the degree of openness of innovation strategies depends on firm-specific (internal) factors and environmental (external) factors (Drechsler and Natter, 2012). Within this perspective, the competiveness of firms is contingent not only on the internal alignment of OI strategies to organizational factors but also on the appropriate fit between organizational strategies and business environment (Takeuchi, 2009).

Furthermore, the resource-based view (RBV) and its extensions, such as knowledge-based view (KBV), suggest that firms build collaboration networks with external partners in order to access and benefit from their new technologies, skills and expertise (Ahuja, 2000; Huggins and Thompson, 2015; Lavie, 2006; Meroño-Cerdan et al., 2008; Popa et al., 2016). OI permits firms to explore outside knowledge and to exploit existing internal resources in order to gain competitive advantages (Drechsler and Natter, 2012). In the specific context of SMEs, purposive inflows and outflows of knowledge are even more relevant for sustainable competitiveness because they face more severe resource constraints (Dahlander and Gann, 2010; Spithoven et al., 2013).

Drawing on the Contingency Theory and RBV, this paper develops and tests a research model to assess the organizational antecedents of innovation climate and its role for OI, the moderating effect of external factors on the relationship between innovation climate and OI as well as the impact of OI on the firm performance of SMEs (see Fig. 1). This set of relationships is illustrated in Fig. 1 and is elaborated further in the following subsections.

2.2. Organizational antecedents of innovation climate and its crucial role for OI

Innovation climate has been identified in literature as a core prerequisite for innovation performance. Innovation culture builds upon

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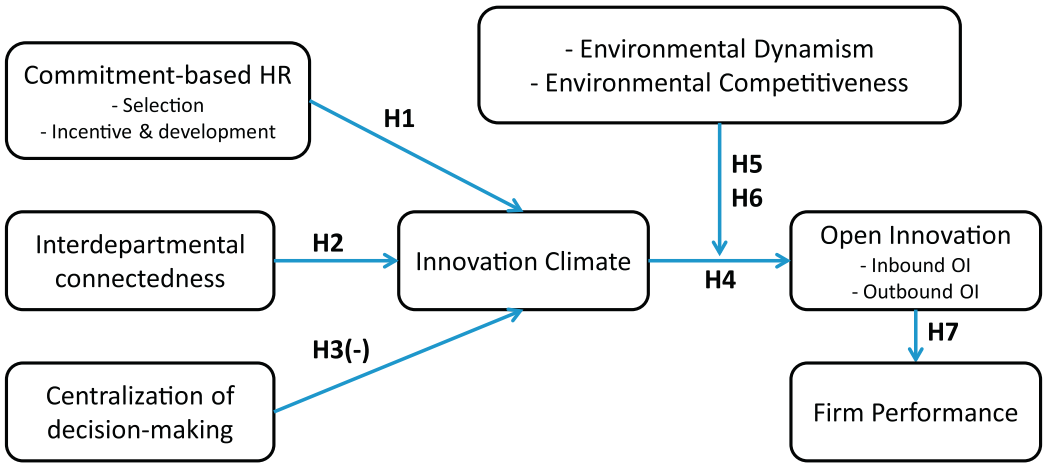

Fig. 1. Research model.

values, beliefs and assumptions that are shared by firm members, facilitating innovation processes (Martín-de Castro et al., 2013). Organizational climates that foster innovation capacity of employees, creativity, risk propensity and personal growth are labeled as "innovation culture" (Menzel et al., 2007). Consistent with the Social Exchange Theory, previous literature suggests that commitment-based human resources (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). Thus, commitment-based HR practices are expected to contribute to the establishment of an innovation climate.

To extrapolate this climate for innovation at a firm-level, it is necessary to support knowledge sharing and collaboration across firms' functional areas. In fact, previous studies suggest that interdepartmental connectedness is advantageous for developing trust and cooperation among organization members because it increases opportunities for informal social relations as well as accessibility, deep understanding and further refinement of existing knowledge (Adler and Kwon, 2002; Subramaniam and Youndt, 2005; Jansen et al., 2006). In this vein, inter-departmental connectedness is expected to be important for innovation climate. At the same time, recent research suggests that open communication, decentralization and high job autonomy are core factors in fostering innovativeness (Prakash and Gupta, 2008). In this sense, Çakar and Ertürk (2010) provide empirical evidence for the positive effect of employee empowerment on innovation capability of SMEs. On the contrary, the lack of employee empowerment in the process of decision-making may hinder openness and internal commitment. Thus, the centralization of decision-making is expected to diminish the establishment of an organizational culture for innovation. Based on these arguments, the following hypotheses are proposed:

Hypothesis 1. Commitment-based HR practices have a positive effect on innovation climate.

H1a. Commitment-based HR selection practices have a positive effect on innovation climate.

H1b. Commitment-based HR incentive and development practices have a positive effect on innovation climate.

Hypothesis 2. Inter-departmental connectedness has a positive effect on innovation climate.

Hypothesis 3. The centralization of decision-making has a negative effect on innovation climate.

Previous literature suggests that creating a suitable climate for innovation fosters the innovativeness of SMEs. For instance, Kmieciak et al. (2012) show that innovation climate facilitates the innovation activity in SMEs. In the same venue, the disposal of SMEs to develop OI practices could be influenced by innovation climate. Firms that have a strong internal innovation climate encourage lateral thinking and risk taking (Oke et al., 2013). Moreover, the development of OI depends on the involvement of stakeholders in the innovation process. Collaboration networks between firms and external partners are built upon a climate of cooperation and trust (Wagner and Bukó, 2005). In this sense, previous studies suggest that such an involvement is more likely to take place in firms that have a strong internal innovation climate (Carayannis et al., 2015; Oke et al., 2013). Furthermore, the organizational culture is considered to be an important factor in deciding strategies for taking advantage of technological knowledge assets (Martín-de Castro et al., 2013). Therefore, corporate culture has a central role in the settlement of management systems for the exploitation of technological knowledge trough the use of patents and intellectual property rights (Hsu and Fang, 2009). Consistent with these arguments, innovation climate may enable firms to explore, internalize and exploit outside knowledge in order to improve their innovation capabilities. Building on these arguments, the following hypotheses are formulated:

Hypothesis 4. Innovation climate has a positive effect on OI.

H4a. Innovation climate has a positive effect on Inbound OI.

H4b. Innovation climate has a positive effect on Outbound OI.

2.3. Environmental moderators of the relationship between innovation climate and OI

Drawing on the Contingency Theory, OI research suggests that firms' migration toward opening up innovation strategies is influenced by both internal and external factors (Huizingh, 2011). Moreover, the literature agrees on the fact that capabilities development and evolutionary processes are dependent on the business context (Lichtenthaler, 2009; Teece, 2007). Consistent with this view, previous studies that focus on the external context characteristics of OI suggest that opening up innovation strategies is more suitable in

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business environments characterized by globalization, competitive intensity, and market and technological turbulence (Gassmann, 2006; Huizingh, 2011). For instance, Chesbrough (2006) states that firms scan their external environment prior to initiating Research and Development (R&D) projects. Based on the comparison of firms' current knowledge and the required knowledge for strategic objectives, strategic gaps might be identified. In order to fill these gaps and, subsequently, align their knowledge bases and strategies, firms need to actively search for new market opportunities. Furthermore, Laursen and Salter (2006) find that the extent of use of external knowledge is shaped in part by environmental factors, such as environmental turbulence or technological opportunities.

In dynamic environments the current knowledge bases of firms rapidly become obsolete (Jansen et al., 2006; Teece, 2007). At the same time, competitive environments have been associated with high pressures for efficiency and lower prices. To remain competitive in dynamic environments, firms adopt OI practices to acquire external knowledge and technology. Moreover, the benefits that derive from strong knowledge management capabilities are expected to be even greater in dynamic environments (Lichtenthaler and Lichtenthaler, 2009). In this sense, the way how firms deploy innovation climate to effectively develop OI is expected to be contingent on environmental dynamism and competitiveness. Drawing on the above mentioned arguments, we propose the following hypotheses:

Hypothesis 5. Environmental dynamism strengthens the positive effect of innovation climate on OI.

H5a. Environmental dynamism strengthens the positive effect of innovation climate on Inbound OI.

H5b. Environmental dynamism strengthens the positive effect of innovation climate on Outbound OI.

Hypothesis 6. Environmental competitiveness strengthens the positive effect of innovation climate on OI.

H6a. Environmental competitiveness strengthens the positive effect of innovation climate on Inbound OI.

H6b. Environmental competitiveness strengthens the positive effect of innovation climate on Outbound OI.

2.4. OI impact on firm performance

OI provides multiple benefits to firms. Inbound OI enables a firm to benefit from new ideas and combinations of knowledge, new market opportunities and renewed problem-solving capabilities (Hung and Chou, 2013; Zahra et al., 2006). At the same time, outbound OI permits firms to obtain monetary and non-monetary benefits from the exploitation of their existing knowledge and technologies and at the same time to minimize obsolescence threats and remain competitive (Hung and Chou, 2013).

Most of previous research on OI effectiveness suggests a positive impact of OI on different measures of firm performance (Carayannis and Grigoroudis, 2014). For instance, Chiesa et al. (2009) provide empirical support for a positive effect of OI on R&D performance, Rohrbeck et al. (2009) show that new product success is positively influenced by OI and still other works (e.g. Chiang and Hung, 2010; Reed et al., 2012) find that OI practices have a positive and significant impact on firms' profitability. In contrast, Torkkeli et al. (2009) show a negative effect of OI practices on performance, while Laursen and Salter (2006) found that breadth and depth of external search is curvilinearly related to performance. Thus, the literature has produced mixed results regarding the relation between OI and firm performance. In addition, recent research considers that SMEs are more likely to benefit from OI practices than their larger counterparts because of their superior flexibility and responsiveness to market needs (Spithoven et al., 2013). Based on the assumption that OI effectiveness can result in lower costs, shorter time to market, increased sales, enhanced technological position and access to new markets (Huizingh, 2011; Lichtenthaler, 2007), the following hypotheses incorporate these expectations:

Hypothesis 7. OI practices have a positive impact on firm performance of SMEs.

H7a. Inbound practices have a positive impact on firm performance of SMEs.

H7b. Outbound practices have a positive impact on firm performance of SMEs.

3. Methodology

3.1. Data and sample

The firms selected for this study are Spanish SMEs from the manufacturing sector with at least 20 employees. These criteria have been established in order to ensure a minimum level of complexity of firms in which OI may be relevant. The study used a sample of 3000 firms selected randomly from a list of 10,460 manufacturing SMEs with at least 20 employees included in the SABI (Sistema de Análisis de Balances Ibéricos) 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 was collected in two stages. First, we performed a pilot study and following that we conducted a questionnaire. Fifteen 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 2016 by using computer-assisted telephone interviewing (CATI) software. In total, a final dataset of 429 valid cases was obtained, yielding a response rate of 14.3%, 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 fifteen 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 1.

All the variables used in the study were operationalized using multi-item instruments. Using the scales established by Collins and Smith (2006) and Ceylan (2013) we drew up a second-order construct to reflect Commitment-based HR Practices (CHR). Overall, 10 item were adapted to measure the extent of use of different commitment-based long-term oriented practices along two dimensions: (1) selection policies; and (2) incentive and training and development policies. Inter-departmental connectedness (IDC) was operationalized using a 2 item

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scale from Chang et al. (2011) which measures the extent to which employees from different departments are networked. Based on previous work of Chang et al. (2011) a 3 item scale was used to measure the Centralization of decision making (CDM). Innovation climate (IC) was operationalized by using the scale of Oke et al. (2013) which measured the extend of use of key practices that aim to create a suitable culture to facilitate knowledge and idea sharing, stimulate creativity and generate innovative ideas through open communications. In measuring open innovation (OI), the scale from Cheng and Shiu (2015) was adapted to construct two metrics: (1) inbound OI; (2) outbound OI. Inbound OI focuses on practices that allow firms to gain and explore knowledge from external sources, while outbound OI captures the firm's approaches to commercialize ideas and innovations developed internally. Based on Jansen et al. (2006) environmental dynamism and environmental competitiveness were measured using 3 items instruments. Drawing on Martín-Rojas et al. (2011), Martinez-Conesa et al. (2017); Murray and Kotabe (1999) and Soto-Acosta et al. (2016a), 5 items were employed to evaluate firm performance (FP) relative to its main competitors along five key areas: ROA, ROE, ROS, market share and sales growth. In addition, a number of control variables that may influence firm performance were included (firm size, firm age and industry in which the firm operates). These variables are commonly used as controls by authors studying innovation and OI (Chang et al., 2011).

3.3. Instrument validation

The measures from the dataset were refined by assessing their unidimensionality and reliability. First, an initial exploration of unidimensionality was made using Maximum Likelihood factor analyses with Promax rotation. The exploratory factor analysis yielded and acceptable ten factor model: KMO = 0.866, total variance explained = 61.1%, non-redundant residuals = 2%, all eigenvalues >1, all factor loadings >0.50, no substantial cross-loadings (Hair et al., 2010). Next, confirmatory factor analysis (CFA) was performed to establish the required convergent validity, discriminant validity, and reliability of the constructs. The measurement model presented a good fit to the data ($\chi^2(389) = 714.818$; RMSEA = 0.04; CFI = 0.96; IFI = 0.96; TLI = 0.95). All traditionally reported fit indexes were within the acceptable range.

Construct reliability assesses the degree to which items are free from random error and, therefore, yield consistent results. This study calculated reliability of measures using Bagozzi and Yi's (1998) composite reliability index and Fornell and Larcker's (1981) average variance extracted index. For all the measures both indices were higher than the evaluation criteria, namely 0.6 for composite reliability and 0.5 for the average variance extracted. Convergent validity assesses the consistency across multiple constructs. As shown in Table 1, after dropping insignificant items, all estimated standard loadings are 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 – Fornell and Larcker's (1981) criterion, that the square root of average variance extracted for each construct (diagonal elements of the correlation matrix in Table 2) 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 2 also provides an overview of the means, standard deviations and correlations of the constructs.

Since both independent and dependent variables were collected simultaneously from the same respondents, common method variance could be a concern in this study. 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 three 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, 10 factors were extracted. The variance explained ranged from 12.7% to 2%, indicating no substantial common method bias. Second, the "unmeasured latent factor method" suggested by Podsakoff et al. (2003) was employed to extract the common variance. This procedure requires the addition of an unmeasured latent factor to the measurement model during CFA. This latent factor includes all indicators from all other latent factors. This approach detects the variance common among all observed indicators. The indicator loadings on this common latent factor are constrained to be equal to each other to ensure that the unstandardized loadings will be equal. Squaring the unstandardized loading (which for all indicators will be the same value) then gives the percent of common variance across all indicators in the model. The results of this test showed that 26% of the variance could be due to common method bias, showing no evidence of common method bias. Third, the correlation matrix (Table 2) 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.

Table 1
Measurement model: confirmatory analysis and scale reliability.

Construct	Indicators	S. loadings	*t*-Value	Reliability
1. CHRP1 (selection)	CHR1	0.647	–	CR = 0.85
	CHR2	0809	13.67	AVE = 0.59
	CHR3	0.832	13.92	
	CHR4	0.769	13.17	
2. CHRP2 (incentive and development)	CHR5	0.831	–	CR = 0.83
	CHR6	0.804	17.04	AVE = 0.63
	CHR8	0.738	15.65	
3. Interdepartmental connectedness	IDC1	0.830	–	CR = 0.75
	IDC2	0.713	10.03	AVE = 0.60
4. Centralization of decision making	CDM1	0.611	–	CR = 0.81
	CDM2	0.866	11.97	AVE = 0.59
	CDM3	0.811	14.14	
5. Innovation climate	IC1	0.822	–	CR = 0.87
	IC2	0.800	18.24	AVE = 0.63
	IC3	0.775	17.52	
	IC4	0.777	17.57	
6. Inbound OI	OI1	0.802	–	CR = 0.81
	OI2	0.829	15.90	AVE = 0.59
	OI3	0.665	13.29	
7. Outbound OI	OI5	0.749	–	CR = 0.79
	OI6	0.820	13.55	AVE = 0.56
	OI7	0.662	12.16	
8. Environmental dynamism	ED2	0.788	–	CR = 0.81
	ED3	0.861	11.20	AVE = 0.68
9. Environmental competitiveness	EC1	0.702	–	CR = 0.76
	EC2	0.759	0.759	AVE = 0.51
	EC3	0.679	0.679	
10. Firm performance	FP1	0.939	–	CR = 0.91
	FP2	0.924	32.33	AVE = 0.72
	FP3	0.796	23.05	
	FP5	0.710	18.66	

Fit statistics for measurement model: $\chi^2(389) = 714.818$; RMSEA = 0.04; CFI = 0.96; IFI = 0.96; TLI = 0.95; insignificant factors are dropped (CHR7, CHR9, CHR10, OI4, OI8, ED1 and FP4); (–): fixed items; CR: composite reliability; AVE: average variance extracted.

4. Results

This paper performs structural equation modeling (SEM) to test the hypotheses, using maximum likelihood estimation techniques to test

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Table 2
Descriptive statistics and discriminant validity.

			Correlation matrix									
Constructs	Av.	SD	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1. CHRP1	5.46	1.13	**0.77**									
2. CHRP2	4.42	1.52	0.57**	**0.79**								
3. Iconnect	5.78	1.06	0.58**	0.37**	**0.77**							
4. DMcentr	4.05	1.43	−0.10*	−0.15**	−0.1*	**0.77**						
5. InnClim	4.04	1.51	0.58**	0.65**	0.36**	−0.07	**0.79**					
6. Inbound	3.80	1.55	0.39**	0.43**	0.23**	0.04	0.59**	**0.77**				
7. Outbound	2.13	1.29	0.31**	0.30**	0.15**	0.05	0.45**	0.51**	**0.75**			
8. Edynam	4.11	1.72	0.34**	0.36**	0.23**	0.10*	0.38**	0.35**	0.35**	**0.83**		
9. Ecompet	5.72	1.19	0.25**	0.14**	0.29**	0.12**	0.07	0.23**	0.06	0.36**	**0.71**	
10. Fperfom	4.52	1.20	0.38**	0.32**	0.27**	−0.04	0.39**	0.28**	0.22**	0.24**	0.05	**0.85**

Significance levels: $p < 0.05$*; $p < 0.01$**; na. Variance extracted is not applicable to the single-item constructs.
Diagonal values in bold represent the square root of the AVE.

the model. The fit of the model is satisfactory ($\chi^2(501) = 948.595$; RMSEA = 0.046; CFI = 0.95; IFI = 0.95; TLI = 0.94), suggesting that the nomological network of relations fits the data and the validity of the measurement scales (Churchill, 1979).

Fig. 2 shows the standardized path coefficients with their respective significant levels. Hypothesis 1 was confirmed (H1a: 0.30, $p < 0.01$ and H1b: 0.49, $p < 0.01$). These results show that commitment-based HR practices are an important factor for the development of an innovation climate. Hypotheses 2 and 3 did not find any support, indicating a non-significant relation between interdepartmental connectedness and innovation climate and a non-significant relation between centralization of decision-making and innovation climate. Hypothesis 4 was confirmed (H4a: 0.57, $p < 0.01$ and H4b: 0.41, $p < 0.01$). The results show that innovation climate contributes positively to both inbound OI and outbound OI. Hypothesis 5 found moderate support (H5a: N.S., $p < 0.01$ and H5b: 0.57). Environmental dynamism strengthens the positive effect of innovation climate on outbound OI (see Fig. 3), while it does not moderate the relation between innovation climate and inbound OI. Hypothesis 6 did not find any support, suggesting that environmental competitiveness does not moderate the relation between innovation climate and OI. In addition, the results show that outbound OI and inbound OI contribute positively to firm performance (H7a: 0.25, $p < 0.01$ and H7b: 0.12, $p < 0.01$). Thus, Hypothesis 7 found support.

5. Discussion and conclusions

Drawing on the RBV, the KBV and the Contingency Theory, this study sheds light on the antecedents of OI and its consequences on firm performance. Within the organizational context, the results revealed that organizational factors have different impact on innovation climate. Commitment-based HR practices have a positive influence on innovation climate, with incentive and development HR practices having a stronger effect than selection HR practices. A possible explanation to this may be that selection practices focus more on assessing the candidates' fit to the company while incentive and development practices emphasize more on motivation and long-term growth (Collins and Smith, 2006). These findings are consistent with previous studies that suggest that HR practices with commitment orientation help to motivate employees to socially interact while developing their day-to-day tasks (Camelo-Ordaz et al., 2011). Thus, building an adequate work environment is key for enhancing human capital creativity and innovativeness (Ceylan, 2013; Dul et al., 2011). In contrast, the effects of interdepartmental connectedness and centralization of decision making on innovation climate were found to be non-significant. These findings depart from existing studies analyzing the organizational antecedents of innovation, which suggest that various internal organizational structures such as interdepartmental connectedness and centralization are critical to facilitate the appearance of exploitative and explorative

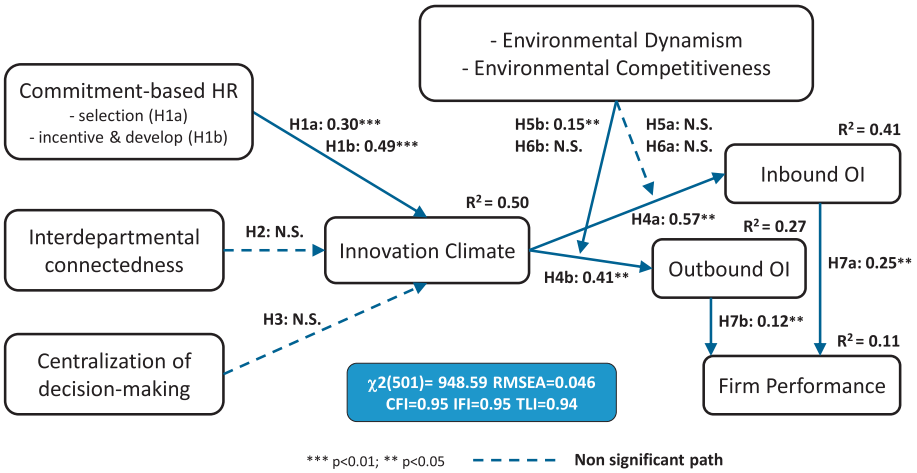

Fig. 2. Results.

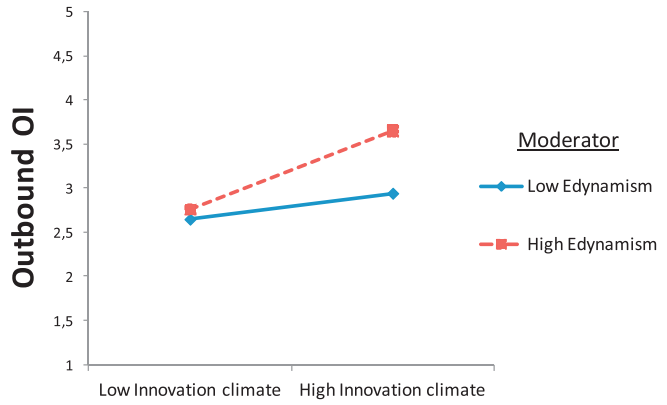

Fig. 3. Two-way interaction effect of environmental dynamism and innovation climate on outbound OI.

innovations at the firm level (Atuahene-Gima, 2003, 2005; Jansen et al., 2006). This may be explained because previous works have focused on large firms (Jansen et al., 2006) and, within that specific context, coordination mechanisms are more formal than it could be in the case of SMEs. This argument is in line with previous literature, which suggests that SMEs are less bureaucratic and more internally adaptive than larger firms (Chang et al., 2011; Moilanen et al., 2014), while the latter have internal structures that over time become laden with rules and procedures (Morris et al., 2008).

The results suggest that the innovation climate has a positive effect on both inbound and outbound OI. These findings support previous research which, although not focusing on OI, found that innovation climate enhances the innovativeness of SMEs (Kmieciak et al., 2012). Firms that have a strong internal innovation climate stimulate lateral thinking and risk taking (Oke et al., 2013), encouraging firms to take advantage of outside knowledge (Carayannis et al., 2015; Laursen and Salter, 2006). Thus, our results show that SMEs with a strong innovation climate are more likely to look beyond their boundaries and enrich their own knowledge pool through the use of inbound OI. At the same time, the results provide empirical support for studies suggesting that the innovation climate has a central role in the settlement of management systems for the exploitation of technological knowledge through the use of patents and intellectual property rights, which defines the firm's extent of commitment with outbound OI (Hsu and Fang, 2009).

Within the environmental context, the moderating effects of environmental dynamism and competitiveness on the effect of innovation climate on OI were analyzed. The results show that environmental dynamism strengthens the positive effect of innovation climate on outbound OI, while it does not moderate the relation between innovation climate and inbound OI. In addition, results regarding the moderating effect of environmental competitiveness suggest that the relation between innovation climate and OI is not contingent on this factor. These findings partially support recent research, which suggest that OI is more suitable in dynamic and highly competitive environments (Huizingh, 2011). In dynamic environments the existing knowledge of firms rapidly becomes obsolete (Jansen et al., 2006; Teece, 2007). At the same time, competitive environments have been associated with high pressures for efficiency and lower prices. In order to remain competitive in dynamic environments, firms try to keep upgraded their knowledge bases and technologies. However, SMEs have comparatively less resources to screen the external environment for valuable information than their larger counterparts (Dahlander and Gann, 2010; Van de Vrande et al., 2009). Therefore, SMEs may only consider environmental dynamism when developing outbound OI, as they can see a direct monetary benefit from commercializing internally developed innovations.

With respect to the consequences of OI, the results suggest that both inbound and outbound OI contribute positively to firm performance. These findings shed light on the mixed results regarding the relation between OI and firm performance. The majority of studies confirm a positive impact of OI on different measures of firm performance (Chiang and Hung, 2010; Chiesa et al., 2009; Reed et al., 2012; Rohrbeck et al., 2009), whereas others found a negative or a curvilinear effect of OI on performance (Laursen and Salter, 2006; Torkkeli et al., 2009). Moreover, recent studies highlight that SMEs have advantages over large firms in the way that they are more likely to benefit from outside knowledge because SMEs are comparatively less bureaucratic, more responsive to market needs and more flexible (Spithoven et al., 2013). Consistent with this argument, SMEs may improve their firm performance through inbound and outbound OI.

This study provides important implications for research and management. Most of previous literature on OI has focused on large firms, whereas it is widely accepted that the empirical finding regarding OI practices and consequences in large firms cannot be generalized to the case of SMEs (Lee et al., 2010; Spithoven et al., 2013). In this sense, this paper contributes to existing research on OI as it is the first study that develops and empirically tests an integrative research model to assess the effect of organizational antecedents and innovation climate on both inbound and outbound OI as well as the moderating role of environmental context and its consequences on firm performance. It was found that HR practices strongly influence innovation climate which, in turn, is crucial for improving OI. More specifically, incentive and development HR practices with commitment orientation were found to be the strongest predictor of innovation climate. In addition, contrary to our expectations, structural factors such as interdepartmental connectedness and centralization of decision making seem to have non-significant effects on innovation climate. Thus, to create a suitable climate for innovation firms should pay more attention to HR practices than to structural factors. At the same time, it was found that innovation climate supports the development of OI and that the positive effect of innovation climate on outbound OI is strengthened by environmental dynamism. Finally, the findings corroborated that OI contributes positively to firm performance. Overall, this study's findings confirm that SMEs management need to be aware of the necessity of creating an innovation climate in order to improve inbound and outbound OI. They need to recognize that there is a growing trend toward opening the innovation strategy and, if the firm does not respond, they will be at a competitive disadvantage.

As any other research, ours suffers from some limitations which can be addressed in future research. First, 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. Second, firm performance measures are subjective in the sense that they were based on 7 point Likert-scale responses provided by managers. Thus, it could also be interesting to include objective indictors for measuring financial performance. In addition, future research could consider other important organizational factors such as organizational strategy and leadership. Third, this research takes a static, cross-sectional picture of factors affecting OI, 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 taken into account in future studies to increase the validity of our findings.

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Appendix 1. Variable definitions

Independent variables
*Commitment-based HR Practices (**CHR**)*
Regarding HR practices in your firm, to what extent do you agree with the following statements? (1–7)
Selection Policies
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.
Incentive and Training and Development Policies
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.
*Inter-departmental connectedness (**IDC**)*
Regarding your firm, to what extent do you agree with the following statements? (1–7)
IDC1. In our company, employees from different departments feel comfortable calling each other when the need arises.
IDC2. In our company, it is easy to talk with virtually anyone you need to, regardless of rank or position.
*Centralization of decision-making (**CD**)*
Regarding your firm, to what extent do you agree with the following statements? (1–7)
CDM1. There can be little action taken until a supervisor approves a decision.
CDM2. People need to ask their supervisor before they do almost anything.
CDM3. Most decisions people make here have to have their supervisor's approval.
*Environmental dynamism (**ED**)*
Regarding your firm, to what extent do you agree with the following statements? (1–7)
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.
*Environmental competitiveness (**EC**)*
Regarding your firm, to what extent do you agree with the following statements? (1–7)
EC1. Our organizational unit has relatively strong competitors.
EC2. Competition in our local market is extremely high.
EC3. Price competition is a hallmark of our local market.
0.5
Dependent variables
*Innovation climate (**IC**)*
Regarding your firm, to what extent do you agree with the following statements? (1–7)
IC1. Our company provides time and resources for employees to generate, share/exchange, and experiment with innovative ideas/solutions.
IC2. Our employees are working in diversely skilled work groups where there is free and open communication among the group members.
IC3. Our employees frequently encounter nonroutine and challenging work that stimulates creativity.
IC4. Our employees are recognized and rewarded for their creativity and innovative ideas.
*Open innovation (**OI**)*
Regarding your firm, to what extent do you agree with the following statements? (1–7)
Inbound practices
OI1. External partners, such as customers, competitors, research institutes, consultants, suppliers, government, or universities, are directly involved in all our innovation projects
OI2. All our innovation projects are highly dependent upon the contribution of external partners, such as customers, competitors, research institutes, consultants, suppliers, government, or universities
OI3. Our firm often buys R&D related products from external partners
OI4. Our firm often buys intellectual property, such as patents, copyrights, or trademarks, belonging from external partners to be used in our innovation projects
Outbound practices
OI5. Our firm often sells licenses, such as patents, copyrights, or trademarks, to other firms to better benefit from our innovation efforts
OI6. Our firm often offers royalty agreements to other firms to better benefit from our innovation efforts
OI7. Our firm strengthens every possible use of our own intellectual properties to better benefit our firm
OI8. Our firm founds spin-offs to better benefit from our innovation efforts
*Firm performance (**FP**)*
Relative to your main competitors, what is your firm's performance in the last three years in the following areas? Likert 1- much worse than my competitors - 7- much better than my competitors
FP1. Organizational performance measured by return on assets (ROA).
FP2. Organizational performance measured by return on equity (ROE).
FP3. Organizational performance measured by return on sales (ROS).
FP4. Organization's market share in its main products and markets.
FP5. Growth of sales in its main products and markets.

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