



R&D internationalization in medium-sized firms: The moderating role of knowledge management in enhancing innovation performances

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ABSTRACT

The aim of this paper is to analyze the relationship between SMEs' R&D internationalization and their innovation outcomes. Most studies on the topic focused on large multinational companies (MNCs), leaving several gaps in the literature with regard to SMEs. Using data from 106 Italian SMEs we performed an OLS regression analysis to test and find evidence of a positive linear relationship between SME's R&D internationalization and innovation performance. In addition, we found that this relationship is positively moderated by knowledge management (KM) orientation. Main contributions are directed to the empirical test of the aforementioned relationships in a specific under developed research area, i.e. non-high tech SMEs, thus highlighting the positive effect of foreign acquisition of diverse cross-cultural knowledge on innovation. Moreover, KM orientation has been found to amplify this effect in the context of SMEs, due to a better management and integration of key internal and external knowledge.

1. Introduction

In recent times, the rapid evolution of the world's markets and the dynamic nature of global industries influenced both the structure and strategies of many organizations. As a result, companies invested in a range of innovations in several countries to reinforce their R&D departments (Gassmann & Von Zedtwitz, 1999; Bresciani, Ferraris, & Del Giudice, 2016) in order to remain competitive in the market and leverage their technical abilities (Oxley & Sampson, 2004; Bresciani & Ferraris, 2014).

Since the 1970s, the phenomenon of investing in R&D out of firm's home countries became more evident in many multinational companies that started to source technical solutions and new knowledge from different parts of the world (Cantwell, 1995; Gassman and von Zedtwitz, 1999; Patel & Pavitt, 1991). As a consequence, the management of international R&D activities increased in complexity giving life to a flourished stream of research and experts deeply investigated the relationship between the level of firms' R&D internationalization and their innovation performance as well as may different moderator and

mediator factors (Phene & Almeida, 2008; Iwasa & Odagiri, 2004; Penner-Hahn & Shaver, 2005; Chen, Huang, & Lin, 2012; Hurtado Torres et al., 2018), with a major focus on multinational companies.

More recently, the internationalization of innovation forced companies to build always more cross-border R&D collaborations that involve more and more smaller organizations (Narula, 2004), providing them great opportunities and notable challenges related to the management of cross-cultural innovation and teams (Kafourous, Buckley, Sharp, & Wang, 2008; Bouncken et al., 2008; Narula and Martínez-Noya, 2015; Ahammad, Tarba, Liu, & Glaister, 2016). So, with a certain delay compared to MNEs, SMEs started to invest in different forms of innovation performing a portion of their R&D activities abroad, thanks to the new ways in which the wider economy enabled cross-border innovations and R&D activities (OECD, 2017b).

In the current context, SMEs play an important role in every economy (McCann & Ortega-Argilés, 2016; Hossain & Kauranen, 2016; OECD, 2014; Ling, Simsek, Lubatkin, & Veiga, 2008) and cross-cultural knowledge and innovation represent a key determinant for SMEs to remain competitive in the international market scenario (Felicio et al.,

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2016; OECD, 2017a; Scuotto, Santoro, Bresciani, & Del Giudice, 2017; Santoro, Mazzoleni, Quaglia, & Solima, 2019) but R&D internationalization stream of literature usually neglected these companies. Thus, one of the main motivations of this paper is related to the fact that in the majority of the studies on R&D internationalization, the primary focus was on large corporations and little attention has been given at the impact of R&D internationalization on SMEs' innovation performances and related potential moderator factors (Genc, Dayan, & Genc, 2019; Booltink & Saka-Helmhout, 2018; Palmiè et al., 2016; Love & Roper, 2015).

Within this stream of research, one of the main common highlighted point is the crucial factor of managing knowledge across different cultural and geographical borders (Ambos & Schlegelmilch, 2004; Asakawa, 1996; Teigland, Fey, & Birkinshaw, 2000; Kuemmerle, 1999; Hoegl & Proserpio, 2004; Gassmann & Von Zedtwitz, 2003; Montoya-Weiss, Massey, & Song, 2001; Schmidt, Montoya-Weiss, & Massey, 2001). In reinforcing this concept, there have been increasingly and emerging evidences from related streams of research, i.e. open innovation and knowledge management (KM), that underlined the management of cross-cultural knowledge as a key factor to help companies that operate in different countries to succeed in their innovation strategies (e.g. Ferraris et al., 2017a; Ferraris et al., 2017b; Santoro, Ferraris, Giacosa, & Giovoando, 2018).

Thus, this paper aims to fill this research gap, examining the relationship between R&D internationalization and innovation performance in medium-sized Italian firms. At the same time, it investigates the moderator effect of knowledge management orientation, which is a key firm capability that may help SMEs in the management of heterogeneous and difficult to codify and understand cross-cultural innovation, improving R&D internationalization's positive effect on SMEs' innovation performances. Among the different reasons of SMEs' internationalization of R&D - e.g. market, production, technology, innovation, cost or policy driven motives - (Gammeltoft, 2006), we focused on the opportunity to leverage the foreign knowledge and cross-cultural innovation with the aim to improve SMEs' innovation performance outcomes (OECD, 2017b), e.g. product, services and process innovation (Aloini, Pellegrini, Lazzarotti, & Manzini, 2015).

Through the use of a questionnaire, we gathered information from CEOs of non-high tech medium-sized internationalized companies headquartered in Italy to test and analyze their approaches to R&D internationalization and knowledge management and their impact on innovation.

The study is of relevance because SMEs are fundamental for the Italian (and European) economy accounting for the 99.9% of its companies (OECD, 2014), with a value added created of 67.1% (EU average 56.8%) and an employment rate generated of 78.5% (EU average 66.4%) (SBA, 2018). For this reason, Italy represents one of the most suitable country for the analysis and many previous studies on SMEs and internationalization and/or innovation focused on Italy as context of analysis (e.g. Majocchi & Zucchella, 2003; Kalinic et al., 2012; D'Angelo et al., 2013; Bigliardi & Galati, 2016; Di Cintio, Ghosh, & Grassi, 2017; Usai, Scuotto, Murray, Fiano, & Dezi, 2018).

This study provides two major contributions. First, it is one of the first studies to analyze the relationship between R&D internationalization and innovation performance, specifically in this under-investigated non-high-tech domain (Booltink & Saka-Helmhout, 2018). One recent exception is the research of Booltink and Saka-Helmhout (2018), which analyzed the role of R&D activities and internationalization on performance of non-high-tech SMEs but without analyzing the specific relationship between R&D internationalization and innovation performances. Despite this, very few studies take into consideration non-high-tech SMEs in their analysis (Booltink & Saka-Helmhout, 2018; Nunes, Serrasqueiro, & Leitão, 2012). Our research addresses this deficit.

Second, this study highlighted the relevance of KM in the aforementioned context and within the specific relationship investigated

(Hoegl & Proserpio, 2004). Also in the context of SMEs, the role of KM and firm internal processes (that have been developed in order to create, store, transfer and apply key knowledge in R&D internationalization) should be taken into account to improve the effectiveness of successful cross-cultural innovation implementation (Darroch, 2005). KM orientation thus becomes a key corporate capability that amplify (positively moderates) the effect of international R&D on SME's innovation.

The paper is organized as follows: the first section provides a discussion of the literature to derive a hypothesis about the link between R&D internationalization and innovation performance, and the moderator effect of knowledge management. Then, a description of the methodology is presented, together with a description of the data. After that, empirical findings are presented and discussed. Conclusions and research contributions are finally outlined, together with the limitations of the study.

2. Literature review and formulation of hypotheses

2.1. R&D internationalization and innovation performance

Since the 1970s, more companies started to develop their R&D activities abroad thanks to advancing internationalization and globalization (Cantwell, 1995). To increase their level of technical knowledge, the majority of large companies focus on developing their products (Penner-Hahn & Shaver, 2005) to create a competitive advantage (Filatotchev & Piesse, 2009; Gassman and von Zedtwitz, 2003) by placing their R&D teams in other countries (Dunning & Lundan, 2009; Yamin & Andersson, 2011). The level of dispersion of R&D activities and the degree of collaboration between units was investigated by Gassmann and Von Zedtwitz (1999). This identified some differences in organizational structure and behavioral orientations. The major trend was the presence of large corporations in a few, but important, geographical leading areas to drive their international R&D efforts.

When implementing R&D activities abroad, companies and managers faced many challenges (Anderson & West, 1998; Bain, Mann, & Pirola-Merlo, 2001; Ambos & Schlegelmilch, 2004; Asakawa, 1996; Teigland et al., 2000) but they also boosted their innovative performances when the R&D internationalization process was well managed (Penner-Hahn & Shaver, 2005; Iwasa & Odagiri, 2004; Phene & Almeida, 2008).

Here, several factors have been taken into consideration by researchers, including the research abilities of companies (Penner-Hahn and Shaver, 2005), the different sources of knowledge available to companies (Phene & Almeida, 2008), R&D localization choices (Bresciani & Ferraris, 2014), the level of intensity and diversity managed by companies (Hsu, Lien, & Chen, 2015), the level of R&D diversification (Hurtado Torres et al., 2018), and the impact of geographic dispersion (Singh, 2008). Also, the link between R&D internationalization and related challenges as well as its impact on corporate performance was investigated, including the role of cross-country leaders (Zheng, Khoury, & Grobmeier, 2010; Eisenbeiß & Boerner, 2010; Bass, 1999; Keller, 2006; Podsakoff, MacKenzie, & Bommer, 1996; Mann & Atkins, 2005), the importance of the team dynamic (Anderson & West, 1998; Bain et al., 2001) and the influence of team-based organization (Cooper & Kleinschmidt, 1995).

Mainstream research revealed that the results were not universal due to the different perspectives that the studies took into consideration when the relationship between the level of R&D internationalization and innovation performance was taken into account (Phene & Almeida, 2008; Penner-Hahn and Shaver, 2008; Singh, 2008; Chen et al., 2012; Hurtado Torres et al., 2018).

Summarizing main ideas, for some researchers, companies with a high level of R&D internationalization achieved better innovation performances (Iwasa & Odagiri, 2004; Kafourous et al., 2008; Rahko, 2015) and patent output (Penner-Hahn and Shaver, 2005), while for others there is a U shaped relationship between R&D internationalization and

innovation performance (Hsu et al., 2015; Hurtado Torres et al., 2018) or a S-shaped relationship (Chen et al., 2012). These results show that there is not unanimous consensus on R&D internationalization on innovation performances. However, since the 1970s the majority of these studies were focused on large corporations without considering and testing R&D internationalization and related factors on the innovation performance of SMEs, that started to attract the interest of researchers only more recently (Genc et al., 2019; Ren, Eisingerich, & Tsai, 2015; OECD, 2002).

When it comes to SMEs, there are some studies investigating the impact of internationalization on innovation considering different elements and mediating variables in their analysis (e.g. Soto-Acosta, Popa, & Martinez-Conesa, 2018; Booltink & Saka-Helmhout, 2018; Genc et al., 2019). Among these studies, Soto-Acosta et al. (2018) analyzed a group of Spanish SMEs considering the ambidexterity and results underlined that innovation ambidexterity has a positive influence on SME's performances. Genc et al. (2019) studied the impact of the degree of internationalization (DoI) on innovation performance finding a positive influence of internationalization on innovation performance with a mediation of the market and the entrepreneurial orientation. Finally, Booltink and Saka-Helmhout (2018) discovered that investments in R&D are fundamental for non-high-tech companies and that an increased level of internationalization helped these companies exploit their internal R&D investments in a more effective way, increasing the company's performance to a critical threshold. When the companies under investigation were further analyzed, it was found that R&D internationalization activities have an impact on the innovation performance of these companies. In some of cases, those impacts were positive while in other cases they were linked to some other variables (i. e. international experience, level of internationalizations, etc.). However, only few studies explicitly link SMEs R&D internationalization with their innovation performances.

Focusing on the specific effects of R&D internationalization, SMEs have the opportunity to enhance their level of knowledge and competitiveness (Naldi & Davidsson, 2014) by locating their international R&D activities near to customers and foreign players, or in a center of excellence, taking advantage of the cross-cultural knowledge and improving their level of innovation (Kafourous et al., 2008). SMEs that decide to internationalize their R&D activities can obtain access to a different source of knowledge that is not available in the country of origin raising the possibility to innovate (Love & Ganotakis, 2013). Compared to MNEs, SMEs did not expand their R&D activities so rapidly because of a lack of human, financial and managerial resources, making their international expansion slower (Lee, Kelley, Lee, & Lee, 2012). On one hand, this limitation can stop SMEs from gaining knowledge from different countries but, on the other hand, this can also reduce the cost implications and other challenges often associated with internationalization (e.g. manage multiple heterogeneous cultural contexts), which may negatively affect the innovation performance related to R&D internationalization. This may be reflected in a continuously positive linear relationship between the two main variables, without incurring curvilinear relationships. Based on the aforementioned discussion, the study proposes the following hypothesis:

H1: There is a positive linear relationship between the level of R&D internationalization of medium-sized companies and their innovation performance.

2.2. R&D internationalization and knowledge management

SMEs are important for the economic development of many countries (OECD, 2002; Ling et al., 2008; OECD, 2014) and recently have started to compete on a global stage, changing their knowledge strategies and developing new knowledge management practices (Teece, 2007; Desouza & Awazu, 2006; Della Peruta, Campanella, & Del Giudice, 2014). Knowledge management (KM) has the objective to use the all organization's knowledge base together with "individual skills, competencies,

thoughts, innovation, and ideas to create a more efficient and effective organization" (Dalkir, 2013). In the last decades, KM became a popular discipline (Darroch, 2005) due to the importance that it plays in the international business landscape (Shams et al., 2019) and its ability in influencing companies' propensity to innovate through the knowledge coming mostly from host country firms (Phene & Almeida, 2008). However, knowledge needs to be internally and externally managed with respect to a company's country of origin, including its overseas R&D collaborations (Desouza & Awazu, 2006; Ferraris, 2014; Santoro, Vrontis, & Pastore, 2017).

A primary goal of R&D internationalization is the ability to develop new or improved versions of products, services and processes (Awate, Larsen, & Mudambi, 2012). When R&D and cross-cultural knowledge is used to create new scientific knowledge (Holden, 2002; Mansfield, 1984), companies develop competencies and enhance their corporate performance to overcome new competitors in the market. Thus, knowledge is one key intangible asset for companies to realize a competitive advantage (Rexhepi, 2015) but it needs to be controlled to affect innovation performance (Alegre, Sengupta, & Lapiedra, 2013; Ferraris et al., 2017a) or results did not necessarily improve the quality of a company's innovation (Singh, 2008).

A higher level of R&D internationalization implies that organizations have access to more knowledge and information from different geographical and cultural contexts (Cohen & Levinthal, 1990; Bresciani et al., 2016). In fact, going international with R&D activities implies to obtain new information, knowledge and opportunities from local players and sources in the host countries (Mu, Gnyawali, & Hatfield, 2007; Kafourous et al., 2008; Ferraris, Mazzoleni, Devalle, & Couturier, 2018). However, a higher level of R&D internationalization can lead to the creation of a more complex environment, with higher costs that need to be managed (Ambos & Schlegelmilch, 2004; Asakawa, 1996; Teigland et al., 2000; Kuemmerle, 1999; Gassmann & Von Zedtwitz, 1999; Argyres and Silverman, 2004; Sanna-Radaccio and Veugelers, 2007). Some of the issues that companies have to manage, together with the knowledge creation process, are linked with people management. Namely, the ability to coordinate people involved in these R&D activities and related knowledge flows in an effective way (Gassmann & Von Zedtwitz, 1999) and the ability to choose the right KM tools and mechanisms that can positively influence the process and provide beneficial results for the company (Zheng et al., 2010; Donate and Sanchez de Pablo, 2015).

There are some important contributions in the literature that shed lights on the relationship between R&D teams, geographic dispersion, leadership style and their impact on knowledge (Eisenbeiß & Boerner, 2010; O'Leary and Cummings, 2007). For example, the proximity of team members can facilitate internal communication, which helps coordinate the team, but situations can be different according to the nature of products that have to be developed (Hoegl & Proserpio, 2004). O'Leary and Cummings (2007) analyzed the geographic dispersion of teams considering three distinct elements that can influence the process of knowledge sharing and coordination: spatial distance, temporal distance and number of sites. The first element can affect face-to face communication, the second can affect the ability to expedite speedy problem solving and the last element can impact team coordination.

In this context, SMEs have different success factors to consider when they managed knowledge (Yew Wong & Aspinwall, 2005) in fact they tend to use a different approach in transferring knowledge, that is usually created by the entire organization and not by individuals (Del Giudice & Maggioni, 2014). The collectively approach can be reinforced by R&D collaboration abroad, developing innovative relationships as entrepreneurs used to do in their companies (Usai et al., 2018). However, SMEs seem to be less prepared in managing knowledge construction and less incline to social interaction (McAdam & Reid, 2001).

SMEs encounter the same coordination problems faced by multinational corporations, but with more limited resources (Lu & Beamish, 2001; Kumar, 2009; Lee et al., 2012) and managerial possibilities (Lee

et al., 2012) as well as less formal procedures (Andriopoulos & Lewis, 2009). Thus, a structured knowledge management (KM) process may play a more important role for medium-sized companies looking to internationalize their R&D investments, compared to multinational companies (Ferraris, Bresciani, & Del Giudice, 2016; Ferraris et al., 2017b). This is because KM orientation - that is a concept similar to market orientation but in this case firms collect information not only externally but also internally (Darroch, 2005) - has become a key factor within a company to allow continuity and constant creation of value (Del Giudice & Maggioni, 2014; Del Giudice, Della Peruta, & Maggioni, 2015; Martinez-Conesa, Soto-Acosta, & Carayannis, 2017). Darroch (2005) defined KM orientation using three elements that have to be evaluated: knowledge acquisition, knowledge dissemination and responsiveness to knowledge.

Thus, KM may amplify the positive effects of R&D internationalization on innovation performance through a better management of key knowledge processes (acquisition, storage, transfer and application). Based on the aforementioned discussion, the study proposes the following hypothesis:

H2: The relationship between R&D internationalization and innovation performances is positively moderated by the firm's knowledge management (KM) orientation.

3. Research design

The research involves data gathered from CEOs of medium-sized internationalized firms, headquartered in Italy. Italy represents an ideal context for the analysis since it is one of the countries among OECD countries with the highest results considering number of SMEs on the total number of companies (99.9%), the level of employment assured by SMEs (80%) and the value added created (67%) (OECD, 2014).

We decided to focus only on medium-sized companies because small firms in Italy have very few resources to devote to complex, risky and unfamiliar R&D activities abroad. First, a total of 1000 medium sized firms were randomly selected from the Amadeus database, a European database that has been used for many similar studies (e.g. Bresciani & Ferraris, 2016). In line with the recommendations from the European Commission (2009), we selected medium-sized firms that have between 50 and 250 employees. Second, an email was sent to all the firms asking them to participate in the survey, along with further details on the study's purpose and other general information. A total of 266 firms responded positively (a response rate of 26.6%). Third, a structured questionnaire was sent to these firms using established scales and items drawn from the literature (see next section for further details on variables). A final sample of 106 CEOs successfully answered our questions.

We used questionnaires in order to collect fresh and primary data on internationalization and innovation of firms belonging to an original and unique sample of medium sized firms and because questionnaires have already been used by many previous studies on the topic (e.g. Alegre et al., 2013; Bresciani et al., 2016; Ferraris et al., 2018; Tang, Tang, & Su, 2018). With this regard, there are other studies that suggest to use other data but these are measure more helpful and convenient for big multinational firms (e.g. Filatotchev & Piesse, 2009; Chen et al., 2012; Hsu et al., 2015).

Regarding the construction of the questionnaire, we asked questions related to our dependent variable after the questions about the independent variables in order to reduce the effects of consistency artefacts (Salancik & Pfeffer, 1977) and prevent respondents from understanding the relationship underlining our analysis, and reducing the likelihood of a social desirability bias.

On average, firms in our sample have 202 employees, operate in 12 foreign different countries and have a turnover of € 35 million. The main foreign export countries include the USA, Russia, China and other EU markets. The Italian firms in our sample operate in several sectors such as the Food and Beverage, Handcraft, Engineering, Furniture and Construction industries.

Some other descriptive statistics and correlations among the variables are presented in Table 1.

3.1. Main variables

We used the study of Aloini et al. (2015) to address *innovative performance*, using four key questions to capture the relevant information on our dependent variable. The respondents were asked to evaluate the improvements of the firm in the last 5 years with regard to: (a) new products or services; (b) new processes; (c) the decrease of risks related to innovations in new products and services; (d) the decrease of costs related to new processes realized. We used a seven-point Likert-type scale from 0 (weak improvements) to 7 (strong improvements). The variable *innovative performance* was constructed using the average values reported for the four indicators (Cronbach's alpha is 0.88).

In order to measure the *R&D internationalization intensity* of the firms in our sample, we asked the respondents to report the intensity of foreign R&D investments on the total R&D investments carried out by the firm in a given year (as suggested by Tang et al., 2018). Prior studies on the topic used the number of R&D subsidiaries (or subsidiaries that have a R&D unit) in their company, including the total number of foreign subsidiaries (e.g., Lu & Beamish, 2004; Hsu et al., 2015; Ferraris et al., 2016) but it is a measure that is more suitable for big multinational firms.

Then, we used a similar variable to the one used by Darroch (2005) for *KM orientation*, focusing on three key components of KM, these are: knowledge acquisition, knowledge dissemination and responsiveness to knowledge. Six factors have been used to evaluate the knowledge acquisition construct: (a) employees' attitudes and values; (b) the development of financial reporting systems; (c) being sensitive to information about marketplace changes; (d) the technology and science human capital profile; (e) collaboration with international partners; (e) being sensitive to market surveys. Knowledge dissemination is captured by five factors: (a) information about market is freely disseminated; (b) knowledge sharing practices are adopted on-the-job; (c) formalized techniques to spread knowledge are adopted; (d) usage of technology tools (such as videoconferencing and teleconferencing) to improve communication flows; and (e) dissemination of knowledge using written communication. Lastly, five factors were used to assess the responsiveness to knowledge, with regard to the ability of firms when responding to: (a) customers' relevant knowledge; (b) knowledge about competitors; (c) new technologies; and the ability of firms to: (d) effectively design and exploit the marketing function; (e) develop flexibility and opportunistic behavior by quickly changing and adapting products, processes and strategies.

We used five-point Likert-type scales ranging from 1 (very low), to 5 (very high). Our variable has been built by using the average value (Cronbach's alpha is 0.84).

3.2. Control variables

R&D intensity has been collected as the ratio of R&D expenditure on the firm's total sales revenue (Hitt, Hoskisson, & Kim, 1997). This control variable has been included because R&D intensity means the investment on innovation and knowledge gained by the firm should play a crucial role in the relationship between R&D internationalization and innovation performances, influencing the overall knowledge of the firm (Cohen & Levinthal, 1990).

Following previous studies (e.g., Filatotchev & Piesse, 2009), we measure *internationalization experience* by dividing the firm's export sales by the total sales revenue in a given year. In fact, having more international experience in sales activities may affect the R&D internationalization process due to increased exposure to international markets (Ren et al., 2015).

In line with prior studies, we include the number of different foreign countries in which the company invest in innovation activities (e.g.

Table 1
Descriptive statistics and correlations.

Variables	Mean	S.D.	1	2	3	4	5	6
1. R&D internat_intensity	0.23	0.171						
2. KM orientation	2.15	0.787	0.163					
3. R&D intensity	0.18	0.129	0.389**	0.394**				
4. Internationalization experience	0.21	0.191	0.542**	0.331*	0.281*			
5. Age	18	5.329	0.273*	0.369**	0.166**	0.528**		
6. Size	5.2	2.108	0.457*	0.216*	0.214*	0.429**	0.313*	
7. Innovation performance	4.23	0.876	0.153**	0.369**	0.289**	0.471**	0.421*	0.238*

Kotabe, Dunlap-Hinkler, Parente, & Mishra, 2007) to control for the geographic diversification of R&D internationalization. We also decided to include two well-known quantities: the age and size of the company. This is because mainstream innovation and international business research emphasizes their importance to control the potential effects influencing the relationship we tested in this research. Regarding a company's age, we measured it as the number of the years since the firm's establishment (Ferraris et al., 2018). Regarding company size, we used the natural logarithm of the firm's total number of employees (Huerger & Jaumandreu, 2004).

Lastly, we included a dummy variable (1 = family, 0 = non-family) regarding the ownership control of the firm so that the impact of internationalization on innovation may be positively moderated by founding family ownership, which may mitigate problems associated with innovation activities, outweighing potential agency costs (Sola, Quaglia, Couturier, & Pinto, 2012).

4. Results

We used ordinary least squares (OLS) regression analysis to test our hypotheses and we present the results in Table 2. We used this quantitative method because it is in line with the research purposes and is widespread in the literature on both innovation and international business studies (Parida, Westerberg, & Frishammar, 2012; Bresciani & Ferraris, 2016).

We found several studies in our literature review that argued for a curvilinear effect between R&D internationalization and innovation performance. We also tested for the quadratic term but we did not find significant results, confirming our main hypothesis related to the nature and characteristics of SMEs.

Thus, in Model 1 only the control variables have been included, showing their effects on firms' innovation performance. Model 2, instead, shows the effect of the two independent variables

Table 2
Results of the regression analysis.

Variable	Firm innovation performance		
	Model 1	Model 2	Model 3
R&D internat_intensity	–	0.06**	0.17*
KM orientation	–	0.11*	0.12*
Interaction term (R&D internat_intensity × KM orientation)	–	–	0.33**
R&D intensity	0.04*	0.05*	0.03*
Internationalization experience	0.06*	0.03*	0.02*
Age	–0.03	–0.04	–0.03
Size	0.03	0.05	0.02
Industry (1 = retail and service, 0 = manufacturing)	0.05	0.04	0.05
Ownership (1 = family, 0 = non family)	0.11*	0.12*	0.07*
R ²	0.12	0.24	0.54
Adjusted R ²	0.10	0.21	0.50
F-value	2.11*	4.26***	6.79**

* P < .05.

** P < .01.

*** P < .001.

independently (R&D internationalization intensity and knowledge management orientation). Lastly, Model 3 included the interaction term with the aim of testing the conjoint effect between the two independent variables. In Table 2, R² and adjusted R² and F-values of all the models have been presented.

The results of the empirical analysis indicate that R&D international intensity positively affects the firm's innovation performance, confirming our first hypothesis (see Model 2). This means that firms that invest more in foreign R&D have higher innovation performances due to the exposure to heterogeneous non overlapping knowledge coming from different innovation ecosystems. At the same time, in Model 2, we found a positive effect of KM orientation on innovation performance, but the most important results emerge in Model 3, where KM orientation has found to significantly moderate the aforementioned relationship. Thus, Hypothesis 2 is confirmed (t-value 0.33, significant at five per cent level) with the model that shows higher explanatory power. This showed how firms that invest contemporaneously in foreign R&D and in internal KM skills and competencies may achieve a higher innovation performance due to the amplificatory effect of KM orientation of the firm that make more effective foreign R&D.

Regarding the control variables, internal R&D significantly affects innovation performances in each model because a higher level of absorptive capacity allows the firms to be more innovative and the firm's international experiences make them more adept with international issues and challenges. Moreover, ownership dummy variable shows positive and significant results, opening up potential and interesting avenues for future research. This means that the family control over the company affect internationalization decisions and performances. None of the other control variables showed significant results.

5. Discussion and conclusions

The phenomenon of internationalization played a fundamental role in the companies' development influencing their ability to gather new competitive advantages (Oxley & Sampson, 2004; Bresciani & Ferraris, 2014), to collaborate across borders in search of new technologies and knowledge (Narula and Martínez-Noya, 2015; Bresciani, 2017) and to manage the organization in an ever changing environment (Bertoldi, Giachino, Rossotto, & Bitbol-Saba, 2018). In this scenario, the role of R&D and innovation as well as their internal and external dynamics changed (Lefebvre, De Steur, & Gellynck, 2015). Research on the influence of R&D internationalization has mainly focused on large corporations (Phene & Almeida, 2008; Chen et al., 2012; Hurtado and Torres, 2018), while few studies investigated how those internationalized teams can influence the innovation performance of medium-sized and, more specifically, non-high-tech companies (e.g. Booltink & Saka-Helmhout, 2018; Nunes et al., 2012).

This paper aimed to fill this research gap, testing the effect of R&D internationalization on innovation performance (i.e. new products, services and processes) for medium-sized companies, as well as the moderator effect of KM orientation, which is fundamental for a structured managerial approach to cross-cultural knowledge and innovation. In fact, there are different motives to internationalize R&D (market, production, technology, innovation, cost or policy reasons) (Gammeltoft, 2006) but for SMEs the opportunity and possibility to gain

knowledge from foreign partners (cross-cultural innovation) can improve significantly their innovation performance (OECD, 2017b).

By analyzing the results obtained from questionnaires collected from 106 medium-sized companies, we found a positive effect of foreign R&D international intensity on SMEs innovation performance. Moreover, we found that KM orientation show a positive effect on innovation outcomes and that also positively moderate the relationship between R&D internationalization and innovation performance. Those results underline the importance of investing in foreign R&D for non-high-tech medium-sized companies as well as on internal knowledge management mechanisms, tools, processes and culture (Bootink & Saka-Helmhout, 2018; Ferreira, Mueller, & Papa, 2018).

From a theory point of view, the contribution of our study is to fill in a gap present in this stream of research, namely the influence of R&D internationalization on innovation performance of medium-sized companies. Previous research mainly focused on large companies (Phene & Almeida, 2008; Iwasa & Odagiri, 2004; Penner-Hahn & Shaver, 2005; Chen et al., 2012; Hurtado Torres et al., 2018) and, when medium-sized companies were taken in to consideration, the analysis almost always focused on the high-tech sector (Palmiè et al., 2016; Narula, 2004; Love & Roper, 2015). Moreover, our research highlighted the importance of KM for medium-sized companies in amplifying the influence of international R&D investments on innovation performance. So, the development of KM orientation of the firm has been found to be crucial for SMEs' innovation in the creation, transfer, sharing and application of cross-cultural knowledge.

Our research provides evidence to managers of medium-sized companies on the importance of investing in foreign R&D in order to maximize their innovation performance. Beyond this, this study suggests managers to carefully develop internal mechanisms related to knowledge management in order to improve the effectiveness of foreign R&D investments. In fact, the management of external and internal knowledge is crucial for innovation, also in the underdeveloped research context of low-tech medium-sized companies. For instance, investment decisions regarding the development of new R&D collaborations abroad should be considered based on the potential incremental gains to innovation performance. Knowledge management and innovation are two fundamental key drivers to create value and keep businesses growing in the real world. SME managers should take into account the risks associated with internationalize their R&D and, in order to gain and benefit from their positive effects, they should develop a strong knowledge management culture for employees as well as to diffuse this culture to external collaborators.

This research has some limitations. As many studies, it only focuses on Italian medium-sized companies and it can be argued that our results might be geographically biased, especially when considering that Italian companies tend to be more internationalized than others and that they are influenced by the specifics and peculiarities of their home country. Thus, future research may test the same relationships of medium sized firm headquartered in different and heterogeneous countries, to control the differences related to cultural, institutional and economic aspects.

Moreover, family ownership of a company might play a significant role, not only whether it is a family business as tested in the present study, but when it comes to the potential involvement of the family in management activities. Different kinds of involvement of the family, or related intangible factors and multiple dimensions connected to the presence of the family, may play a critical role on the performance of the organization, as well as of innovation (Sola et al., 2012) and this can be further tested. Finally, future research could test other moderating factors, such as ICT capabilities and the different entry modes used by medium-sized companies in non-domestic markets related to R&D internationalization. In fact, it has been increasingly observed that ICT capabilities are instrumental in the diffusion of knowledge, especially when it comes to internal social networks that give international teams the same access to the latest innovations within the organization (Ferraris et al., 2018).

The choice of market-entry strategies has also been revealed as an important factor on performance (e.g. Halliburton, Couturier, & Sola, 2010). The role of local factors, such as the level of market consolidation and market growth, also play a key role in the choice of entry mode and future innovation performance. It might, therefore, be worth assessing to what extent entry mode might play a moderating role on the international performance of innovation, also depending on peculiarities of each sector (e.g. Baregheh, Rowley, Sambrook, & Davies, 2012).

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