The current issue and full text archive of this journal is available on Emerald Insight at:
https://www.emerald.com/insight/1460-1060.htm

Industry and country effects on innovation effort

Mariano Nieto
CUNEF, Madrid, Spain and
Universidad de León, León, Spain, and
Daniel Alonso-Martínez and Nuria González-Álvarez
Universidad de León, León, Spain

Received 27 February 2020
Revised 10 September 2020
Accepted 16 November 2020

Abstract

Purpose – The purpose of the paper is to study the determinants of firms' innovation effort using the main approaches in strategic management. The authors specifically analyze the joint effects of industry structure and country characteristics on innovation effort while controlling for firm resources.

Design/methodology/approach – The hypotheses proposed are tested using a data set that includes firms registered in the EU Industrial R&D Investment (IRI) Scoreboard (European Commission, 2011). Specifically, the authors designed and applied a Generalized Method of Moments (GMM) method to perform an empirical analysis using a panel of 1,211 innovative firms in 55 industries and 26 countries between 2004 and 2012.

Findings – Country factors have significant effects on innovation effort. Results also indicate that the moderating and complementary effects of industry and country factors depend on the geographical area.

Practical implications – Although managers have generally tended to take into account only the firm perspective in innovation activities, this paper highlights that institutional factors are also relevant and play a key role in innovation effort. The authors provide suggestions for managers on how to ensure that their investment in innovation is efficient. They also suggest that the effect of some institutional factors may be modified by competitive pressure on firms' innovation effort.

Originality/value – The paper makes an incremental contribution to the literature on the determinants of innovation by providing a different approach to firm innovation determinants and taking into account the complementarities between institutional and industrial factors.

Keywords Innovation effort, Institutional factors, Industrial factors, Innovation strategies, R&D, Panel data

Paper type Research paper

1. Introduction

Research on the determinants of firm innovative behaviour has been conducted from different viewpoints and at different levels of analysis. Until recently, the predominant paradigms in the study of innovation effort have been, as in other fields of strategic management, the resource-based view and the industry-based view (Garrido *et al.*, 2014). The resource-based view holds that firm strategy is determined by firm-specific resources and capabilities (Barney, 1991). From this perspective, the relations between innovation effort and a large number of firm characteristics have been analyzed (Ahuja *et al.*, 2008).

The industry-based view has prioritized the study of the influence of industry structural factors on innovation effort (Cohen, 2010). Beginning with the structure-conduct-performance (SCP) paradigm (Bain, 1959), it has shown that the firm strategy for competing in the market is determined by the industry structure (Porter, 1990).

In recent research, a certain distancing has occurred with respect to views based on the industry and the firm. The influence of location factors on innovative activities has been recognized (Moulaert and Sekia, 2003). Currently, the institutional framework plays a relevant role in the innovative process, as do the stock of knowledge spillovers (Naz *et al.*, 2015) and other factors related to geographic areas, such as countries (Fagerberg *et al.*, 2007),

Funding: This work was supported by the Spanish Ministry of Science and Innovation, under grant PID2019-105140RB-100.

European Journal of Innovation Management
© Emerald Publishing Limited
1460-1060
DOI 10.1108/EJIM-06-2020-0240

regions (Asheim and Gertler, 2005; Barasa *et al.*, 2017), clusters (Delgado *et al.*, 2014), industrial districts (Becattini, 2004) and cities (Florida *et al.*, 2017). In this century of increasing globalization, economic activities related to the production of new knowledge and innovation are paradoxically increasingly influenced by geographic proximity (Acs *et al.*, 2002).

Along these lines, a new paradigm known as the institution-based view of strategy has appeared (Peng *et al.*, 2009). It emphasizes the impact that the geographic area of the firm's location has on firm strategy. This view is based on institutional theories from economic (North, 1990), sociological (Powell and DiMaggio, 1991) and organizational (Scott, 1995) perspectives. It reinforces the idea that innovations are produced in a certain institutional framework and are generated from interactions among local agents, the interchange of knowledge and geographic concentration and proximity (Binz *et al.*, 2014). These approaches are consistent with Marshallian research which stresses that agglomeration economies, specifically knowledge spillovers, are significant in generating innovative activity (Audretsch and Feldman, 2004). This view coincides with the results of influential investigations conducted on national systems of innovation (Lundvall, 1992, 2007) in which national and geographic settings have been shown to have major impacts on how firms allocate resources to innovative activities (Ács *et al.*, 2014).

In short, the institution-based view reinforces the idea that the institutions that characterize a certain geographic area play a role that is "*fundamental, not incidental, to the innovation process*" and that one "*simply cannot understand innovation properly if one does not appreciate the central role of spatial proximity and concentration in this process*" (Asheim and Gertler 2005, p. 292). This view provides an ideal framework for examining the influence of institutions on firm innovation effort (Mueller *et al.*, 2013) and provides an explanation of why companies located in certain countries exert greater innovation effort (Porter and Ketels, 2009). The institution-based view has also grown in response to long-standing criticism of the industry-based and resource-based views' lack of attention to contexts. It also complements these traditional perspectives, improving knowledge on how factors influence innovation effort at three levels of analysis (firm, industry and country) (Peng *et al.*, 2009).

There are very large bodies of research on the determinants of innovation strategies at each of these three levels of analysis: firm, industry and country. Attention has been paid to the latter two levels in particular; however, little is known theoretically or empirically about how they can complement each other to affect the different innovation strategies of firms (Karlsson and Tavassoli, 2016). Different research traditions and the difficulty of carrying out empirical studies using factors that jointly represent the interaction effects on innovation have possibly led scholars to study their effects separately (Nieto and González-Álvarez, 2014). This has resulted in partial views of the determinants of firms' innovation effort (Ahuja *et al.*, 2008). It has been observed that the innovative activity patterns of firms and industries differ systematically and consistently across countries (Malerba and Orsenigo, 1996). For this reason, there is a need to analyze how the relations between firms' innovation effort and variables at the industry level are modified when the interaction of characteristics of the countries in which they are located is taken into account, while controlling for firm resources and capabilities (Cefis and Orsenigo, 2001). Boundary theory (Busse *et al.*, 2016) can help us analyze these interaction effects between industry and country characteristics and their influence on firms' innovation effort. According to Busse et al. (2016, p. 7), the boundary conditions function of a given theory depicts the accuracy of theoretical predictions for any context. Similarly, Edwards and Berry (2010, p. 676) state: "*contingencies built into theories increase precision by specifying when and how the relationships predicted by the theory should vary and whether the theory in toto is applicable in particular circumstances*". Busse *et al.* (2016, p. 9) show that moderating analysis is the most established form of exploring boundary conditions. Based on these arguments, we formulate our main research question: How do institutional industry context interactions influence firm R&D investment?

The main goal of this study is to fill this gap in the literature by examining industry and country effects on firms' innovation effort. We intend to delve into recent research, which in other areas jointly analyzed, for example, the effects of these dimensions on the strategies of multinational corporations (Makino *et al.*, 2004), on diversification strategies (Casson and Singh, 1993) and on firm performance (Bamiatzi *et al.*, 2016).

The present study advances our knowledge of firms' innovation effort in different ways. We analyze the interaction effects of industry factors and country characteristics on innovation effort while controlling for the effects of firm factors on this relationship. Specifically, based on the current relevance of the institutional framework, we analyze how these factors interact with industry factors to enhance or reduce firms' innovation effort. Our findings show that all country factors have an influence on innovation effort, and the effects of variables related to industry become less significant when country factors are included in the model. However, results also show that industry effects become less significant because they moderate the influence of institutional variables. Although country characteristics influence firm's innovation effort, this influence may be attenuated or reduced depending on industry factors. These findings might challenge the view in the literature on innovation which has traditionally highlighted the role of industries as the drivers of change inside firms. Our findings support the thesis of a new paradigm in the innovation literature (Kukk *et al.*, 2016; Kooijman *et al.*, 2017; Ho *et al.*, 2018) and defend the capacity of public agents and institutional frameworks to influence innovative firm structures. But, instead of considering these in isolation, as has been done in the literature to date, we propose an integrative analysis that considers "industry-country" relationships.

The rest of the paper is structured as follows. The next section analyzes the characteristics of each variable in the model and considers how they are related. Section 3 defines the sample and the measures taken to make each of the variables operative, while Section 4 presents the empirical analysis and the results. Finally, Section 5 offers a discussion of the results and concluding remarks.

2. Theoretical background and hypotheses

2.1 Firms' innovation effort

The firm's innovation effort includes a sequence of decisions aimed at the generation of new knowledge and applying it to new products, processes, organizational methods, combinations of inputs and new markets (Antonelli *et al.*, 2013). These decisions are related to the assignment of resources to innovative activities and are, to a great extent, reflected at the level of firms' innovation effort (Li and Atuahene-Gima, 2001). The intensity of the innovation effort that a firm exerts defines its innovation effort and depends on the incentives that it has to innovate (Ahuja *et al.*, 2008). The study of incentives for innovation and the determinants of firms' innovation effort has therefore been a relevant and fruitful field of research in management and economics. Many scholars have contributed to our understanding of the determinants of innovation effort by integrating the incentive-based approach into different research frameworks (Le Bas and Scellato, 2014). As stated in the Introduction, three frameworks are crucial: the resource-based view, the industry-based view and the institution-based view. This research was carried out based on the last two views while controlling for the first, because it has been widely developed in the extant literature. These variables can be grouped under two broad headings: (1) industry structure and (2) country characteristics.

2.2 Industry structure

The industry-based view emphasizes the importance of industry structure in shaping firm behaviour. According to this view, which is reflected in the SCP paradigm, firms are integral parts of an industry, and industries with distinct market structures, market conduct and performance tend to differ significantly (Bain, 1959). The structure of each industry, which is exogenously determined by internal competitive forces, influences the strategic decisions of firms (Bamiatzi *et al.*, 2016). From this perspective, industrial organization scholars have provided extensive empirical evidence on the ways in which certain factors of industry structure, such as industry composition (Gumbau-Albert and Maudos, 2013), competitive pressure (Crowley and Jordan, 2017) and technological opportunity (Geroski, 1990), among others (see (Kamien and Schwartz, 1982; Cohen, 2010) for a review), influence firms' innovation effort. This research has made clear the existence of a relationship between industry structure and firms' innovation effort that can be stated as follows:

H1. The industry's structure influences the incumbent firm's innovation effort.

From the whole factors relating to industry structure, competitive pressure is the most relevant because of the extent of its impact on innovation activities and the interest it has sparked in the literature (Cohen, 2010; Thomas, 2017). On the one hand, Schumpeterian hypotheses indicate that concentrated markets in which there is less competitive pressure provide the best environment to internalize the benefits of innovation effort. It has been argued that in these markets, firms will invest more in R&D because they can achieve superior benefits, have more and cheaper financial resources to spread the risk, take advantage of the effects of economies of scale and scope and have a greater capacity for specialization in people and equipment (Gilbert, 2006). Furthermore, firms with market power have motivations to innovate, and, therefore, to create entry barriers for potential competitors (Beneito *et al.*, 2015). Alternatively, it has been noted that by increasing the number of firms – a typical measure of increased competitive pressure in the industry – innovation effort increases (Arrow, 1972). The relationship between competitive pressure and innovation effort has been estimated thousands of times from samples obtained in practically all industries and countries, yielding barely conclusive results (Crowley and Jordan, 2017). The empirical evidence shows positive (Griffith *et al.*, 2006), negative (Spence, 1984) and *U*-shaped (Aghion *et al.*, 2005) relations. Against the background of these arguments, we posit the following non-directional relationship:

H1a. Competitive pressure influences the incumbent firms' innovation effort.

Firms' innovation effort can be affected by the existence of technological opportunities (Koeller, 2005). The level of technological opportunity in an industry depends on the nature of its technologies, on the extent of its applications, on accumulated scientific knowledge, on its proximity to basic science and on advances in the technologies of other sectors that can be applied in the industry (Klevorick *et al.*, 1995). Technological opportunity reflects the path that the technologies of the industry have followed in the past (Nelson and Winter, 2002) and determines the possibilities for future development (Geroski, 1990). Technological opportunities can influence a firm's innovation effort in a dual sense. On the one hand, the more technological opportunities an industry offers, the greater the innovation effort of the firms operating in it. In fact, in industries with high levels of technological opportunity, firms may access superior technological know-how and improve the capabilities of their R&D personnel (Geroski, 1990), thus increasing the probability of success in innovation, which constitutes a stimulus for greater innovation effort (Klevorick *et al.*, 1995). On the other hand, technological opportunities may induce a substitution effect and discourage the realization of R&D activities by the firm. In industries with high levels of technological opportunity, firms design innovation strategies to use the technological knowledge developed by public research centres, universities or suppliers, which leads them to reduce their R&D expenditures (Becker and Peters, 1998). Thus, considering both arguments, we posit the following non-directional hypothesis:

H1b. Technological opportunities influence incumbent firms' innovation effort.

2.3 Country characteristics

The institutional-based view of strategy emphasizes the influence that the institutional framework of a country exerts on different dimensions of the strategic behaviour of firms located therein (Peng *et al.*, 2009). The institutional framework is a durable system of established and embedded social rules that structure social interactions (Hodgson, 2006) and comprise both formal and informal constraints (North, 1990). Formal constraints include political, judicial and economic arrangements, whereas informal constraints include values and socially sanctioned norms of behaviour, which are embedded in culture and ideology (Scott, 1995). These elements differ in every country and establish the structure of incentives that regulates economic exchange (North, 2005). Specifically, they determine the assignment of resources to innovation activities (Furman *et al.*, 2002). In this view, the relationships between firms' innovation effort and different dimensions of the institutional environment, such as the regulatory framework (Barbosa and Faria, 2011; Donbesuur *et al.*, 2020), political institutions (Vasudeva, 2009) and system of values (Mueller *et al.*, 2013), among others (Tsai *et al.*, 2011), have been studied. The results of this research have clarified that the institutional characteristics of countries not only play a determining role in the design of firms' innovation effort (Mueller *et al.*, 2013) but also modify the relationships among the firm's resources and capabilities, industry structure and innovation effort (Narayanan and Fahey, 2005). In addition, innovation scholars have documented the influence of innovation effort on other country-specific factors, such as localized knowledge spillovers (Feldman, 1999). The empirical evidence suggests that location clearly matters in exploiting knowledge spillovers (Audretsch and Feldman, 1996) and that these stimulate innovation in firms that are located in the nearest geographic environment, for example, in that country. Oliveira and Natário (2016) show that innovation is positively associated with a diverse set of institutional factors that shape a territorially embedded innovation system, in which firms' innovation activity is chiefly based on localized learning processes. Recently, Rodríguez-Pose and Zhang (2020) showed that poor institutional quality is an important barrier for firm-level innovation. In short, the innovation effort exerted by the firms located in a certain country is determined by the characteristics of its institutional environment and by the knowledge spillovers to which they have access. Also, firms that grow up in pro-innovation institutional environments acquire specific habits and develop innovative behaviours that are maintained regardless of their growth. Thus, we can posit the following hypothesis:

H2. Country characteristics influence firms' innovation effort.

The institutional framework of a country includes a set of formal and informal restrictions that condition the decisions that firms may take. That is, using North's well-known metaphor (1990, p. 3), the institutional framework establishes the social and economic "rules of the game" in each country. These rules are specified in laws, regulations, customs, behavioural patterns, cultural values and so forth (Peng *et al.*, 2009). Institutional theory explains how the formal and informal elements of the institutional environment establish the incentive structure that determines firms' innovation effort and legitimizes their actions (DiMaggio and Powell, 1991; North, 2005). The institutional characteristics of countries condition firms' innovation effort and determine innovation effort in various ways. It has been verified that quality institutional environments provide economic interchanges and reduce the uncertainty associated with innovative activities that encourage firms' innovation effort (Karniouchina *et al.*, 2013). Furthermore, innovation effort is higher in countries that have efficient institutions that supply financing for R&D activities (Rajan and Zingales, 2003) and protect the property rights of innovative firms, guaranteeing the recovery of their investments (Isobe *et al.*, 2000). These arguments suggest that the availability and value of innovation resources, as well as the decisions for assigning these resources to innovation projects, are determined by institutions (Peng, 2002). In short, a quality institutional framework with clear and stable rules that promote competition, efficiently regulate markets and protect property rights limits the risk perceived by firms and stimulates innovation effort (North, 2005). On the basis of these arguments, we posit the following hypothesis:

H2a. The quality of a country's institutional framework influences firms' innovation effort.

Current research has highlighted the impact of knowledge spillovers on the innovation activities of firms located in a country (Feldman, 1999). Since Marshall (1961) recognized the existence of a geographic component in the spillover mechanism, several studies have shown the origin (Feldman and Kelley, 2006), territorial scope (Jaffe *et al.*, 1993) and effects of knowledge spillovers on innovation activities (see Döring and Schnellenbach, 2006, for a review). It has been argued that geographic clustering or concentration facilitates searches for information, increases search intensity and, in general, aids in the coordination of tasks (Furman *et al.*, 2002). In addition, knowledge is not easy to contain, and the geographic limits of countries provide a method of defining the spillovers. Hence, the knowledge spillovers that have accumulated in a country can stimulate the innovation effort of its firms, producing higher rates of technological progress and economic growth (Feldman, 1999). Despite the fact that knowledge spillovers have traditionally been thought to decrease firms' incentives to invest in R&D since the returns from innovation cannot be fully appropriated (Bernstein and Nadiri, 1988), most empirical studies have found a positive relationship between knowledge spillovers and innovation effort (Tappeiner *et al.*, 2008). These knowledge spillovers increase a firm's absorptive capacity, that is, its ability to assimilate knowledge from its environment (Cohen and Levinthal, 1990), and consequently induce complementarities in firms' R&D efforts (Aghion and Jaravel, 2015). Knowledge spillovers, combined with the firm's existing knowledge, create opportunities for developing new products (Yli-Renko *et al.*, 2001), thus increasing innovation effort. Spillovers stemming from knowledge generated by public research projects offer new opportunities that stimulate innovation, improve firms' innovation performance (Ahuja *et al.*, 2008) and consolidate a habit of innovation from the start. Based on these arguments, we posit the following hypothesis:

H2b. Knowledge spillovers in a country influence firms' innovation effort.

It has been observed that the innovation activity patterns of firms and industries differ systematically and consistently across countries (Malerba and Orsenigo, 1996). Some authors argue that regardless of the industry in which they operate, firms located in countries with quality institutional environments will exert greater innovation effort (Furman *et al.*, 2002). However, others show that industry-specific characteristics largely explain differences in innovation across countries (Furman *et al.*, 2002). Similarly, Barbosa and Faria (2011) argue that "stricter anti-trust laws could have a negative impact on innovation". Other authors suggested that less competition could possibly boost innovation in laggard industries but would hinder it in leading industries (Aghion *et al.* (2005). Finally, Coad *et al.* (2019) suggest that more research is needed to understand the influence of the sector and of "policy interventions" on firms' innovation effort.

Previous works (Coad *et al.*, 2019, among others) widely recognize that innovation and its processes exhibit important sector specificities, so it is important to analyze how firms' innovation could be supported by policy interventions in a context-specific and effective manner. Also, due to market globalization, other authors have shown that the institutional characteristics of countries can also be affected by the competitive structures of industries (Coad *et al.*, 2019, for a review). Firms located in countries that have accumulated a high volume of knowledge spillovers and have quality institutional frameworks could be more innovative if industry characteristics support this knowledge absorption (Furman *et al.*, 2002). According to this paradigm, industry and institution-based views become complementary since firms with high potential to absorb knowledge from the industry and country will be more innovative. Usually, such firms have larger market shares or at least a good position in the global market. Several authors argue that it is difficult to separate the influence of both concepts (industry and country) on firms' innovation effort as they may be complementary (Peng *et al.*, 2009; Garrido *et al.*, 2014). This cross-context effect has been used previously and suggests the need to analyze the boundary effect using an interaction term (Busse *et al.*, 2016). Furthermore, much of the innovation effort that the firms in an industry exert is motivated by the use of knowledge gained from clients and suppliers (Cappelli *et al.*, 2014), which is transferred better in institutional environments that allow for cooperation and knowledge interchange (Aghion and Jaravel, 2015). These arguments point to the importance of combining country and industry effects to analyze firms' innovation effort (Coad *et al.*, 2019). Based on previous literature that highlights the role of markets in innovation (Barbosa and Faria, 2011; Barasa *et al.*, 2017), we suggest that it is necessary to explore the interaction between competitive pressure and institutional variables on firms' innovation effort.

H2c. The effects of country characteristics on firms' innovation effort are moderated by the competitive pressure of the industry.

3. Data and methods

3.1 Data

The data set is a panel of firms registered in the EU Industrial R&D Investment (IRI) Scoreboard (European Commission, 2011). The IRI Scoreboard provides economic and financial data on the top 2,000 firms in the world ranked by their investments in R&D and by year. The data set covers 96.1% of R&D carried out in 2007 by the top 2,000 corporations in the world that are listed in the EU-JRC-IPTS 2008 industry R&D Scoreboard, which is itself representative of more than 85% of worldwide R&D in the private sector (Business Enterprise R&D). Sample selection bias in investing relative to the population is not likely large (Montresor and Vezzani, 2015). Therefore, these data sources are used in a growing number of research papers (e.g. García-Manjón and Romero-Merino, 2012; Cincera and Veugelers, 2014; Montresor and Vezzani, 2015; Castellani *et al.*, 2017).

In this paper, the IRI Scoreboard was used to estimate industry and firm variables. To measure the location variables, it was necessary to use the following databases: the OECD's Main Science and Technology Indicators [1] and the Global Competitiveness Report [2] compiled by the World Economic Forum.

The resulting panel comprises 3,682 firms and 16,355 observations. Some companies entered and others exited the ranking during the study period (2004–2012). Thus, the panel was unbalanced, that is, a panel in which data are not observed for all categories and years of the study period. To ensure at least four consecutive years of data for every company in our panel, we reduced the final unbalanced panel for the regression analysis (GMM) to 1,211 firms and 7,283 observations [3]. This final sample represented 32.88% of the initial number of companies (3,682) and 44.53% of the initial number of observations, with a margin of error of 2.31% [4]. We must note that unbalanced panels are used frequently in empirical research, allowing us to control for both entry and exit and mitigating potential selection and survivor biases (Carpenter and Petersen, 2002).

3.2 Variables and descriptive statistics

Innovation effort is measured as the ratio of R&D expenditures to the net sales of the firm by year (INNOV); previous studies have also used this measure (McCutchen and Swamidass, 1996; Bolívar-Ramos, 2017). This is a measure of input into the innovation process that is widely used in the literature and is related to innovation indicators through some knowledge production function (Mairesse and Mohnen, 2004). Previous authors have used this measure from the same database because of its relevance to capturing firms' innovation efforts and perseverance in these investments (Cincera and Ravet, 2010; Moncada-Paternò-Castello *et al.*, 2010; García-Manjón and Romero-Merino, 2012; Cincera and Veugelers, 2014; Montresor and Vezzani, 2015). The explanatory variables were classified at two levels, depending on whether the influence they exert on innovation effort stems from industry structure or geographical location. Additionally, we consider the influence of firm-level factors on innovation effort as control variables. Table 1 defines each variable used in the empirical analysis and lists the data sources.

First, variables representing the industry structure were included in the model and were measured as follows. Competitive pressure (CPRESSURE) was calculated as a Herfindahl-Hirschman Index (HHI) for each of the 55 industries present in the sample. The industries were defined using the 2002 two-digit NACE codes [5]. HHIs were based on the annual market shares of firms belonging to each global industry for each of the nine years analyzed. Technological opportunity was estimated indirectly via dummy variables following seminal research in this field (Scherer, 1965). Industries were classified into three levels of technological opportunity: low (LOW-OPPORT), medium (MED_OPPORT) and high (HIGH_ OPPORT). The allocation of categories was based on the technological intensity of each industry (Ortega-Argilés *et al.*, 2011). The assumption behind this procedure is that firms in industries in the same group perform their activities using similar technologies from the perspective of the level of technological development. Such technologies are linked to scientific areas that are closely connected, so they have the same possibilities for technological development, that is, the same conditions for technological opportunity (Nieto and Quevedo, 2005).

Second, the influence exerted by factors relating to geographical location on the firm's innovation effort is reflected in the model using two types of variables. The institutions variable (INSTITUTIONS) is determined by the legal and administrative framework within which individuals, firms and governments interact to generate wealth. This indicator was normalized on a 1-7 scale and was based on seven dimensions (property rights, ethics and corruption, undue influence, government inefficiency, security, corporate ethics and accountability). The calculations were performed using data from the Global Competitiveness Report (World Economic Forum, 2020). Knowledge spillovers (SPILLOVERS) were measured as the ratio of government budget appropriations or outlays for R&D (GBOARD) to gross domestic product (GDP) by country and year. The calculations were performed using data from the Main Science and Technology Indicators (OECD, 2015).

Third, we consider two moderator variables. Specifically, we use the interaction between CPRESSURE and INSTITUTIONS and between CPRESSURE and SPILLOVERS to create these new variables, which aim to capture the complementarities between both external factors of the firm to analyze the implications for R&D investment.

Fourth, we consider control variables representing the firm level since the resources that a firm owns and has full control will impact firm innovation (Demirkan, 2018). Thus, we include in the model the stock of resources accumulated by the firm (SIZE) and the annual flow of investment (CapEx). These variables were measured using the IRI Scoreboard data in the following way: firm size (SIZE) was measured as the logarithm of the number of employees in the firm by year, and capital expenditure (CapEx) was measured as the ratio of capital expenditure to the net sales of the firm by year.

Table 2 includes a cross-table of industries, countries, firms and observations in order to more thoroughly describe the sample analyzed. Table 3 covers the main descriptive statistics for the dependent variable (INNOV) for the various countries and industries included in the final sample.

Dependent variable	Variable	Description	Data source
Innovative effort	INNOV	Ratio between R&D expenditures and net sales (in %) [years 2004–2012]	EU Industrial R&D Investment Scoreboard (IPTS-IRI, 2005–2013)

Industry variables	Variable	Description	Data source
Competitive pressure	CPRESSURE	Hirschman–Herfindahl Index (HHI) [years 2004–2012]	Estimation based on data collected in the EU Industrial R&D Investment Scoreboard (IPTS-IRI, 2005–2013)
Technological opportunity	LOW_OPPORT	Dummy variable identifying low-tech industries (1) and medium-tech and high-tech industries (0) according to the OECD classification [Estimation in 2007]	Ortega-Argiles *et al.* (2011)
	MED_OPPORT	Dummy variable identifying med-tech industries (1) and medium-tech and high-tech industries (0) according to the OECD classification [Estimation in 2007]	
	HIGH_OPPORT	Dummy variable identifying high-tech industries (1) and medium-tech and low-tech industries (0) [Estimation in 2007]	

Country characteristics	Variable	Description	Data source
Institutions	INSTITUT	Concepts related to the protection of property rights efficiency and transparency of public administration, independence of the judiciary, physical security, business ethics and corporate governance. Public and private institutions. [years 2004–2012]	Global Competitiveness Report. World Economic Forum database. (WEF, 2005–2013)
Knowledge spillovers	SPILLOVERS	GBAORD / GDP, % [years 2004–2012]	Estimation based on data collected in the Main Science and Technology Indicators (OECD, 2015)

Firm control variables	Variable	Description	Data source
Firm size	SIZE	Number of employees (in logs) [years 2004–2012]	EU Industrial R&D Investment Scoreboard (IPTS-IRI, 2005–2013)
Capital expenditure	CAPEX	Capital expenditure / net sales, % [years 2004–2012]	EU Industrial R&D Investment Scoreboard (IPTS-IRI, 2005–2013)

Table 1. Variable definitions and data sources

Country	Industries	Firms	Number of observations
Austria	12	14	57
Belgium	13	20	83
Canada	14	16	85
China	5	8	32
Denmark	18	21	86
Finland	24	34	136
France	27	51	218
Germany	21	103	425
Greece	4	1	4
Ireland	7	9	47
Italy	10	17	71
Japan	21	226	1,622
Luxembourg	3	2	9
Norway	6	6	42
Poland	1	1	4
Portugal	3	2	9
Russia	1	1	9
Singapore	1	1	4
Slovenia	1	1	4
Spain	6	8	32
Sweden	18	35	150
Switzerland	3	2	10
The Netherlands	12	22	89
Turkey	2	2	12
UK	23	124	525
USA	25	484	3,518
Total: 26 countries	55	1,211	7,283

Table 2.
Sample description at firm-, industry- and country levels

3.3 Models

To test the hypotheses proposed in the theoretical section, the following dynamic linear model was specified:

$$\text{INNOV}_{it} = \beta_1\text{CPRESSURE}_{it} + \beta_2\text{TECH\_OPPORT}_{it} + \beta_3\text{INSTITUTIONS}_{it} + \beta_4\text{SPILLOVERS}_{it} + \beta_5\text{MODERATORS}_{it} + \beta_6\text{Controlvariables}_{it} + \mu_{it}$$

As explained in the variables section, technological opportunity is a qualitative variable that groups support polices into three possible categories; thus, to operationalize it, three dummy variables are defined. However, in the regression models, it is only possible to add $k-1$ dummies (in our case, 2); otherwise, the parameters cannot be estimated. Therefore, the results are presented by combining the dummies into pairs to understand what their coefficients truly mean. It is sufficient to state the results of the combination of dummy HIGH_OPPORT and LOW-OPPORT or MED_OPPORT because the results of the remaining combinations can be deduced from the previous one.

To test the hypotheses proposed in the theoretical background section, we used the STATA12 program. Additionally, due to concerns of endogeneity between the dependent variable (INNOV) and the independent variables and to take into account the panel structure of the data, GMM and instrumental variables are the most frequently considered approaches to solve this problem when the dependent variable is continuous due to the characteristics of the estimators developed (Arellano and Bond, 1991; Blundell and Bond, 1998).

Country	N	Share (%)	Mean	Std. dev.	Min.	Max.
Austria	57	0.783	20.243	83.236	0.039	524
Belgium	83	1.140	7.156	10.134	0.128	53.694
Canada	85	1.167	7.734	7.092	0.406	30.361
China	32	0.439	2.682	2.498	0.140	9.4
Denmark	86	1.181	16.103	62.078	0.156	500.326
Finland	136	1.867	5.399	6.677	0.003	28.864
France	218	2.993	9.453	18.837	0.061	200.5
Germany	425	5.836	9.343	32.705	0.025	514.889
Greece	4	0.055	2.689	0.889	1.882	3.927
Ireland	47	0.645	7.590	13.494	0.402	54.751
Italy	71	0.975	4.497	4.692	0.053	19.308
Japan	1,622	22.271	4.837	4.672	0.1	47.607
Luxembourg	9	0.124	2.774	5.898	0.515	18.487
The Netherlands	89	1.222	16.628	60.961	0.128	553
Norway	42	0.577	2.065	5.605	0.273	2.065
Poland	4	0.355	0.319	0.036	0.285	0.366
Portugal	9	0.124	1.952	1.627	0.194	3.904
Russia	9	0.124	0.582	0.191	0.273	0.954
Singapore	4	0.055	1.591	0.154	1.482	1.7
Slovenia	4	0.055	7.519	0.275	7.242	7.881
Spain	32	0.439	9.030	19.512	0.128	65.395
Sweden	150	2.060	7.890	10.466	0.310	61.36
Switzerland	10	0.137	4.076	2.313	1.427	8.077
Turkey	12	0.165	0.899	0.755	0.138	2.2
UK	525	7.209	11.890	27.808	0.067	308.25
USA	3,518	48.304	17.257	46.147	0.064	997.333
Worldwide	7,283	100	12.260	36.640	0.025	997.333

Table 3. Descriptive statistics of dependent variable (R&D/net sales) by country

In particular, the GMM estimator uses internal instruments, specifically, instruments that are based on lagged values of the right-hand-side explanatory variables that may present problems of endogeneity (in this study, we instrumented all independent and control variables). To check the validity of the model specification when using GMM, the Hansen statistic of overidentifying restrictions is used to test for the absence of correlations between the instruments and the error term, M2 statistics were used to verify the lack of second-order serial correlation in the first-difference residuals and Wald tests analyzed the joint significance of the reported coefficients. In contrast, the traditional estimator of instrumental variables (although consistent) is inefficient in presence of heteroscedasticity (Baum *et al.*, 2003). Furthermore, there is the problem of identifying the adequate instruments. Thus, the principal limitation of the instrumental variables approach is the choice of external instruments that are not correlated with the error term and that contain sufficient information about the explanatory variables in the model that are not strictly exogenous (Pindado and Requejo, 2015). For this reason, this study uses the GMM approach.

4. Results

Table 4 shows the descriptive statistics, including the mean, standard deviation and minimum and maximum of the variables. These values were within the expected range, so the possibility of our results being due to a mistaken sample selection was ruled out. Additionally, Table 5 lists the correlation coefficients of the variables used in the regression analyzes. Although some of the variables show statistically significant correlations, an analysis of the variance inflation factors (VIFs) revealed no evidence of multicollinearity, as all of the values remained under 10 (Kleinbaum *et al.*, 1988).

	Mean	Std. dev.	Min.	Max.
INNOV	12.260	36.640	0.025	997.333
CPRESSURE	0.060	0.051	0.014	1
HIGH_OPPORT	2.535	2.890	0	9
MED_OPPORT	1.237	2.341	0	9
LOW_OPPORT	0.634	1.800	0	9
INSTITUTIONS	5.015	0.363	2.94	6.18
SPILLOVERS	0.751	0.114	2	1.13
SIZE	8.975	1.656	3.664	13.171
CAPEX	5.502	6.484	0	182.1

Note(s): N = 7,283

Table 4.
Descriptive statistics

Table 6 and Figure 1 show the results of the GMM models estimated for testing the hypotheses regarding relations between the three groups of independent variables and innovation effort.

The GMM1 model covers the influence exerted by control variables at the firm level (SIZE, CapEx) on the dependent variable. According to the specification tests (joint and individual), the model is significant. Our results show that size and capital expenditure exert a significant influence on innovation effort. On the one hand, these results indicate that the relation between firm size and innovation effort is significantly negative ($\beta = -6.69$, $p < 0.01$). Previous studies (Barbosa and Faria, 2011, p. 1158) show that "*small firms tend to outperform large firms when using innovation counts as an indicator for innovation*". In this regard, this study empirically supports previous studies that show that large firms tend to innovate more occasionally, never innovate or generate a large number of innovations only in particular years (Cefis and Orsenigo, 2001). In addition, as has been indicated in previous studies, the entrepreneurial spirit of scientists in large firms and their ability to capture the benefits of their individual efforts in many cases impede greater investment in innovation effort (Ahuja *et al.*, 2013). Additionally, as a control variable, new evidence is provided on the existence of a positive relation between capital expenditure and innovation effort ($\beta = 1.18$, $p < 0.01$). This finding reinforces the results obtained in previous studies that capital expenditure complements investments in R&D (Harmantzis and Tanguturi, 2007; Piergiovanni and Santarelli, 2013).

The GMM2 model covers the influence of the independent variables at the industry level (CPRESSURE, HIGH_OPPORT, MED_OPPORT) and control variables at the firm level (SIZE, CAPEX) on the dependent variable. According to the specification tests, the model is significant. The results confirm the relations proposed in hypothesis 1b, but do not confirm hypothesis 1a. Thus, in relation to industry level variables, only technological opportunity (H1b) exerts a significant and positive effect on firm innovation effort. In particular, technological opportunity seems to have (as expected) a stronger effect on HIGH_OPPORT ($\beta = 0.58$, $p < 0.01$) and MED_OPPORT ($\beta = 0.22$, $p < 0.1$) than on LOW_OPPORT in terms of firm innovation effort. This result is consistent with those obtained in most prior research (Klevorick *et al.*, 1995) and confirms the idea that firms operating in industries with high levels of technological opportunity exert greater innovation effort (Bala Subrahmanya, 2005; Raymond and St-Pierre, 2010). This result, which is not new in the literature on innovation (Gilbert, 2006), reduces the importance that has traditionally been assigned to market power as a determinant of innovation effort under the influence of Schumpeterian hypothesis. Moreover, similarly to GMM1, the firm control variables (SIZE and CAPEX) have an influence on firms' innovation effort.

Table 5. Correlation matrix

		1	2	3	4	5	6	7	8	9
1	INNOV	1								
2	CPRESSURE	−0.015	1							
3	HIGH_TECH	0.145***	0.049***	1						
4	MED_TECH	−0.124***	−0.189***	−0.464***	1					
5	LOW_TECH	−0.095***	0.251***	−0.309***	−0.186***	1				
6	INSTITUTIONS	−0.013	0.025**	−0.195***	−0.016	−0.017	1			
7	SPILLOVERS	0.012	0.003	0.213***	0.094***	0.021*	0.080***	1		
8	SIZE	−0.328***	0.027**	−0.159***	0.143***	0.197***	−0.087***	−0.003	1	
9	CAPEX	0.276***	0.009	−0.052***	−0.056***	0.133***	−0.006	−0.026**	−0.014	1

Note(s): N = 7,283; *** Significant at 0.01; ** significant at 0.05; * significant at 0.1

Table 6. Determinants of innovation strategy

Variables	GMM1	GMM2	GMM3	GMM4	GMM5
SIZE	−6.69*** (2.59)	−9.36*** (3.51)	−3.14* (1.75)	−6.80*** (2.59)	−8.60*** (0.55)
CAPEX	1.18*** (0.46)	0.82*** (0.21)	0.83*** (0.20)	0.82** (0.33)	1.14*** (0.09)
CPRESSURE		−4.54 (4.85)		−5.52 (6.28)	−71.3** (32.52)
HIGH_OPPORT		0.58*** (0.19)		0.33** (0.17)	0.37*** (0.06)
MED_OPPORT		0.22* (0.13)		0.04 (0.23)	0.10 (0.07)
INSTITUTIONS			2.34** (1.13)	2.45** (1.16)	−0.14 (0.47)
SPILLOVERS			3.52*** (1.08)	2.68** (1.16)	2.60 (0.95)
CPRESSURE*INSTITUTIONS					14.21** (5.76)
CPRESSURE*SPILLOVERS					−0.59 (10.79)
Firms	1,211	1,211	1,211	1,211	1,211
No. of observations	7,283	7,283	7,283	7,283	7,283
Wald (df) LL	9.64***	27.03***	26.03***	19.48***	626.78***
Hansen test (instruments)	27.94 (28)	113.63 (145)	53.01 (60)	59.48 (80)	203.76 (203)
AR(1)	−0.18	−0.06	−0.05	−0.05	−0.16
AR(2)	0.44	0.46	0.47	0.46	0.43
Z1	9.64***	27.03***	26.03***	19.48***	626.78***

Note(s): *** Significant at 0.01; ** significant at 0.05; * significant at 0.1; standard errors are shown in brackets. AR(1) and AR(2) are tests of the null hypothesis of, respectively, no first- or second-order serial correlation. Hansen is a test of the validity of the overidentifying restrictions based on the efficient two-step GMM estimator

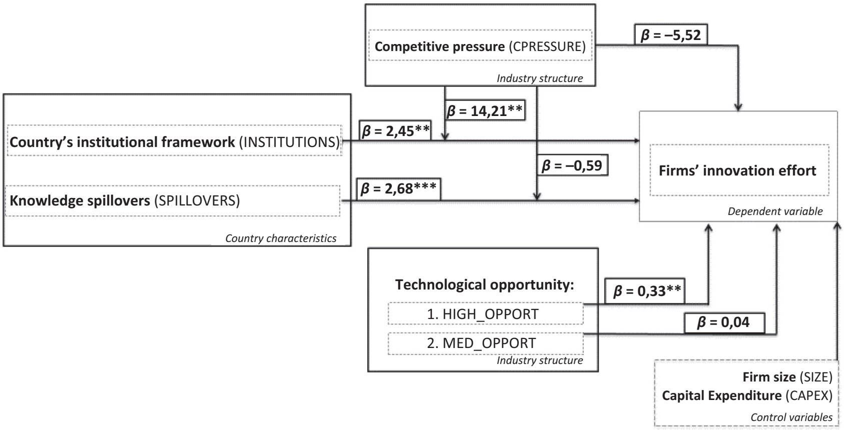

Figure 1.
Main results

In addition, the GMM3 model considers the influence of factors relating to country characteristics (INSTITUTIONS and SPILLOVERS) and control variables on the dependent variable. According to the specification tests (joint and individual), the model is significant. These results allow us to confirm Hypotheses 2a and 2b. Country characteristics seem to have a positive and significant effect on firms' innovation effort, as shown in previous studies (Vasudeva, 2009; Barbosa and Faria, 2011; Mueller *et al.*, 2013). Specifically, our results show that firms located in strong environments that have well-established property rights, are more ethical and less corrupt, have efficient governments, secure environments and a greater proportion of ethical firms (H2a), high levels of public innovation in their countries of origin and high knowledge spillovers (H2b) are more likely to invest in R&D, with values of ($\beta = 2.34$, $p < 0.05$) and ($\beta = 3.52$, $p < 0.01$), respectively.

The GMM4 model empirically analyzes the influence of all the independent and control variables on firms' innovation effort. According to the specification tests (joint and individual), the models are significant. At the same time, this model rechecks previously confirmed hypotheses using the GMM2 and GMM3 models. Specifically, although the coefficients and significance of some variables are low, our results confirm hypotheses H1b, H2a and H2b. In particular, when institutions (H2a) and knowledge spillovers (H2b) are included, the effect of the variables at the industry level [technological opportunity (H1b)] is less significant in the case of high technology and non-significant in the case of medium technology. The fact that some variables lose significance when country and industry variables are present suggests that there are some common effects that might be repeated.

Finally, to consider in depth the real influence of country and industry factors, the GMM5 model analyzes the moderation effects. We can confirm the positive moderation effect exerted by competitive pressure on the relationship between institutions and R&D investment (H3), although it is not possible to confirm it with the spillovers variable. These results show that firms located in less competitive industries or firms with larger market shares in the industry take advantage of institutional factors in their country of origin to a greater degree than firms located in more competitive industries. This boundary analysis enhances the need to consider both factors (industry and institutions) to determine R&D firm investment.

4.1 Robustness check

We designed several robustness checks to verify our main relationships. Firstly, we repeated the estimations considering only the companies for which we have a balanced panel

(334 firms), that is, companies for which we have complete information for the nine years considered (2004–2012). The results are similar, and all hypotheses are confirmed. Secondly, we decided to use other independent variables instead of "institutions". Since "institutions" is an aggregate measure of the quality of the institutions in a country, we decided to disaggregate it into six variables based on the main institutional variables suggested in previous literature (Barbosa and Faria, 2011; Barasa *et al.*, 2017; Alam *et al.*, 2019). Since all six variables are also included in the "institutions" variable, we aimed to check if it was also possible to confirm these main relationships. Table 7 contains two models with the same sample and methodology that was used in Table 6, but with the "institutions" variable disaggregated into six. In the first model, we only analyzed the effect of institutional variables, while in the second one, we also added industry variables. Our results showed that not all the "institutional" variables affect R&D investment, and one of them has a negative influence, while the rest affect it positively. Specifically, the legal framework does not favour R&D firm investment ($\beta = -0.43$, $p < 0.01$) maybe because the rules, rights and obligations are too rigid for companies, governments and citizens and hamper the introduction of innovations. Conversely, controlling the level of corruption in the country ($\beta = 0.47$, $p < 0.01$) and offering an efficient labour force ($\beta = 1.40$, $p < 0.05$) and financial market development ($\beta = 0.96$, $p < 0.05$) enhance firms' investment in R&D. All these factors maintain their magnitude and significance when industry variables are present. Similarly, industry factors lost significance and effect when institutional variables were included.

Thirdly, to check the validity of our results and to go into greater depth in the boundary analysis, we repeated all the main models for three different geographical areas (Table 8): Europe, North America and Asia. Although we found some similarities, we also found differences between geographical areas. In Europe, country variables exert a significant effect on firms' investment in R&D, while the effects of industry variables are residual or non-existent. However, the moderation role of competitiveness pressure does not affect institutions but does affect spillovers. It seems that firms that operate in less competitive

Table 7. Determinants of innovation strategy decoupled

Variables	Model 1	Model 2
SIZE	−3.58*** (0.46)	−3.69*** (0.37)
CAPEX	0.51*** (0.08)	0.49*** (0.05)
CPRESSURE		−0.77 (2.85)
HIGH_OPPORT		0.12 (0.09)
MED_OPPORT		0.15** (0.06)
SPILLOVERS	5.56*** (1.51)	5.43*** (0.88)
BUROCRACY	−0.04 (0.15)	0.05 (0.11)
LEGAL_FRAMEWORK	−0.43** (0.21)	−0.55*** (0.15)
CORRUPTION	0.47*** (0.16)	0.22** (0.09)
HIGH-TECH EXPORTS	−0.03 (0.04)	0.02 (0.02)
LABOR_MARKET _EFFICIENCY	1.40** (0.61)	1.33*** (0.42)
FINANCIAL_MARKET_DEVELOPMENT	0.96** (0.40)	1.03*** (0.31)
Firms	1,211	1,211
No. of observations	7,283	7,283
Wald (df) LL		212.11***
Hansen test (instruments)		119.95 (110)
AR(1)		0.96
AR(2)		0.67
Z1		212.11***

Note(s): *** Significant at 0.01; ** significant at 0.05 standard errors are shown in brackets. AR(1) and AR(2) are tests of the null hypothesis of, respectively, no first- or second-order serial correlation. Hansen is a test of the validity of the overidentifying restrictions based on the efficient two-step GMM estimator

Table 8. Determinants of innovation strategy by geographical areas

Variables	GMM1	GMM2	GMM3	GMM4	GMM5	GMM6	GMM7	GMM8	GMM9	GMM10	GMM11	GMM12
	Europe				America				Asia			
SIZE	−8.28***	−3.98*	−3.51***	−7.38***	−10.55*	−16.16***	−11.13***	−9.65***	−0.06	−0.22	0.09	0.33
	(3.11)		(0.66)	(1.29)	(5.90)	(3.56)	(1.89)	(0.76)	(0.32)	(0.38)	(0.53)	(0.54)
CAPEX	0.05	0.28*	0.22**	0.30***	1.71***	1.44***	1.74***	2.29***	0.08***	0.07***	0.04***	0.04***
	(0.16)		(0.11)	(0.09)	(0.62)	(0.24)	(0.15)	(0.07)	(0.01)	(0.01)	(0.01)	(0.01)
CPRESSURE		−0.08	−3.09	−169.97***		−3.59	−5.18	−306.19***		1.13	−4.60**	50.68
			(2.29)	(36.97)		(6.34)	(4.72)	(28.99)		(1.01)	(2.29)	(33.79)
HIGH_OPPORT		0.04	−0.04	0.01		0.72***	0.47***	0.24***		0.11***	0.19***	0.15***
			(0.17)	(0.18)		(0.27)	(0.13)	(0.08)		(0.03)	(0.06)	(0.06)
MED_OPPORT		−9.82	0.20*	−0.21		0.34*	0.25**	−0.02		0.04**	−0.01	−0.30
			(0.11)	(0.14)		(0.20)	(0.12)	(0.05)		(0.02)	(0.03)	(0.03)
INSTITUTIONS			−0.25	0.40			0.54	−2.98***			−0.74***	−0.13
			(0.47)	(0.76)			(0.62)	(0.47)			(0.24)	(0.28)
SPILLOVERS			3.49**	5.23**			1.51**	1.02			4.70***	6.84
			(1.72)	(2.19)			(0.65)	(0.80)			(0.76)	(0.94)
CPRESSURE*INSTITUTIONS				20.67**				58.66***				−3.15
				(8.66)				(5.32)				(5.71)
CPRESSURE*SPILLOVERS				61.13*				19.99**				−47.80***
				(34.71)				(8.90)				(13.39)
Firms	494	494	494	494	495	495	495	495	233	233	233	233
No. of observations	2021	2021	2021	2021	3,604	3,604	3,604	3,604	1,658	1,658	1,658	1,658
Wald (df) LL	7.38**	10.57***	56.05***	1036.68***	9.08***	40.19***	158.02***	16156.96***	85.37***	169.96***	86.92***	92.11***
Hansen test (instruments)	32.78	39.30	31.17	197.19	80.56	66.34	664.9	183.01	74.69	52.38	198.87	165.69
	(58)	(108)	(51)	(88)	(58)	(68)	(99)	(165)	(29)	(14)	(170)	(149)
AR(1)	−0.23	−0.24	−0.23	−0.25	0.55	0.68	0.56	0.19	−1.49	−1.62	−1.73	−1.73
AR(2)	−0.71	−0.72	−0.70	−0.76	0.76	0.79	0.77	0.74	−0.67	−0.72	−0.55	−0.49
Z1	7.38**	10.57***	56.05***	1036.68***	9.08***	40.19***	158.02***	16156.96***	85.37***	169.96***	86.92***	92.11***

Note(s): *** Significant at 0.01; ** significant at 0.05; * significant at 0.1; standard errors are shown in brackets. AR(1) and AR(2) are tests of the null hypothesis of, respectively, no first- or second-order serial correlation. Hansen is a test of the validity of the overidentifying restrictions based on the efficient two-step GMM estimator markets or that have larger market shares take advantage of innovation knowledge present in the country of origin to invest in R&D. In America, both industry and country variables are determinant for firms' investment in R&D. And similarly, in Europe, competitive pressure enhances the relationship between knowledge spillovers and firms' investment in R&D. However, Asian firms are quite different. Similarly to the main model and the other geographical areas, capital expenditure, technological opportunity and knowledge spillovers exert a positive and significant influence on firms' investment in R&D. However, other country variables such as institutions or competitive pressure exert a negative effect on it. From this perspective, institutions in Asia constrict firms' innovation efforts. Also, firms that operate in more competitive markets present larger R&D investments.

5. Discussion and conclusions

5.1 Discussion

The main objective of this paper was to analyze the impact of factors relating to industry structure and country characteristics and their complementarities on innovation effort, taking into account firm resources and capabilities as control variables. Insights obtained from the aggregated and disaggregated analyzes allow us to draw several conclusions.

Our results show that institutional factors exert a predominant role in firms' innovation effort. These factors establish the incentive system that determines firms' innovation effort and defines resource allocation to R&D activities (Lu *et al.*, 2008). These insights find support in previous literature which suggested that formal institutions determine the number and nature of innovation opportunities and firms' direct innovation effort (Broberg *et al.*, 2013). Informal institutions (i.e. cultural values) influence individuals' attitudes towards innovation and guide firms' innovations strategy (Mueller *et al.*, 2013). On the other hand, the knowledge spillovers generated mainly by R&D activities and financed by the public sector strengthen firms' innovation efforts. This can be explained by the fact that public funds for R&D may, directly or indirectly, complement and stimulate private investment (Veugelers, 1997), because firms can combine any external knowledge to which they have access, with the skills and knowledge they already have (Yli-Renko *et al.*, 2001).

Conversely, although previous literature showed that firms' innovation effort can be determined by industry conditions, we suggest that not all industry factors exert an influence, or, at least, not in the same way. After exploring a linear relationship between competitive pressure and firms' innovation effort in line with previous literature (Boone, 2001; Dubey and Wu, 2002; Dinlersoz and MacDonald, 2009), we did not obtain significant effects. This result contrasts with the arguments of the industry-based view of strategy (Potter, 1980) used in previous research to explain the influence exerted by this variable on innovation effort, both positively and negatively (Ahuja *et al.*, 2008). However, previous empirical evidence showed that competitive pressure only explains a small part of the variance of innovation effort (Cohen, 2010), and it has been suggested that it probably reflects the influence of other more fundamental determinants of technical advance, specifically technological opportunity (Klevorick *et al.*, 1995). We found a positive influence of technological opportunity on firms' innovation effort that supports this idea found in previous research.

Another explanation for the non-significant effect of competitive pressure on firms' innovation effort can be found in a change of paradigm in firms' innovation behaviour. A new trend in innovation suggests that linear relationships for established factors are no longer significant, and that we need to search for complementarities of these factors (Busse *et al.*, 2016). After exploring these complementarities, we showed that competitive pressure moderates the influence of country variables. Thus, firms in industries with less competitive pressure or with larger market shares are able to take advantage of the institutional factors provided by their country of origin to a higher degree than those in more competitive industries. Not only are our results supported by the theoretical works of Schumpeter that emphasize the relevance of creating stronger firms in each industry, but they also provide new insights reinforcing the idea of cross-context factors as suggested by boundary theory (Busse *et al.*, 2016). The reputation of the firm stemming from its market share, its level of productivity and its capacity to hire new workers or to "sell" the boundaries of its country of origin in the world are some factors that may lead firms to innovate and take advantage of institutional boundaries. Such boundaries include facilities on the financial market, better and more efficient regulation and labour market or public innovations and knowledge spillovers. However, due to geographical differences, these complementarities are not equally relevant everywhere. The geographical area where a firm develops still conditions its innovation behaviour either directly or through the influence of situational factors. In fact, our partial analyzes show that competitive pressure sometimes does not have a direct effect (in European and American firms), but in Asian firms, it may exert a negative direct influence. This result shows that Asian firms are more innovative in competitive markets.

Nevertheless, although competitive pressure exerts a moderating effect, we find that technological opportunity still has a significant direct impact on innovation effort. This confirms that when firms are in industries with a high degree of technological opportunity, they are more likely to invest in R&D. In such industries, scientific advances can be achieved more easily, at a lower cost and faster, so there is greater motivation to carry out R&D. In this respect, the results are largely consistent with the prior literature (Veugelers, 1997). However, when the variables representing country characteristics are included, the impact of technological opportunity becomes weaker. These differences indicate that the combined effects of the factors representing country characteristics (institutional framework and knowledge spillovers) reduce the effect of technological opportunity on innovation effort. These insights find support in the recent literature that questions the importance traditionally placed on the industry-based view and on industry structure as a determinant of innovation activity and draws attention to country characteristics stemming from the institution-based view of strategy (Peng *et al.*, 2009).

5.2 Implications

This paper contributes to a better understanding of the importance of institutional factors, in addition to the industry dimension, for improving innovation. From the results, recommendations can be derived for innovation and technology policies. In general terms, policies to promote innovation effort will be more effective if they focus on country-level variables, taking into account their complementarities with industry-level variables. Also, the partial analysis that explored all these innovation effects across regions contributes to the design of policies that are appropriate for each geographical context. In this respect, the focus should be on the advantages derived from the relationship between competition and institutional framework. More protective industries allow firms to better absorb institutional resources (i.e. knowledge spillovers, country reputation, qualified personnel, financial opportunities). Greater complementarity between both dimensions may reduce the uncertainty inherent in innovative activities while also strengthening firms' innovation effort. Thus, policies should develop mechanisms that facilitate the accumulation and dissemination of knowledge spillovers: increased public investment in R&D and elimination of obstacles to technological transfer between universities and firms by promoting the incorporation of PhDs in firms, for example. However, such policies should also consider industry characteristics to reinforce the use of public resources. Country specificities must also be considered because, while in some countries it is advisable to protect certain industries to reduce industry competitiveness, in others (i.e. Asian countries), it will be necessary do the opposite to enhance firms' innovation effort.

5.3 Limitations

Our study has several limitations. First, although we used an international sample, almost 50% of it corresponds to European countries. Moreover, we must point out the diversity of the firms analyzed, because some of them are present in two or more countries and in two or more sectors. Our study assigned each firm to one country and one sector. However, some of the companies included in the database may be multinational and therefore carry out R&D efforts in several countries. We tried to solve this limitation by including in the analysis the variable competitive pressure (considering total market shares around the world). Also, we performed some robustness checks to control for geographical areas, and, finally, we included an interaction term to control for the industry-country boundaries that may affect innovation.

Moreover, the same limitation could be applied to the sectoral classification since, although the companies are assigned to their main sector of activity, in many cases they could be sector-diversified companies. Future research could control for the effect of internationalization and diversification on firms' innovation effort.

Finally, the IRI Scoreboard contains the top 2,000 companies that perform R&D activities. To include in the sample more companies with lower levels of innovation effort might be an interesting line to explore in the future.

5.4 Conclusions

Our study provides a more fine-grained perspective of the determinants of firms' innovation effort than previous literature. Although we recognise the greater relevance of institutional variables in line with previous literature (Peng *et al.*, 2009), we conclude that direct relationships may be little more than a mirage. Similarly, we consider that industrial factors by themselves are not enough to explain firms' innovation effort. Our study goes beyond the current discussion in the literature that analyzes which factors exert a greater influence on firms' innovation effort. Nowadays, it is stated that the institutional framework influences firms' strategy and performance as much as industry structure and firms' resources (Peng *et al.*, 2009). These arguments are also consistent with the hypothesis of the institutional theory that institutional pressures affect firms as strongly as market pressures (Powell and DiMaggio, 1991). Our insights point to a complementary relationship between industry and country factors. Using boundary theory, we can explain better in which circumstances firms increase their innovation effort. In fact, after exploring the moderation effects of competitive pressure on institutional factors, we suggest the need to consider combined cross-context effects. In general, our insights suggest it is necessary to reduce competitiveness in the market and reinforce institutional norms. However, not all institutional characteristics favour firms' innovation effort. Controlling the level of corruption and improving the efficiency of labour and the financial market contribute to enhancing firms' innovation efforts, but an excessive legal framework can reduce the incentives of firms to invest in innovations.

Additionally, our insights provide some conclusions of the applicability of innovation theories for each geographical location. While institutional variables are determinant for European firms, their influence on American and Asian firms is lower. On the contrary, we find that the influence of industrial characteristics is a determinant for Asian firms, and lower or null for the rest. In sum, we conclude that institutional factors are determinants for European firms' innovation effort, while firm factors are determinant for American firms and industrial factors for Asian firms. Moreover, while a less competitive market favours the appropriability of country knowledge spillovers for European and American firms, highly competitive markets enhance the harnessing of institutional conditions in Asian firms.

Notes

1. www.oecd.org/sti/msti
2. http://reports.weforum.org/global-competitiveness-index/
3. Panel data may be unbalanced for several reasons, for example, due to not having the data for one of the transversal units in one of the years of analyzes, when attrition occurs (some of the transversal units leave the panel) or when the transversal units do not disappear but some of the variables are not shown for all the analyzed years. In our case, the panel is unbalanced mainly because of circumstances not under our control, for example, firms being listed or delisted.
4. Furthermore, we have repeated the estimations considering only companies for which we have a balanced panel, that is, companies for which we have complete information for the nine years considered (2004–2012), which provides a sample of 334 firms (27.6% of the sample considered) and 2,672 observations.
5. NACE codes in the EU (http://ec.europa.eu/environment/emas/pdf/general/nacecodes_en.pdf) are the same as the United Nations ISIC Rev. 3 classification and are used by the OECD (https://stats.oecd.org/Index.aspx?DataSetCode=STAN08BIS).

References

Acs, Z.J., Anselin, L. and Varga, A. (2002), "Patents and innovation counts as measures of regional production of new knowledge", North-Holland, *Research Policy*, Vol. 31 No. 7, pp. 1069-1085, doi: 10.1016/S0048-7333(01)00184-6.

Ács, Z.J., Autio, E. and Szerb, L. (2014), "National systems of entrepreneurship: measurement issues and policy implications", North-Holland, *Research Policy*, Vol. 43 No. 3, pp. 476-494, doi: 10.1016/J.RESPOL.2013.08.016.

Aghion, P. and Jaravel, X. (2015), "Knowledge spillovers, innovation and growth", John Wiley & Sons, *The Economic Journal*, Vol. 125 No. 583, pp. 533-573, doi: 10.1111/ecoj.12199.

Aghion, P., Bloom, N., Blundell, R., Griffith, R. and Howitt, P. (2005), "Competition and innovation: an inverted-U relationship", *The Quarterly Journal of Economics*, Vol. 120 No. 2, pp. 701-728, doi: 10.1093/qje/120.2.701.

Ahuja, G., Lampert, C.M. and Tandon, V. (2008), "Moving beyond Schumpeter: management research on the determinants of technological innovation", Academy of Management, *The Academy of Management Annals*, Vol. 2 No. 1, pp. 1-98, doi: 10.5465/19416520802211446.

Ahuja, G., Lampert, C.M. and Novelli, E. (2013), "The second face of appropriability: generative appropriability and its determinants", Academy of Management, *Academy of Management Review*, Vol. 38 No. 2, pp. 248-269, doi: 10.5465/amr.2010.0290.

Alam, A., Uddin, M. and Yazdifar, H. (2019), "Institutional determinants of R&D investment: evidence from emerging markets", *Technological Forecasting and Social Change*, Vol. 138, pp. 34-44, doi: 10.1016/j.techfore.2018.08.007.

Antonelli, C., Crespi, F. and Scellato, G. (2013), "Internal and external factors in innovation persistence", Routledge, *Economics of Innovation and New Technology*, Vol. 22 No. 3, pp. 256-280, doi: 10.1080/10438599.2012.708135.

Arellano, M. and Bond, S. (1991), "Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations", *The Review of Economic Studies*, Vol. 58 No. 2, pp. 277-297, doi: 10.2307/2297968.

Arrow, K.J. (1972), "Economic welfare and the allocation of resources for invention", in *Readings in Industrial Economics*, Springer, pp. 219-236.

Asheim, B.T. and Gertler, M.S. (2005), "The geography of innovation: regional innovation systems", in *The Oxford Handbook of Innovation*.

Audretsch, D.B. and Feldman, M.P. (1996), "R&D spillovers and the geography of innovation and production", American Economic Association, *The American Economic Review*, Vol. 86 No. 3, pp. 630-640, available at: http://www.jstor.org/stable/2118216.

Audretsch, D.B. and Feldman, M.P. (2004), "Knowledge spillovers and the geography of innovation", in *Handbook of Regional and Urban Economics*, Elsevier, pp. 2713-2739.

Bain, J.S. (1959), *Industrial Organization*, Bain Industrial Organization, New York.

Bala Subrahmanya, M.H. (2005), "Pattern of technological innovations in small enterprises: a comparative perspective of Bangalore (India) and Northeast England (UK)", Elsevier, *Technovation*, Vol. 25 No. 3, pp. 269-280, doi: 10.1016/S0166-4972(03)00094-4.

Bamiatzi, V., Bozos, K., Cavusgil, S.T. and Hult, G.T.M. (2016), "Revisiting the firm, industry, and country effects on profitability under recessionary and expansion periods: a multilevel analysis", *Strategic Management Journal*, Vol. 37 No. 7, pp. 1448-1471, doi: 10.1002/smj.2422.

Barasa, L., Knoben, J., Vermeulen, P., Kimuyu, P. and Kinyanjui, B. (2017), "Institutions, resources and innovation in East Africa: a firm level approach", *Research Policy*, Vol. 46 No. 1, pp. 280-291, doi: 10.1016/j.respol.2016.11.008.

Barbosa, N. and Faria, A.P. (2011), "Innovation across Europe: how important are institutional differences?", North-Holland, *Research Policy*, Vol. 40 No. 9, pp. 1157-1169, doi: 10.1016/J.RESPOL.2011.05.017.

Barney, J. (1991), "Firm resources and sustained competitive advantage", SAGE Publications, *Journal of Management*, Vol. 17 No. 1, pp. 99-120, doi: 10.1177/014920639101700108.

Baum, C.F., Schaffer, M.E. and Stillman, S. (2003), "Instrumental variables and GMM: estimation and testing", SAGE Publications, *STATA Journal*, Vol. 3 No. 1, pp. 1-31, doi: 10.1177/1536867X0300300101.

Becattini, G. (2004), *Industrial Districts: A New Approach to Industrial Change*, Edward Elgar Publishing, Northampton, MA.

Becker, W. and Peters, J. (1998), "R&D-Competition between vertical corporate networks: market structure and strategic R&D-Spillovers", Routledge, *Economics of Innovation and New Technology*, Vol. 6 No. 1, pp. 51-72, doi: 10.1080/10438599800000013.

Beneito, P., Coscollá-Girona, P., Rochina-Barrachina, M.E. and Sanchis, A. (2015), "Competitive pressure and innovation at the firm level", *The Journal of Industrial Economics*, Vol. 63 No. 3, pp. 422-457, doi: 10.1111/joie.12079.

Bernstein, J.I. and Nadiri, M.I. (1988), "Interindustry R&D spillovers, rates of return, and production in high-tech industries", American Economic Association, *The American Economic Review*, Vol. 78 No. 2, pp. 429-434, available at: http://www.jstor.org/stable/1818163.

Binz, C., Truffer, B. and Coenen, L. (2014), "Why space matters in technological innovation systems—mapping global knowledge dynamics of membrane bioreactor technology", North-Holland, *Research Policy*, Vol. 43 No. 1, pp. 138-155, doi: 10.1016/J.RESPOL.2013.07.002.

Blundell, R. and Bond, S. (1998), "Initial conditions and moment restrictions in dynamic panel data models", North-Holland, *Journal of Econometrics*, Vol. 87 No. 1, pp. 115-143, doi: 10.1016/S0304-4076(98)00009-8.

Bolívar-Ramos, M.T. (2017), "The relation between R&D spending and patents: the moderating effect of collaboration networks", Elsevier, *Journal of Engineering and Technology Management*, Vol. 46, pp. 26-38, doi: 10.1016/J.JENGTECMAN.2017.11.001.

Boone, J. (2001), "Intensity of competition and the incentive to innovate", *International Journal of Industrial Organization*, Vol. 19 No. 5, pp. 705-726, doi: 10.1016/S0167-7187(00)00090-4.

Broberg, J.C., McKelvie, A., Short, J.C., Ketchen, D.J. and Wan, W.P. (2013), "Political institutional structure influences on innovative activity", Elsevier, *Journal of Business Research*, Vol. 66 No. 12, pp. 2574-2580, doi: 10.1016/J.JBUSRES.2012.05.014.

Busse, C., Kach, A.P. and Wagner, S.M. (2016), "Boundary conditions: what they are, how to explore them, why we need them, and when to consider them", SAGE Publications, *Organizational Research Methods*, Vol. 20 No. 4, pp. 574-609, doi: 10.1177/1094428116641191.

Cappelli, R., Czarnitzki, D. and Kraft, K. (2014), "Sources of spillovers for imitation and innovation", North-Holland, *Research Policy*, Vol. 43 No. 1, pp. 115-120, doi: 10.1016/J.RESPOL.2013.07.016.

Carpenter, R.E. and Petersen, B.C. (2002), "Capital market imperfections, high-tech investment, and new equity financing", Royal Economic Society, Wiley, *The Economic Journal*, Vol. 112 No. 477, pp. F54-F72, available at: http://www.jstor.org/stable/798491.

Casson, M. and Singh, S. (1993), "Corporate research and development strategies: the influence of firm, industry and country factors on the decentralization of R&D", John Wiley & Sons, *R&D Management*, Vol. 23 No. 2, pp. 91-108, doi: 10.1111/j.1467-9310.1993.tb00078.x.

Castellani, D., Montresor, S., Schubert, T. and Vezzani, A. (2017), "Multinationality, R&D and productivity: evidence from the top R&D investors worldwide", Pergamon, *International Business Review*, Vol. 26 No. 3, pp. 405-416, doi: 10.1016/J.IBUSREV.2016.10.003.

Cefis, E. and Orsenigo, L. (2001), "The persistence of innovative activities: a cross-countries and cross-sectors comparative analysis", North-Holland, *Research Policy*, Vol. 30 No. 7, pp. 1139-1158, doi: 10.1016/S0048-7333(00)00139-6.

Cincera, M. and Ravet, J. (2010), "Financing constraints and R&D investments of large corporations in Europe and the US", *Science and Public Policy*, Vol. 37 No. 6, pp. 455-466, doi: 10.3152/030234210X508642.

Cincera, M. and Veugelers, R. (2014), "Differences in the rates of return to R&D for European and US young leading R&D firms", *Research Policy*, Vol. 43 No. 8, pp. 1413-1421, doi: 10.1016/j.respol.2014.03.004.

Coad, A., Grassano, N., Hall, B.H., Moncada-Paternó-Castello, P. and Vezzani, A. (2019), "Innovation and industrial dynamics", *Structural Change and Economic Dynamics*, Vol. 50, pp. 126-131, doi: 10.1016/j.strueco.2019.06.008.

Cohen, W.M. and Levinthal, D.A. (1990), "Absorptive capacity: a new perspective on learning and innovation", Sage Publications, Johnson Graduate School of Management, Cornell University, *Administrative Science Quarterly*, Vol. 35 No. 1, pp. 128-152, doi: 10.2307/2393553.

Cohen, W.M. (2010), "Fifty years of empirical studies of innovative activity and performance", in *Handbook of the Economics of Innovation*, North-Holland, Vol. 1, pp. 129-213, doi: 10.1016/S0169-7218(10)01004-X.

Crowley, F. and Jordan, D. (2017), "Does more competition increase business-level innovation? Evidence from domestically focused firms in emerging economies", Routledge, *Economics of Innovation and New Technology*, Vol. 26 No. 5, pp. 477-488, doi: 10.1080/10438599.2016.1233627.

Delgado, M., Porter, M.E. and Stern, S. (2014), "Clusters, convergence, and economic performance", North-Holland, *Research Policy*, Vol. 43 No. 10, pp. 1785-1799, doi: 10.1016/J.RESPOL.2014.05.007.

Demirkan, I. (2018), "The impact of firm resources on innovation", Emerald Publishing, *European Journal of Innovation Management*, Vol. 21 No. 4, pp. 672-694, doi: 10.1108/EJIM-12-2017-0196.

DiMaggio, P.J. and Powell, W.W. (1991), "The new institutionalism in organizational analysis: Introduction", in *The New Institutionalism in Organizational Analysis*, University of Chicago Press, Chicago, IL, pp. 1-38.

Dinlersoz, E.M. and MacDonald, G. (2009), "The industry life-cycle of the size distribution of firms", *Review of Economic Dynamics*, Vol. 12 No. 4, pp. 648-667, doi: 10.1016/j.red.2009.01.001.

Donbesuur, F., Ampong, G.O.A., Owusu-Yirenkyi, D. and Chu, I. (2020), "Technological innovation, organizational innovation and international performance of SMEs: the moderating role of domestic institutional environment", *Technological Forecasting and Social Change*, Vol. 161, p. 120252, doi: 10.1016/j.techfore.2020.120252.

Döring, T. and Schnellenbach, J. (2006), "What do we know about geographical knowledge spillovers and regional growth?: a survey of the literature", Routledge, *Regional Studies*, Vol. 40 No. 3, pp. 375-395, doi: 10.1080/00343400600632739.

Dubey, P. and Wu, C. (2002), "When less competition induces more product innovation", *Economics Letters*, Vol. 74 No. 3, pp. 309-312, doi: 10.1016/S0165-1765(01)00555-9.

Edwards, J.R. and Berry, J.W. (2010), "The presence of something or the absence of nothing: increasing theoretical precision in management research", *Organizational Research Methods*, Vol. 13, pp. 668-689.

European Commission (2011), "EU industrial R&D investment scoreboard", available at: http://iri.jrc.es/reports.htm.

Fagerberg, J., Srholec, M. and Knell, M. (2007), "The competitiveness of Nations: why some countries prosper while others fall behind", Pergamon, *World Development*, Vol. 35 No. 10, pp. 1595-1620, doi: 10.1016/J.WORLDDEV.2007.01.004.

Feldman, M.P. and Kelley, M.R. (2006), "The ex ante assessment of knowledge spillovers: government R&D policy, economic incentives and private firm behavior", North-Holland, *Research Policy*, Vol. 35 No. 10, pp. 1509-1521, doi: 10.1016/J.RESPOL.2006.09.019.

Feldman, M.P. (1999), "The new economics of innovation, spillovers and agglomeration: areview of empirical studies", Routledge, *Economics of Innovation and New Technology*, Vol. 8 Nos 1-2, pp. 5-25, doi: 10.1080/10438599900000002.

Florida, R., Adler, P. and Mellander, C. (2017), "The city as innovation machine", Routledge, *Regional Studies*, Vol. 51 No. 1, pp. 86-96, doi: 10.1080/00343404.2016.1255324.

Furman, J.L., Porter, M.E. and Stern, S. (2002), "The determinants of national innovative capacity", North-Holland, *Research Policy*, Vol. 31 No. 6, pp. 899-933, doi: 10.1016/S0048-7333(01)00152-4.

García-Manjón, J.V. and Romero-Merino, M.E. (2012), "Research, development, and firm growth. Empirical evidence from European top R&D spending firms", North-Holland, *Research Policy*, Vol. 41 No. 6, pp. 1084-1092, doi: 10.1016/J.RESPOL.2012.03.017.

Garrido, E., Gomez, J., Maicas, J.P. and Orcos, R. (2014), "The institution-based view of strategy: how to measure it", No longer published by Elsevier, *BRQ Business Research Quarterly*, Vol. 17 No. 2, pp. 82-101, doi: 10.1016/J.BRQ.2013.11.001.

Geroski, P.A. (1990), "Innovation, technological opportunity, and market structure", Oxford University Press, *Oxford Economic Papers*, Vol. 42 No. 3, pp. 586-602, available at: http://www.jstor.org/stable/2663063.

Gilbert, R. (2006), "Looking for Mr. Schumpeter: where are we in the competition–innovation debate?", University of Chicago Press, *Innovation Policy and the Economy*, Vol. 6, pp. 159-215, available at: http://www.jstor.org/stable/25056183.

Griffith, R., Huergo, E., Mairesse, J. and Peters, B. (2006), "Innovation and productivity across four EUROPEAN countries", *Oxford Review of Economic Policy*, Vol. 22 No. 4, pp. 483-498, available at: http://www.jstor.org/stable/23606776.

Gumbau-Albert, M. and Maudos, J. (2013), "The evolution of technological inequalities: country effect vs industry composition", Emerald Group Publishing, *European Journal of Innovation Management*, Vol. 16 No. 2, pp. 190-210, doi: 10.1108/14601061311324539.

Harmantzis, F.C. and Tanguturi, V.P. (2007), "Investment decisions in the wireless industry applying real options", Pergamon, *Telecommunications Policy*, Vol. 31 No. 2, pp. 107-123, doi: 10.1016/J.TELPOL.2006.02.005.

Ho, C.-Y., Huang, S., Shi, H. and Wu, J. (2018), "Financial deepening and innovation: the role of political institutions", Pergamon, *World Development*, Vol. 109, pp. 1-13, doi: 10.1016/J.WORLDDEV.2018.02.022.

Hodgson, G.M. (2006), "What are institutions?", Taylor & Francis, *Journal of Economic Issues*, Vol. 40 No. 1, pp. 1-25.

Isobe, T., Makino, S. and Montgomery, D.B. (2000), "Resource commitment, entry timing, and market performance of foreign direct investments in emerging economies: the case of Japanese international joint ventures in China", Academy of Management, *Academy of Management Journal*, Vol. 43 No. 3, pp. 468-484, doi: 10.2307/1556405.

Jaffe, A.B., Trajtenberg, M. and Henderson, R. (1993), "Geographic localization of knowledge spillovers as evidenced by patent citations", Oxford University Press, *Quarterly Journal of Economics*, Vol. 108 No. 3, pp. 577-598, doi: 10.2307/2118401.

Kamien, M.I. and Schwartz, N.L. (1982), *Market Structure and Innovation*, Cambridge University Press, Cambridge, UK.

Karlsson, C. and Tavassoli, S. (2016), "Innovation strategies of firms: what strategies and why?", *The Journal of Technology Transfer*, Vol. 41 No. 6, pp. 1483-1506, doi: 10.1007/s10961-015-9453-4.

Karniouchina, E.V., Carson, S.J., Short, J.C. and Ketchen, D.J. Jr (2013), "Extending the firm vs. industry debate: does industry life cycle stage matter?", *Strategic Management Journal*, Vol. 34 No. 8, pp. 1010-1018, doi: 10.1002/smj.2042.

Kleinbaum, D.G., Kupper, L.L., Nizam, A. and Rosenberg, E.S (1988), *Applied Regression Analysis and Other Multivariable Methods*, N Education (Ed.), Brooks Cole, Boston, MA.

Klevorick, A.K., Levin, R.C., Nelson, R.R. and Winter, S.G (1995), "On the sources and significance of interindustry differences in technological opportunities", North-Holland, *Research Policy*, Vol. 24 No. 2, pp. 185-205, doi: 10.1016/0048-7333(93)00762-I.

Koeller, C.T. (2005), "Technological opportunity and the relationship between innovation output and market structure", John Wiley & Sons, *Managerial and Decision Economics*, Vol. 26 No. 3, pp. 209-222, doi: 10.1002/mde.1205.

Kooijman, M., Hekkert, M.P., van Meer, P.J.K., Moors, E.H.M. and Schellekens, H. (2017), "How institutional logics hamper innovation: the case of animal testing", North-Holland, *Technological Forecasting and Social Change*, Vol. 118, pp. 70-79, doi: 10.1016/J.TECHFORE.2017.02.003.

Kukk, P., Moors, E.H.M. and Hekkert, M.P. (2016), "Institutional power play in innovation systems: the case of Herceptin®", North-Holland, *Research Policy*, Vol. 45 No. 8, pp. 1558-1569, doi: 10.1016/J.RESPOL.2016.01.016.

Le Bas, C. and Scellato, G. (2014), "Firm innovation persistence: a fresh look at the frameworks of analysis", Routledge, *Economics of Innovation and New Technology*, Vol. 23 Nos 5–6, pp. 423-446, doi: 10.1080/10438599.2014.895511.

Li, H. and Atuahene-Gima, K. (2001), "Product innovation strategy and the performance of new technology ventures in China", Academy of Management, *Academy of Management Journal*, Vol. 44 No. 6, pp. 1123-1134, doi: 10.2307/3069392.

Lu, Y., Tsang, E.W.K. and Peng, M.W. (2008), "Knowledge management and innovation strategy in the Asia Pacific: toward an institution-based view", *Asia Pacific Journal of Management*, Vol. 25 No. 3, pp. 361-374, doi: 10.1007/s10490-008-9100-9.

Lundvall, B.-A. (1992), *National Systems of Innovation: Towards a Theory of Innovation and Interactive Learning*, Pinter, London.

Lundvall, B. (2007), "National innovation systems—analytical concept and development tool", Routledge, *Industry and Innovation*, Vol. 14 No. 1, pp. 95-119, doi: 10.1080/13662710601130863.

Mairesse, J. and Mohnen, P. (2004), "The importance of R&D for innovation: a reassessment using French survey data", *The Journal of Technology Transfer*, Vol. 30 No. 1, pp. 183-197, doi: 10.1007/s10961-004-4365-8.

Makino, S., Isobe, T. and Chan, C.M. (2004), "Does country matter?", John Wiley & Sons, *Strategic Management Journal*, Vol. 25 No. 10, pp. 1027-1043, doi: 10.1002/smj.412.

Malerba, F. and Orsenigo, L. (1996), "Schumpeterian patterns of innovation are technology-specific", North-Holland, *Research Policy*, Vol. 25 No. 3, pp. 451-478, doi: 10.1016/0048-7333(95)00840-3.

Marshall, A. (1961), *Principles of Economics: Text*, Macmillan for the Royal Economic Society, London and New York.

McCutchen, W.W. and Swamidass, P.M. (1996), "Effect of R&D expenditures and funding strategies on the market value of biotech firms", Elsevier, *Journal of Engineering and Technology Management*, Vol. 12 No. 4, pp. 287-299, doi: 10.1016/0923-4748(95)00014-3.

Moncada-Paternò-Castello, P., Ciupagea, C., Smith, K., Tübke, A. and Tubbs, M. (2010), "Does Europe perform too little corporate R&D? A comparison of EU and non-EU corporate R&D performance", North-Holland, *Research Policy*, Vol. 39 No. 4, pp. 523-536, doi: 10.1016/J.RESPOL.2010.02.012.

Montresor, S. and Vezzani, A. (2015), "The production function of top R&D investors: accounting for size and sector heterogeneity with quantile estimations", North-Holland, *Research Policy*, Vol. 44 No. 2, pp. 381-393, doi: 10.1016/J.RESPOL.2014.08.005.

Moulaert, F. and Sekia, F. (2003), "Territorial innovation models: a critical survey", Routledge, *Regional Studies*, Vol. 37 No. 3, pp. 289-302, doi: 10.1080/0034340032000065442.

Mueller, V., Rosenbusch, N. and Bausch, A. (2013), "Success patterns of exploratory and exploitative innovation A meta-analysis of the influence of institutional factors", *Journal of Management*, Vol. 39, pp. 1606-1636, doi: 10.1177/0149206313484516.

Narayanan, V.K. and Fahey, L. (2005), "The relevance of the institutional underpinnings of porter's five forces framework to emerging economies: an epistemological analysis", John Wiley & Sons, *Journal of Management Studies*, Vol. 42 No. 1, pp. 207-223, doi: 10.1111/j.1467-6486.2005.00494.x.

Naz, A., Niebuhr, A. and Peters, J.C. (2015), "What's behind the disparities in firm innovation rates across regions? Evidence on composition and context effects", *The Annals of Regional Science*, Vol. 55 No. 1, pp. 131-156, doi: 10.1007/s00168-015-0694-9.

Nelson, R.R. and Winter, S.G. (2002), *An Evolutionary Theory of Economic Change*, Harvard University Press, Cambridge, MA, 1982.

Nieto, M. and González-Álvarez, N. (2014), "Product innovation: testing the relative influence of industry, institutional context and firm factors", Routledge, *Technology Analysis and Strategic Management*, Vol. 26 No. 9, pp. 1023-1036, doi: 10.1080/09537325.2014.944146.

Nieto, M. and Quevedo, P. (2005), "Absorptive capacity, technological opportunity, knowledge spillovers, and innovative effort", Elsevier, *Technovation*, Vol. 25 No. 10, pp. 1141-1157, doi: 10.1016/J.TECHNOVATION.2004.05.001.

North, D.C. (1990), *Institutions, Institutional Change, and Economic Performance*, Cambridge University Press, Cambridge.

North, D.C. (2005), *Understanding the Process of Economic Change*, Princeton University Press, Princeton, Oxford.

OECD (2015), "Science, technology and industry scoreboard, main science and technology indicators", available at: http://www.oecd.org/sti/scoreboard.htm.

Oliveira, P.M. and Natário, M.M. (2016), "Territorial innovation systems and strategies of collective efficiency: the case of Tagus Valley agro-food complex", Emerald Group Publishing, *European Journal of Innovation Management*, Vol. 19 No. 3, pp. 362-382, doi: 10.1108/EJIM-07-2014-0072.

Ortega-Argilés, R., Potters, L. and Vivarelli, M. (2011), "R&D and productivity: testing sectoral peculiarities using micro data", *Empirical Economics*, Vol. 41 No. 3, pp. 817-839, doi: 10.1007/s00181-010-0406-3.

Peng, M.W., Sun, S.L., Pinkham, B. and Chen, H. (2009), "The institution-based view as a third leg for a strategy tripod", Academy of Management Briarcliff Manor, *Academy of Management Perspectives*, Vol. 23 No. 3, pp. 63-81, doi: 10.5465/amp.2009.43479264.

Peng, M.W. (2002), "Towards an institution-based view of business strategy", *Asia Pacific Journal of Management*, Vol. 19 No. 2, pp. 251-267, doi: 10.1023/A:1016291702714.

Piergiovanni, R. and Santarelli, E. (2013), "The more you spend, the more you get? The effects of R&D and capital expenditures on the patenting activities of biotechnology firms", *Scientometrics*, Vol. 94 No. 2, pp. 497-521, doi: 10.1007/s11192-012-0711-z.

Pindado, J. and Requejo, I. (2015), "Family business performance from a governance perspective: a review of empirical research", John Wiley & Sons, *International Journal of Management Reviews*, Vol. 17 No. 3, pp. 279-311, doi: 10.1111/ijmr.12040.

Porter, M.E. and Ketels, C. (2009), "Clusters and industrial districts: common roots, different perspectives", in *A Handbook of Industrial Districts*, Edward Elgar Publishing, pp. 172-183.

Porter, M.E. (1990), *The Competitive Advantage of Nations*, Harvard Business School Management Programs Cambridge, New York, NY.

Potter, M.E. (1980), *Competitive Strategy: Techniques for Analyzing Industries and Competitors*, The Free Press, New York.

Powell, W.W. and DiMaggio, P. (1991), *The New Institutionalism in Organizational Analysis*, University of Chicago Press, Chicago, Illinois.

Rajan, R.G. and Zingales, L. (2003), "The great reversals: the politics of financial development in the twentieth century", North-Holland, *Journal of Financial Economics*, Vol. 69 No. 1, pp. 5-50, doi: 10.1016/S0304-405X(03)00125-9.

Raymond, L. and St-Pierre, J. (2010), "R&D as a determinant of innovation in manufacturing SMEs: an attempt at empirical clarification", Elsevier, *Technovation*, Vol. 30 No. 1, pp. 48-56, doi: 10.1016/J.TECHNOVATION.2009.05.005.

Rodríguez-Pose, A. and Zhang, M. (2020), "The cost of weak institutions for innovation in China", *Technological Forecasting and Social Change*, Vol. 153, p. 119937, doi: 10.1016/j.techfore.2020.119937.

Scherer, F.M. (1965), "Firm size, market structure, opportunity, and the output of patented inventions", American Economic Association, *The American Economic Review*, Vol. 55 No. 5, pp. 1097-1125, available at: http://www.jstor.org/stable/1809230.

Scott, W.R. (1995), *Institutions and Organizations*, SAGE, Los Angeles, CA.

Spence, M. (1984), "Cost reduction, competition, and industry performance", Econometric Society, Wiley, *Econometrica*, Vol. 52 No. 1, pp. 101-121, doi: 10.2307/1911463.

Tappeiner, G., Hauser, C. and Walde, J. (2008), "Regional knowledge spillovers: fact or artifact?", North-Holland, *Research Policy*, Vol. 37 No. 5, pp. 861-874, doi: 10.1016/J.RESPOL.2007.07.013.

Thomas, A.-D. (2017), "How much and when to innovate: the nexus of environmental pressures, innovation and service firm performance", Emerald Publishing, *European Journal of Innovation Management*, Vol. 20 No. 4, pp. 599-619, doi: 10.1108/EJIM-05-2016-0050.

Tsai, K.-H., Hsieh, M.-H. and Hultink, E.J. (2011), "External technology acquisition and product innovativeness: the moderating roles of R&D investment and configurational context", Elsevier, *Journal of Engineering and Technology Management*, Vol. 28 No. 3, pp. 184-200, doi: 10.1016/J.JENGTECMAN.2011.03.005.

Vasudeva, G. (2009), "How national institutions influence technology policies and firms' knowledge-building strategies: a study of fuel cell innovation across industrialized countries", North-Holland, *Research Policy*, Vol. 38 No. 8, pp. 1248-1259, doi: 10.1016/J.RESPOL.2009.05.006.

Veugelers, R. (1997), "Internal R&D expenditures and external technology sourcing", North-Holland, *Research Policy*, Vol. 26 No. 3, pp. 303-315, doi: 10.1016/S0048-7333(97)00019-X.

World Economic Forum (2020), "Global competitiveness report", available at: http://www.weforum.org/reports/global-competitiveness-report.

Yli-Renko, H., Autio, E. and Sapienza, H.J. (2001), "Social capital, knowledge acquisition, and knowledge exploitation in young technology-based firms", John Wiley & Sons, *Strategic Management Journal*, Vol. 22 Nos 6-7, pp. 587-613, doi: 10.1002/smj.183.

About the authors

Mariano Nieto is a Professor of Strategic Management at the University of Leon, Spain. His most recent research is on innovation management, corporate social responsibility and entrepreneurship. He has contributed to publications in periodicals such as *Research Policy, Journal of Business Research, Technological Forecasting and Social Change, Technological Analysis and Strategic Management* and *Technovation*.

Daniel Alonso-Martínez, PhD, is assistant professor in business management at the Department of Business Administration, University of Leon (Spain). His most recent research is on innovation management, corporate social responsibility and entrepreneurship. He has contributed to publications in periodicals such as *Technological Forecasting and Social Change, Sustainable Development, Corporate Social Responsibility and Environmental Management, Review of Managerial Science* and *Sustainability*. He is involved in the committee of Academy of Management Conference and in the committee of European Academy of Management Conference, in Social Issues Management and Strategy section, respectively. Daniel Alonso-Martínez is the corresponding author and can be contacted at: dalom@unileon.es

Nuria González-Álvarez is an Associate Professor of Strategic Management at the University of Leon, Spain. She holds a PhD in management from the same university. Her research interests concern innovation management and entrepreneurship. She has published in several international journals as *Research Policy, Technovation, Technological Forecasting and Social Change* and *Industry and Innovation*.