Open innovation and intellectual property rights

How do SMEs benefit from patents, industrial designs, trademarks and copyrights?

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Abstract

Purpose – The purpose of this paper is to study the relationship between open innovation and the use of intellectual property rights (IPRs) in small- and medium-sized enterprises (SMEs). The authors consider patents, industrial designs (i.e. design patents in the USA), trademarks, and copyrights.
Design/methodology/approach – The relationships between open innovation, IPRs, and profitability are tested with random-effects panel regressions on data from the Spanish Community Innovation Survey for 2,873 firms spanning the years 2008-2013.
Findings – A key result is that SMEs do not benefit from open innovation or from patenting in the same way as larger firms. Furthermore, the results show that SMEs profit in different ways from IPR, depending on their size and the corresponding IPR.
Research limitations/implications – The different impact of IPRs on the efficiency of open innovation in firms of varying sizes highlights the importance of further investigation into IP strategies and into open innovation in SMEs.
Practical implications – Industrial designs are currently the most efficient IPR for SMEs to protect their intellectual property in open innovation collaborations. Depending on the company size, the use of different IPRs is recommended. Moreover, firms should seek to increase the efficiency of open innovation and the use of IPRs.
Social implications – The high impact of SMEs on employment highlights the importance of fomenting efficient innovation processes in such firms.
Originality/value – This paper opens the black box of IPR in relation to open innovation in SMEs, and draws distinctive conclusions with regards to patents, industrial designs, trademarks, and copyrights.

Keywords SME, Copyright, Patents, Open innovation, Trademark, Industrial design

Paper type Research paper

Introduction

Nowadays the question is no longer if open innovation is important for a company, but rather to what extent. Herskovits *et al.* (2013, p. 631) state that innovation is "the single most relevant element in fuelling corporations' competitive advantage and ultimate value creation," and that it is open innovation which creates new "drivers for value creation." At the same time, especially to prevent unintended knowledge drain, such collaborations lead to a need for knowledge protection through intellectual property (IP) so that companies can profit from these collaborations (Bogers *et al.*, 2012), as there seems to be no automatism for the use of open innovation to raise firm performance (Schuster and Brem, 2015).

Multinational companies explore the boundaries of open innovation extensively, but small- and medium-sized enterprises (SMEs) are catching up. This is important since SMEs represent a significant part of companies in the European Union, and also in other regions like Northern America. In fact, SMEs make up more than 99 percent of all businesses in the European Union, Japan and the USA (European Commission, 2014), and they are drivers of growth and innovation in economies (Eppinger and Vladova, 2013).

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Furthermore, in times of economic downturn, it has been SMEs which have weathered the storm, and not their larger competitors (European Commission, 2014).

SMEs are becoming more and more involved in global markets and competition, compared to the early years of globalization. This means a higher need for protection of products, since the threat of competitors and substitute products is potentially worldwide. Even in markets like China, which has traditionally had a low regime of appropriability, the importance of IP protection seems to be gaining momentum, as local companies start to protect their products from imitation. This is illustrated by the high growth rates for patent and trademarks applications, securing China the top spot for patent applications worldwide (WIPO, 2015). Moreover, in many firms dealing with IP, protection has increased in importance and has moved from being a specialized legal department task to the office of the Chief Executive Officer (Hanel, 2006).

Before this background, we analyze the impact of intellectual property rights (IPRs) on the relationship between open innovation and firm performance, which we measure as turnover. Hence, our analysis encompasses other forms of protection beyond patents, including copyrights, industrial designs, and trademarks. The rationale behind our approach is the indication made by previous research that SMEs do not make use of alternative protection titles beyond patents (Burrone, 2005), despite IP having a strong impact on market leadership and the overall performance of a company (Bollen *et al.*, 2005).

Recent investment projects and SME financing agreements are evidence of the increasing importance of Spanish SMEs not just for the Spanish economy, but also for the European economy as a whole (European Commission, 2016). It is thus especially important to understand how IPR may help or hinder profitable SME collaborations in Spain. Therefore, we use the case of Spanish SMEs, since they have been the most successful companies in obtaining funding from the SME instrument of the European Commission, a fact which is attributed to the vibrant SME network of this country (EASME, 2016). The level of Spanish IPR is on par with some of the most advanced countries in this aspect, e.g. Denmark, Germany, the UK, and Japan, and is second only to those of the USA and Ireland in terms of patent enforcement, patent duration, and international patent agreements (Liu and La Croix, 2015).

This paper is organized as follows. First, we give an overview of the relevant literature on IPR in SMEs and derive our hypotheses. Then, we describe our methodology and sample of Spanish SMEs. Our results overview leads into the discussion section, where we discuss these results before the background of earlier research. Finally, we show limitations of our research, as well as future research paths.

Background and hypothesis development

IPRs have the goal to ensure and foster investments in innovation (West, 2006). "IP refers to unique, value-adding creations of the human intellect that results from human ingenuity, creativity and inventiveness" (Kalanje, 2006, p. 1). This paper is bound to this definition of IP through the consideration of four key IP elements, namely, patents, industrial designs, trademarks, and copyrights. Before we discuss the literature in these areas, we give a brief overview on the linkage between open innovation and firm performance, as earlier research indicates a relationship between IP and firm performance (Bollen *et al.*, 2005).

The relationship between open innovation and IP protection is characterized through a paradox, where the question is if appropriability enforces or impedes open innovation. On the one hand, companies need to consider adequate protection before engaging with external actors to prevent unwanted knowledge spillovers. This is typically solved through the application of IP protection rights. On the other hand, there is only a limited defensibility of such rights in juridical disputes because of high costs and time investments. In addition, competitors may simply find ways to bypass the secured areas, etc. Hence, a balanced

approach is needed where regimes of appropriability are carefully analyzed and adapted to the companies' strategy in order to control and manage access to knowledge (Laursen and Salter, 2004). In the context of SMEs, Jensen and Webster (2006) state using and enforcing IPRs is especially challenging because of a lack of financial resources and enforcement abilities. Since this discussion goes beyond the scope of this paper, we would like to refer to related research in this area for further discussion of this paradox (e.g. West, 2006; Chesbrough, 2006; Belderbos *et al.*, 2010; Michelino *et al.*, 2015).

Open innovation and firm performance in SMEs

While much has been published on open innovation in large, multinational firms, there has been less interest in open innovation in SMEs. In addition, the role of SMEs in open innovation is increasing (Brunswicker and Vanhaverbeke, 2015), and a positive trend toward open innovation in SMEs has been observed (Van de Vrande *et al.*, 2009). In general, earlier research indicates that open innovation is positively related to firm performance. Pullen *et al.* (2012) state that cooperation with outside firms is linked to innovation performance, and particularly in the case of SMEs. SMEs can use open innovation to overcome barriers which result from their size. Huang *et al.* (2013) find that business model innovation is positively linked to firm performance, and can help to overcome organizational inertia. Given the pivotal role played by SMEs in the economy, both at a national and European level, and the increasing importance of open innovation in SMEs, research into open innovation in SMEs is correspondingly of increasing importance.

Research which has been published on open innovation in SMEs has analyzed the difficulties firms face when engaging in open innovation. Many of these difficulties can be categorized into, for example, a lack of funding (Spithoven *et al.*, 2013), or a lack of resources, which in turn affects manufacturing, distribution, marketing, and R&D capabilities, or recruitment of researchers (Lasagni, 2012; Lee *et al.*, 2009). These difficulties are a direct result of the reduced size of the organization, compared to large entities. Other difficulties are also a result of the size of the organization, albeit indirectly. Costliness describes the financial burdens facing SMEs, such as being unable to finance research or in-house R&D departments (Katzy *et al.*, 2013). Open innovation can also prove to be expensive (Christensen *et al.*, 2005) and SMEs are rarely able to afford the direct employment of legal or patent experts (Eppinger and Vladova, 2013), and will need to look outside the company for professional advice when engaging in open innovation activities (Huang *et al.*, 2013). Hence, IPRs offer SMEs opportunities for scaling their R&D activities which would be not feasible without protection options.

Some studies have broached the subject, but the evidence is rather scarce, not timely, and is somewhat conflicting. For example, Hung and Chiang (2010) established that a proclivity toward open innovation positively affects firm performance, whereas Spithoven *et al.* (2013) hypothesize that open innovation has a different impact on firm performance for SMEs compared to large firms, but find no support for this difference in their Belgian data. Kim and Park (2010) found that not all open innovation activities have a positive effect on firm performance, and Lee *et al.* (2009) stated that a closed innovation strategy can have a positive effect on performance, using operating profit ratio as an indicator of performance. Despite using a small data set, this study established that it may be in the best interests of SMEs to pursue a closed innovation strategy. Andries and Faems (2013) undertook research into patenting and firm performance, but use data from 2005, recognizing in the limitations of their research that it is important to study patenting and licensing with more recent data. In their study into the effects of open innovation on performance of SMEs, Kim and Park (2010) suggest further research into open innovation activities of SMEs in other countries. Mortara *et al.* (2013) recommend a clear definition of the metrics of open innovation in order to compare the different types of open innovation, and to measure their success.

From the literature we have reviewed, we consider that there is both a lack of research into open innovation success in SMEs and a lack of consensus. Although the empirical evidence is scarce and conflicting, authors hypothesize positive effects based on the access to resources made available to SMEs through open innovation. We therefore formulate and test the following hypothesis:

H1. Open innovation is positively related to firm performance in SMEs.

Innovations from SMEs come in many cases from an informal nature, where industrial designs, trademarks, and copyrights play a key role to ensure competitive advantage – beyond patents (Granstrand, 1999; Conley *et al.*, 2013). These rights give SMEs the opportunity to differentiate themselves from competition with an exclusive right of using a mark or a design (Burrone, 2005). Hence, our analysis covers patents, industrial designs, trademarks, and copyrights.

IP protection and SMEs: patents, industrial designs, trademarks, and copyrights

Patents are the most common used statutory IPR, but SMEs often neglect using them (Thomä and Bizer, 2013). Research indicates that IP protection through patents is positively related to performance in terms of commercialization success (Andries and Faems, 2013). However, having many patents does not automatically lead to high sales performance (Agostini *et al.*, 2015). Some studies have broached the subject of patenting activities in SMEs, and have linked it to performance. Hanel (2006) states that SMEs have higher patenting rates, but larger companies generate more patents per firm. Andries and Faems (2013) found that both large firms and SMEs can use patenting to increase turnover. Despite finding that patenting is less frequently employed in innovative SMEs, the results of their study showed that when patenting is used in SMEs, it has a positive effect on "innovation and financial performance (p. 1096)." These findings suggest that large firms and SMEs need to use different strategies for patenting, especially when engaging in open innovation. This is in line with Spithoven *et al.* (2013), who state that SMEs differ to large firms in their patenting activities since they patent only the innovations that are likely to be successful. Given the increased resources and personnel of large firms, they are able to patent all their innovations: SMEs, however, face financial and organizational barriers, which impede systematic patenting. Spithoven *et al.* (2013) encourage further study into the specifics of open innovation in SMEs. Kalanje (2006) writes that the barrier of costliness and lack of resources are reasons why SMEs patent less than large firms, and that the patenting process can hamper innovation, but when used befittingly, it can be a source of revenue and consequently affect firm performance. Eppinger and Vladova (2013, p. 64) affirm that "resource shortages" and "lack of Intellectual Property management practices" are some of the barriers faced by SMEs. We can therefore deduce that firm size and the barriers faced by SMEs when engaging in IP mechanisms, such as patenting activities, determine the frequency of patenting activities. Moreover, research from Ernst (2001) indicates a positive relationship between patent activities and firm performance. Finally, earlier research from Dubiansky (2006), Lichtenthaler (2010), and Hagedoorn and Ridder (2012) also indicates a positive relationship between IPR and open innovation:

H2a. IP protection through patents is positively related to firm performance in SMEs.

H2b. IP protection through patents moderates the relationship between open innovation and firm performance so that the relationship is stronger when patent use is high rather than low.

Industrial designs as well as trademarks are considered to be important for taking new products to the market (Kalanje, 2006). In a study by Kitching and Blackburn (1998),

the adoption of industrial designs is at about 31 percent for SMEs, and about 17 percent for micro companies in the UK. These rates closely resemble the application of patents, with around 30 and 18 percent, respectively. An industrial design is a commonly used IP right, especially for SMEs. On average, and weighted by employment, Jensen and Webster (2006) found that the intensity of the usage of industrial designs is double the amount for SMEs compared to large firms (0.339 compared to 0.162 design applications per 1,000 employees). Surprisingly, SMEs only use industrial designs in general to a limited extent, even though such design rights are considered to be ideal for SMEs (Burrone, 2005). Earlier research indicates that industrial designs are in general a less chosen IPR than other forms of protection (Hanel, 2006):

H3a. IP protection through industrial designs is positively related to firm performance in SMEs.

H3b. IP protection through industrial designs moderates the relationship between open innovation and firm performance so that the relationship is stronger when industrial design use is high rather than low.

Eppinger and Vladova (2013) suggest further research into trademarks. However, research on the relationship between trademarks and firm performance is still scarce, even though trademarks can be used as a proxy for innovation (Agostini *et al.*, 2016). Trademarks are a relatively cheap and easy accessible IPR, and are comparable to patents in terms of availability and quantity of data, while offering an exclusive right for the identification of goods and rights at the same time. However, in most jurisdictions, these rights only persist if the registered trademark is used in commerce (Mendonça *et al.*, 2004). Another strong argument for the use of trademarks is the fact that they generate one of the highest IPR revenues; only the value for patents is higher (Doern, 1999). Agostini *et al.* (2016) report that small companies with at least one trademark in their fashion industry sample show higher performance in terms of sales growth than other SMEs with no trademark. However, they cannot find this effect for their other sample in the mechanical industry, where neither trademarks nor patents show a direct impact. A study by Kitching and Blackburn (1998) shows a high adoption of trademarks by SMEs with about 52 percent of the sample, compared to only about 29 percent by micro enterprises with less than ten employees. Research indicates that innovative performance is linked to trademark analysis (Mendonça *et al.*, 2004), and that trademarks can also be used as an indicator for innovation (Schmoch, 2003). Since applying for trademarks is cheaper than for most other statutory IPRs, it is likely that more SMEs will turn to trademarks rather than patents (Mendonça *et al.*, 2004). Finally, in some analyses, SMEs account for the majority of overall trademark applications (Millot, 2011). However, trademarks have been investigated in the context of large firms, and to a lesser instance in the context of SMEs, even though the potential for trademark applications by SMEs seems to be high (Agostini *et al.*, 2016):

H4a. IP protection through trademarks is positively related to firm performance in SMEs.

H4b. IP protection through trademarks moderates the relationship between open innovation and firm performance so that the relationship is stronger when trademark use is high rather than low.

The use of copyrights as a tool for saving creative work and "the expression of ideas" (Depoorter, 2004, p. 53) is gaining momentum, as the rise of ICT in recent years has led to a permanent increasing relevance of such protection (Burrone, 2005). Thomä and Bizer (2013) classify protection mechanism of SMEs into four clusters: an informal protection group, a patent-oriented group, a copyright-oriented group, and a non-protection group.

Their empirical study shows that the latter is the most commonly applied by SMEs at 64 percent, followed by the informal group at 19 percent, the patent group at 11 percent, and the copyright group at 6 percent. Members of the patent-oriented group are considered more innovative, especially in terms of cooperative innovation and new product introductions in the market. In terms of copyrights, they state that the use is widespread across all industry sectors. Finally, the authors highlight that the copyright-oriented group also focuses on trademarks and industrial designs as protection mechanisms. Hence, it can be assumed that the use of copyrights in SMEs is also linked to a higher use of related IPR such as industrial designs. SMEs tend to prefer rights, such as copyrights, which do not necessarily need to be registered. These are used in a UK sample by more than 50 percent of all companies included (Kitching and Blackburn, 1998). Moreover, Seo *et al.* (2015) highlight that informal types of value capturing like copyrights can be especially efficient in the invention stage of product development. Finally, Agostini *et al.* (2015) indicate that informal protection (such as trade secrets) might lead to superior performance:

H5a. IP protection through copyrights is positively related to firm performance in SMEs.

H5b. IP protection through copyrights moderates the relationship between open innovation and firm performance so that the relationship is stronger when copyright use is high rather than low.

Methods

Sample and data source

We use data from the PITEC database, which is the Spanish Community Innovation Survey (CIS). We include data for the years 2008-2013. The PITEC database is a panel data survey of manufacturing and service firms which engage in innovative activity. Whereas the CIS is carried out biannually, the PITEC is an annual survey. The PITEC is of mandatory character, which results in a high response rate of over 96 percent for each of the included years. We exclude firms that were created in the years of the survey, experienced a recent merger or closure, or lack data for some of the years or variables.

We classify the sample into small, medium sized, and large firms as per the SME definition of the European Union (EU) (2015): small firms employ less than 50 people and the annual turnover does not exceed ten million EUR. Medium-sized firms have less than 250 employees and a turnover of 50 million EUR or less. Large firms have 250 employees or more and a turnover of over 50 million EUR. We exclude micro enterprises with less than ten employees. When we refer to SMEs, we include both SMEs. The final sample is a balanced panel data set covering 2,873 firms during six years, i.e. 17,238 firm years.

We also classify the firms according to their industry corresponding to the Eurostat classification which divides industries into low-tech manufacturing (LTM), medium-low-tech manufacturing (MLTM), medium-high-tech manufacturing (MHTM), high-tech manufacturing (HTM), non-knowledge-intensive services (NKIS), and knowledge-intensive services (KIS). The correspondence between PITEC industries and the Eurostat classification is carried out according to the conversion table of Goya *et al.* (2012).

Earlier versions of the PITEC database have been used to investigate, e.g. the complementarity of research and development (Barge-Gil and López, 2013), R&D employment composition (Afcha and García-Quevedo, 2016), the adoption of open innovation (Sandulli *et al.*, 2012), cooperation in service innovation (Trigo and Vence, 2012), human resource barriers to innovation (D'Este *et al.*, 2014), and the impact of firm age on innovation (Coad *et al.*, 2016). Andries and Faems (2013) advocate undertaking research of patenting activities and firm performance with recent data, specifically mentioning data from 2008 onwards. We address this suggestion by using data from 2008 to 2013.

Measures

The dependent variable, firm performance, is measured as the turnover for each firm and year. Padilla-Meléndez *et al.* (2013) found that market results of R&D projects are the best measure of the success of knowledge transfer and exchange. The time lag effects of the independent variables may vary across firm sizes and also across industries. We therefore first conduct the analysis without a time lag and then introduce a one-year time lag. We do not expect longer time lags for our focal object SMEs, since these firms tend to use speed to market as a strategic approach to IPR and therefore have a shorter time span between innovation and performance than firms in general (Leiponen and Byma, 2009). Applying and including the time lag to our analysis, we measured firm performance on the basis of independent variables plus one year for each year between 2009 and 2013. Consequently, our observation cycle is reduced by one year. We use the natural logarithm of turnover to obtain a normally distributed variable, while maintaining other variable characteristics.

Open innovation is measured binarily for each firm year as whether the firm engaged in cooperative innovation activity. The survey question for the year 2013 was:

> During the three years 2011 to 2013, did your enterprise co-operate on any of your innovation activities with other enterprises or institutions? Innovation co-operation is active participation with other enterprises or institutions on innovation activities. Both partners do not need to commercially benefit. Exclude pure contracting out of work with no active co-operation.

We use the wording of the CIS, which the PITEC survey participants received as a Spanish translation. In line with the definition of open innovation as "a distributed innovation process based on purposively managed knowledge flows across organizational boundaries" (Chesbrough and Bogers, 2014, p. 17), cooperation is necessary for a distributed innovation process and is purposively managed. The operationalization of open innovation follows that of Sandulli *et al.* (2012) using the PITEC database.

The use of IPRs is measured binarily for each firm year. For patents, the survey question for the year 2013 was:

> During the three years 2011-2013, did your enterprise apply for any patent to protect its technological inventions or innovations?

For industrial designs, respondents were asked:

> During the three years 2011-2013, did your enterprise register any industrial design or model?

For trademarks, the question was "During the three years 2011-2013, did your enterprise register any trademarks?"

For copyright, the question was phrased "During the three years 2011-2013, did your enterprise claim copyright?" Whereas the CIS question asks about the efficiency of IP strategies for increasing firm competitiveness, the PITEC asks which strategies the firm had used.

In line with prior literature on open innovation, we control for several variables (Spithoven *et al.*, 2013; Fosfuri, 2006; Leiponen and Helfat, 2010): The variable turnover from innovation is used to control for the percentage of turnover that is generated from products introduced during the three years 2011-2013 that were new to the market of the firm. We also control for R&D intensity, calculated as annual R&D expenditure over turnover. Firms with high R&D intensity tend to be more open and innovative (Cassiman and Veugelers, 2006). Internationalization is measured binarily, whereby firms are considered international when they cater to international markets.

Statistical method

We estimate the hypothesized effects with a series of random-effects regression analyses. Our random-effects models specify the error structure for each firm and therefore control for

heterogeneity between firms, i.e. variables that are different between firms, but that are stable for each firm. This method thus controls for factors such as industry, location, regulatory framework, and belonging to a group, which tend to be consistent over time for each enterprise. We hence avoid time-variant and cross-sectional endogeneity issues (Baltagi, 2008). Random effects are preferable to fixed effects as our sample includes a subset of all existing firms. We can express the random-effects model as follows:

$$y_{it} = \alpha + \beta X_{it} + u_i + \varepsilon_{it}$$

where X_{it} is a vector of the independent and control variables, u_i is a random effect for the ith firm, and ε_{it} is the within-firm error (Greene, 1993).

Since the classification according to industry and size tend to be stable within an enterprise, we cannot include these variables control for firm-specific effects at the same time. We therefore run separate random-effects regressions for each size category and for each industry category.

Results

Table I summarizes our hypotheses and the corresponding empirical support as detailed below. The descriptive statistics and correlations among the variables are presented in Table II for the whole sample. Table III reports these descriptive statistics and correlations for the subset of SMEs. Out of the 17,238 firm years (number of firms: 2,873) in the sample, 11,823, i.e. 69 percent belong to SMEs. Of the SMEs, 33 percent used some form of IP rights. Thus, 67 percent of SMEs did not use any IPR, compared to 66 percent in the sample as a whole. According to the variable means, the most frequently used IP right was trademarks, which was employed by 23 percent of all firms in the sample and 22 percent of SMEs. Patents were used by 17 percent of all firms and 16 percent of the SMEs, whereas industrial designs where used by 10 percent of all firms as well as of SMEs. The least used IPR was copyrights, used by only 2 percent of both the sample as a whole and of SMEs. Relatively few firms used several IPR simultaneously, with

Hypothesis	Support
H1: open innovation is positively related to firm performance in SMEs	Not supported
H2a: IP protection through patents is positively related to firm performance in SMEs	Not supported
H2b: IP protection through patents moderates the relationship between open innovation and firm performance so that the relationship is stronger when patent use is high rather than low	Rejected
H3a: IP protection through industrial designs is positively related to firm performance in SMEs	Supported
H3b: IP protection through industrial designs moderates the relationship between open innovation and firm performance so that the relationship is stronger when industrial design use is high rather than low	Not supported
H4a: IP protection through trademarks is positively related to firm performance in SMEs	Supported for small firms, rejected for medium-sized firms
H4b: IP protection through trademarks moderates the relationship between open innovation and firm performance so that the relationship is stronger when trademark use is high rather than low	Supported for medium-sized firms, rejected for small firms
H5a: IP protection through copyrights is positively related to firm performance in SMEs	Not supported
H5b: IP protection through copyrights moderates the relationship between open innovation and firm performance so that the relationship is stronger when copyright use is high rather than low	Supported

Table I.
Summary of hypotheses and corresponding findings

the most frequent case being the simultaneous use of patenting and trademarks, which was implemented by 7 percent of the SMEs.

We find some high correlations between dependent variables, which can be expected since we have several measures for IPRs. However, the variance inflation factors are under 1.25 and the tolerance over 0.80, which indicates that there are no multicollinearity issues (Kutner *et al.*, 2004). For the SMEs, correlations are weaker than for the sample as a whole, particularly between copyright and firm performance, and between industrial designs and open innovation.

Table IV reports the results of the panel regressions per firm size. Models 1 and 2 include all firms in the sample. In models 3 and 4, we restrict the sample to only SMEs. Models 5 and 6 are similarly restricted to small firms, models 7 and 8 include only medium-sized firms, and models 9 and 10 treat large firms only. Models 1, 3, 5, 7, and 9 do not include the moderating effects, which are included in models 2, 4, 6, 8 and 10.

Table V describes the regression results per industry class for the SMEs in the sample. Model 11 includes firms engaged in LTM, model 12 MLTM, model 13 MHTM, model 14 HTM, model 15 NKIS, and model 16 KIS.

Model 2 shows that open innovation is positively related to firm performance for firms in general. For the whole sample with firms of different sizes, IP protection through patents and industrial designs is positively related to firm performance. IP protection through trademarks and copyright on the other hand moderates the relationship between open innovation and firm performance so that the relationship is stronger when trademark use is high rather than low. Figure 1 depicts the interaction between open innovation and copyright for the whole sample.

	Mean	SD	1	2	3	4	5	6	7	8
1. Firm performance	16.531	1.834								
2. Open innovation	0.446	0.497	0.130**							
3. Patents	0.171	0.376	0.064**	0.145**						
4. Industrial designs	0.097	0.296	0.070**	0.036**	0.286**					
5. Trademarks	0.225	0.418	0.054**	0.095**	0.249**	0.338**				
6. Copyright	0.021	0.144	0.014*	0.032**	0.115**	0.188**	0.166**			
7. Turnover from innovation	0.125	0.241	−0.069**	0.083**	0.087**	0.070**	0.071**	0.060**		
8. R&D intensity	0.205	2.123	−0.169**	0.030**	0.045**	−0.014*	−0.000	0.005	0.064**	
9. Internationalization	0.805	0.396	0.140**	0.043**	0.120**	0.084**	0.058**	0.013*	0.028**	−0.053

Notes: $n = 17{,}238$. *,**Significant at the 10 and 5 percent levels, respectively

Table II.
Descriptive statistics and correlations for all firms

	Mean	SD	1	2	3	4	5	6	7	8
1. Firm performance	15.600	1.196								
2. Open innovation	0.408	0.492	0.036**							
3. Patents	0.162	0.369	0.067**	0.131**						
4. Industrial designs	0.095	0.293	0.112**	0.009	0.293**					
5. Trademarks	0.220	0.414	0.056**	0.081**	0.241**	0.318**				
6. Copyright	0.020	0.140	−0.010	0.022**	0.100**	0.154**	0.138**			
7. Turnover from innovation	0.134	0.249	−0.075**	0.092**	0.104**	0.080**	0.086**	0.067**		
8. R&D intensity	0.280	2.558	−0.235**	0.041**	0.053**	−0.018**	−0.001	0.005	0.069**	
9. Internationalization	0.808	0.394	0.286**	0.028**	0.099**	0.089**	0.070**	0.005	0.010	−0.067**

Notes: $n = 11{,}823$. **Significant at the 5 percent level

Table III.
Descriptive statistics and correlations for SMEs

Table IV.
Regression results per firm size

Model	All		SME		Small		Medium		Large	
	1	2	3	4	5	6	7	8	9	10
Open innovation	0.031**	0.024**	0.016*	0.010	0.011	0.011	0.006	−0.006	0.060**	0.050**
Patents	0.017	0.029*	0.004	0.010	0.014	0.016	−0.012	0.001	0.040*	0.075**
Industrial designs	0.033**	0.050**	0.062**	0.062**	0.037	0.039	0.083**	0.080**	−0.018	0.040
Trademarks	0.029**	0.001	0.026**	0.013	0.045**	0.049**	0.005	−0.025	0.053**	−0.018
Copyright	0.018	−0.041	0.020	−0.028	0.003	−0.048	0.016	−0.016	0.007	−0.066
OI × patents		−0.024		−0.011		−0.002		−0.025		−0.058**
OI × industrial designs		−0.035		0.001		−0.007		0.013		−0.089**
OI × trademarks		0.057**		0.027		−0.009		0.062**		0.119**
OI × copyright		0.113**		0.109**		0.135*		0.057		0.112
Turnover from innovation	0.042**	0.044**	0.023	0.024	0.018	0.018	0.021	0.022	0.093**	0.093**
R&D intensity	−0.049**	−0.049**	−0.049**	−0.049**	−0.047**	−0.047**	−0.060**	−0.060**	−0.660**	−0.664**
Internationalization	0.026*	0.026*	0.056**	0.055**	0.114**	0.114**	0.012	0.011	0.028	0.026
Constant	16.488**	16.491**	15.510**	15.513**	14.617**	14.617**	16.432**	16.437**	18.390**	18.397**
Model diagnostics										
R^2 within firms	0.056	0.058	0.088	0.088	0.100	0.100	0.076	0.078	0.031	0.035
R^2 between firms	0.056	0.055	0.108	0.107	0.221	0.222	0.111	0.108	0.060	0.056
R^2 overall	0.041	0.040	0.084	0.083	0.175	0.176	0.080	0.079	0.051	0.048
Wald χ^2 (df)	899**	923**	1008**	1016**	687**	690**	434**	443**	185**	206**
n	17,238	17,238	11,448	11,448	5,802	5,802	5,646	5,646	5,790	5,790
Firms	2,873	2,873	1,908	1,908	967	967	941	941	965	965

Note: *,**Significant at the 10 and 5 percent levels, respectively

Model	LTM 11	MLTM 12	MHTM 13	HTM 14	NKIS 15	KIS 16
Open innovation	0.001	−0.014	0.033*	−0.066	0.060	0.033
Patents	0.036	0.040	0.017	−0.017	−0.014	−0.022
Industrial designs	0.012	0.073*	0.073**	0.029	0.088	0.101
Trademarks	−0.015	0.053*	−0.016	−0.002	0.105**	0.027
Copyright	−0.017	−0.000	−0.064	0.234	−0.207	−0.003
OI × patents	0.023	−0.026	−0.005	−0.069	−0.034	0.022
OI × industrial designs	0.056	0.023	0.007	−0.009	−0.058	−0.042
OI × trademarks	0.021	0.015	0.039	0.094	−0.091	0.036
OI × copyright	0.150	0.112	0.172**	−0.725**	0.100	0.107
Turnover from innovation	0.040	0.010	0.003	0.064	0.015	0.049
R&D intensity	−0.434**	−0.052**	−1.301**	−0.058**	−0.325**	−0.047**
Internationalization	0.016	0.091**	0.014	0.107	0.076	0.023
Constant	15.822**	15.832**	15.888**	15.637**	15.403**	14.845**
Model diagnostics						
R^2 within firms	0.028	0.016	0.048	0.132	0.197	0.171
R^2 between firms	0.096	0.078	0.108	0.077	0.152	0.132
R^2 overall	0.061	0.058	0.082	0.072	0.112	0.117
Wald χ^2 (df)	51**	35**	151**	107**	121**	571**
n	1,854	2,034	3,096	810	576	3,078
Firms	309	339	516	135	96	513

Note: *,**Significant at the 10 and 5 percent levels, respectively

Table V.
Regression results per industry class for SMEs

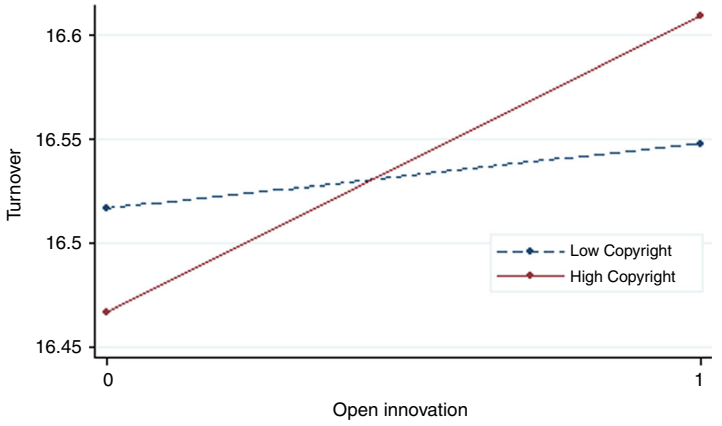

Figure 1.
Interaction between open innovation and copyright for the whole sample

Model 4 reports the results for SMEs and does not support *H1*, which claims that open innovation is positively related to firm performance in these companies. There is no support for this hypothesis in SMEs, small firms (model 6), or medium-sized firms (model 8). The effect for large firms is stronger (model 10) and is behind the positive effect for the sample as a whole.

Our results do not support *H2a* that IP protection through patents is positively related to firm performance in SMEs, nor do they support *H2b* about the moderating effect of patents on the relationship between open innovation and firm performance (models 4, 6, and 8). Whereas patenting has both a direct and a moderating effect in the case of large firms (model 10), no impact is found for SMEs.

Model 4 renders support for *H3a*, regarding the impact of IP protection through industrial designs in SMEs. In particular, this relationship is supported for medium-sized firms (model 8), but not for small (model 6) or for large firms (model 10). The support is stronger for SMEs in medium-high and medium-low-technology manufacturing industries than for firms in general (Models 12 and 13). *H3b* about the moderating effects of industrial designs in SMEs is, however, not supported.

H4a about IP protection through trademarks is only supported for small firms (model 6), but not for medium-sized (model 8) or large (model 10). The moderating effect of trademarks on the relationship between open innovation and firm performance is not supported for SMEs (model 4) but is supported for medium-sized (model 8) and large firms (model 10). The results of model 15 indicate that the direct relationship between IP protection through trademarks and firm performance is stronger for SMEs in non-knowledge intensive service industries than for firms in general.

H5a regarding the positive impact of copyrights on firm performance is not supported by our results. On the other hand, copyright use does have a positive moderating effect on the relationship between open innovation and firm performance in SMEs as per *H5b* (model 4). This impact does, however, not hold for medium-sized or large firms when taken separately (models 8 and 10). For high-technology manufacturing SMEs, the impact of open innovation on firm performance is negative when moderated by IP protection through copyright (model 14). The constant and the Wald χ^2 are significant of all models in Tables IV and V which asserts the validity of the models. Whereas the Wald χ^2 are highest for SMEs (models 3 and 4), the R^2 is highest for small firms (models 5 and 6), which indicates that our models are particularly suitable for small firms. However, the model does not fit large firms as well, as seen by the lower R^2 of models 9 and 10.

In Tables VI and VII, we run the regressions with a one-year time lag between independent and dependent variables. We thus capture the slower effects of open innovation and IPR on firm performance. We do, however, lose one of the six years of data for each firm, which reduces the fit of the model, particularly within firms, as shown, for example, by the R^2 within firms of model 4 which is reduced from 0.088 in Table IV without the time lag to 0.010 in Table VI, where the time lag has been added. The Wald χ^2 is greatly reduced for all models and is not significant for models 12 and 13 in Table VII. This loss of data points reduces the support for *H1*, *H3a*, and *H4b*. However, Table VI also shows a negatively moderating impact of IP protection through patenting, which was not discernible in the short term. This impact rejects *H2b* and is particularly important for medium-sized enterprises (Table VI, model 8) and for firms in HTM (Table VII, model 14). We graph the relationship in Figure 2, and observe that the medium-sized firms that patent experience a negative impact on firm performance from open innovation.

The longer-term direct effect of trademarks is also negative for medium-sized firms (Table VI, model 8) whereas it remains positive for small firms (Table VI, model 6). The moderating effects are, however, inverse: positive for medium-sized firms, and negative for small firms. For large firms, we discern a long-term effect of copyright use, with a negative direct effect on firm performance and a significant moderating effect.

Discussion and theoretical implications

Comparably little is still known about the linkage of a companies' attitude to appropriability with their open innovation activities (Laursen and Salter, 2004; Granstrand and Holgersson, 2014).

Our findings show that although open innovation has a positive impact on firm performance in SMEs, this impact only occurs when coupled with suitable IPRs. Moreover, it is weaker for SMEs than for large firms. Given the trend toward open innovation in SMEs (Van de Vrande *et al.*, 2009), it is worrying that open innovation does not have a clear positive impact on firm performance. As Spanish firms are less propense to collaborate in

Table VI. Regression results per firm size with one-year time lag

	All		SME		Small		Medium		Large	
Model	1	2	3	4	5	6	7	8	9	10
Open innovation	0.009	0.007	−0.005	−0.002	−0.024	−0.013	−0.002	−0.007	0.031**	0.024
Patents	0.000	0.012	0.000	0.023	−0.004	0.011	−0.004	0.031	−0.003	−0.011
Industrial designs	0.029**	0.025	0.044**	0.022	0.057**	0.021	0.034**	0.022	0.008	0.057
Trademarks	0.023**	0.016	0.006	0.011	0.029*	0.056**	−0.022	−0.042**	0.065**	0.040*
Copyright	−0.003	−0.038	0.003	−0.007	−0.053	−0.038	0.039	0.002	−0.032	−0.128**
OI × patents		−0.020		−0.043*		−0.032		−0.064**		0.013
OI × industrial designs		0.005		0.052*		0.091**		0.027		−0.079*
OI × trademarks		0.014		−0.009		−0.066**		0.044**		0.042
OI × copyright		0.069		0.020		−0.052		0.074		0.153**
Turnover from innovation	0.038**	0.038**	0.027	0.027	0.024	0.022	0.020	0.020	0.064**	0.064**
R&D intensity	−0.016**	−0.016**	−0.017**	−0.017**	−0.017**	−0.017**	−0.042**	−0.041**	−0.040	−0.042
Internationalization	0.025**	0.025*	0.064**	0.064**	0.153**	0.0153**	−0.011	−0.010	0.014	0.013
Constant	16.475**	16.476**	15.491**	15.490**	14.575**	14.571**	16.445**	16.446**	18.370**	18.374**
Model diagnostics										
R^2 within firms	0.008	0.008	0.009	0.010	0.010	0.012	0.019	0.022	0.005	0.008
R^2 between firms	0.053	0.052	0.143	0.140	0.265	0.266	0.080	0.079	0.034	0.028
R^2 overall	0.035	0.035	0.099	0.096	0.188	0.189	0.057	0.056	0.024	0.020
Wald χ^2 (df)	107**	112**	124**	130**	138**	146**	100**	109**	29**	38*
n	14,365	14,365	9,540	9,540	4,835	4,835	4,705	4,705	4,825	4,825
Firms	2,873	2,873	1,908	1,908	967	967	941	941	965	965

Note: *,**Significant at the 10 and 5 percent levels, respectively

Model	LTM 11	MLTM 12	MHTM 13	HTM 14	NKIS 15	KIS 16
Open innovation	0.007	−0.028	0.029	−0.132**	0.075	0.008
Patents	0.037	0.006	0.064**	0.091	−0.059	−0.029
Industrial designs	−0.032	−0.027	0.056**	−0.071	0.066	0.040
Trademarks	−0.028	0.059**	0.000	−0.059	−0.040	0.054
Copyright	0.019	0.083	−0.033	−0.180	−0.058	−0.003
OI × patents	−0.002	0.008	−0.067**	−0.212**	−0.077	0.004
OI × industrial designs	0.102**	0.081	−0.005	0.158	0.001	0.034
OI × trademarks	0.015	−0.045	−0.006	0.151**	−0.072	−0.042
OI × copyright	−0.103	−0.082	0.073	−0.411	–	0.072
Turnover from innovation	0.058	0.048	−0.018	0.147*	−0.044	0.024
R&D intensity	−0.256**	0.018	−0.028	−0.033**	−0.125**	−0.016**
Internationalization	0.015	0.089**	0.040	0.196*	0.099	0.022
Constant	15.803**	15.814**	15.786**	15.544**	15.382**	14.820**
Model diagnostics						
R^2 within firms	0.018	0.008	0.006	0.072	0.041	0.019
R^2 between firms	0.065	0.046	0.044	0.026	0.128	0.129
R^2 overall	0.040	0.033	0.030	0.027	0.094	0.084
Wald χ^2 (df)	26**	15	17	43**	20**	58**
n	1,545	1,695	2,580	675	480	2,565
Firms	309	339	516	135	96	513

Note: *,**Significant at the 10 and 5 percent levels, respectively

Table VII.
Regression results per industry class for SMEs with one-year time lag

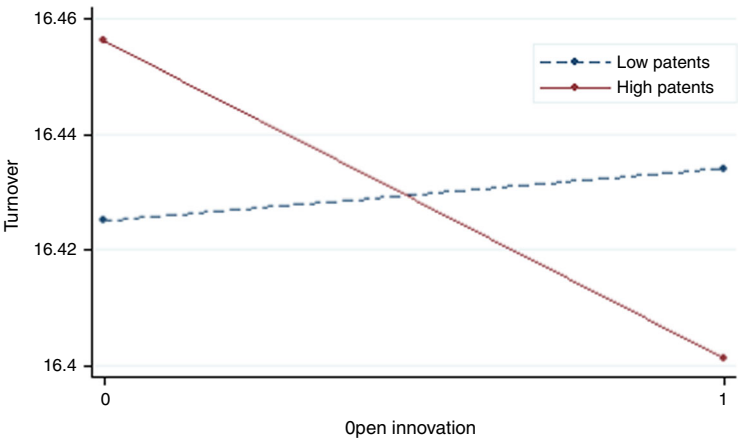

Figure 2.
Interaction between open innovation and patents with time lag for medium-sized firms

innovation compared to firms in other EU countries (Guimón and Salazar-Elena, 2015), the importance of coupling open innovation and IPRs may be even more important in other settings. Our results thus align with those of Lee *et al.* (2009) and Kim and Park (2010) in claiming that open innovation is not necessarily always positive for SMEs. They also support the findings of Agostini *et al.* (2016), who found that small firms profit differently from IPR in terms of firm performance as compared to medium sized or large companies. Hence, it is highlighted that the generally used term "SME" might be too broad to cover the full range of differently sized companies. Future studies need to analyze in more detail each category of the EU (2015) definition, e.g. with medium-sized firms ranging from 50 to 250 employees and 10 to 50 million EUR of sales.

The increased costs related to open innovation possibly offset the resulting profit. This claim is supported by current research. For example, the costs for IP protection may be a culprit: Eppinger and Vladova (2013) point out that SMEs may be unable to afford the expense of certain patenting activities, such as hiring external legal experts, which is also supported by Kalanje (2006) who states that cost and lack of resources hinder SMEs from patenting. Even if they patent, they often use patents only to protect from imitation rather than using it as a basis for their own successful product development (MacDonald, 2004). This is in contrast to big companies which usually have distinct legal departments for IP-related issues, and who use IPR as a strategic tool (Hanel, 2006). When SMEs patent, they focus on innovations where they see a high probability of market success, rather than applying systematic patenting to protect specific technology areas (Spithoven *et al.*, 2013). This is why MacDonald (2004) argues that the patent system itself is designed for large companies, and at the same time much less attractive to small- and medium-sized firms. Contrasting this view, earlier research indicates that SMEs are even more likely to apply for IPR than large firms (Jensen and Webster, 2006).

Family-run businesses, of which most are small to medium sized, make up 89 percent of all businesses in Spain, and create 67 percent of private employment (Instituto de la Empresa Familiar, 2016). In such firms, a small number of family members are responsible for decision making, which is influenced by past experiences and decisions. This can lead to entrenched processes, and finally organizational inertia. Changes in the business environment pose a threat to organizations suffering from inertia, since they are slower at reacting to such changes (Huang *et al.*, 2013). Family members also have a personal interest in the firm, and therefore may make strategic decisions based not on what is best for the organization in the long run, but on what is best for family members. Lasagni (2012) states that such behavior may lead to family members making less innovative changes. Additionally, since it is possible that the creator of the firm is also the owner of an SME, a change in mindset, vision, and leadership may be needed to bring an innovation to fruition (Harryson, 2008). This is in line with Kirschbaum (2005), who stated that the different stages of innovation have different objectives, and therefore a different management style may be needed at each stage. In essence: success may depend on an ongoing change in managerial mindset.

When it comes to the strategic use of IPRs, our results show a negative impact of patenting on the turnover for medium-sized firms that engage in open innovation. These findings contradict earlier studies suggesting a positive link between patenting and firm performance in SMEs (e.g. Andries and Faems, 2013; Spithoven *et al.*, 2013). However, this might be linked to the fact that SMEs in Europe tend to patent less than larger companies in general. Small firms in particular fear litigation, so they are much less involved in such legal issues than large companies (Hanel, 2006). Additionally, the arduous patenting process may cancel out any positive effects (Kalanje, 2006), contrary to previous research (Andries and Faems, 2013, Thomä and Bizer, 2013). Although previous research suggests that SMEs file less patents in total, our findings show the proportion of SMEs that engage in patenting and other IPRs is nearly as large as for firms in general (33 percent vs 34 percent), although each SME may file fewer patents. SMEs only patent a little less than firms in general, whereas the lack of impact on firm performance may call for less or even more focused patenting. This is in line with Thomä and Bizer's (2013) argumentation, that the efficiency of patent protection is too low if the amount spent on obtaining the patent is too high.

As stated by Burrone (2005), SMEs tend to focus on patents rather than on alternative options. In contrast, our results show that 17 percent of SMEs use patents, with 22 percent of SMEs relying on trademarks. This result does not align with earlier research on IPR in SMEs, where it is assumed that SMEs prefer trademarks because of the comparably low costs (Mendonça *et al.*, 2004). In terms of IPRs, only 7 percent of all SMEs use patents and

trademarks simultaneously. This is surprising as technological developments can be saved strategically through such combinations (Kalanje, 2006).

The usage of industrial designs in this sample is comparably low with 10 percent of all company sizes, and within the sample of SMEs, compared to a study in the UK with over 30 percent (Kitching and Blackburn, 1998). However, other research indicates that such rights are generally less used by SMEs (Hanel, 2006; Burrone, 2005) and that small firms tend to avoid using registered IPR (Thomä and Bizer, 2013). Medium-sized firms could opt for industrial designs, especially if they are active in medium-high and medium-low-technology manufacturing industries. This IPR does not, however, improve the firm performance of small firms, based on our results. An explanation for the low number might be the fact that companies prefer to opt for an examined patent, rather than rely on an unexamined industrial design. Another reason could the fact that these companies focus more on technological development and the positioning of a brand in the market.

Trademarks are the most used IP right in our sample, which is in line with other studies, such as Kitching and Blackburn (1998). This is not surprising as such rights are comparably cheap and easy to access, while offering specific protection to a product (Mendonça *et al.*, 2004). This is also shown by earlier research which highlights that trademarks typically generate a high IPR revenue (Doern, 1999), and that SMEs with innovations of a mainly informal nature rely more on trademarks and related IPR to differentiate themselves (Burrone, 2005). Our empirical investigation has, however, shown that the impact on firm performance of using trademarks in combination with open innovation is complex, and that short-term positive effects may be reduced by negative effects in a longer term.

Copyrights protect the expression of literary, artistic, and scientific work (Bogers *et al.*, 2012), which is especially important in areas like software development. Companies in the sample do not use copyrights strategically, with a share of only 2 percent. Despite a rise in importance in recent years through ICT, it may be the case that a high percentage of SMEs does not know that they can also use copyrights strategically as an IPR, as they might even have copyrights without being aware of it. One explanation could be the fact that copyrights are granted through publication, without further formal processes. According to our findings, relying on copyrights for IP protection does not increase firm performance in our focal firms.

Managerial and policy implications

Our results not only have major implications for managers in these companies, but also for policymakers, in order to foster innovation in all kinds of SMEs, which are so important for regional economies.

The inefficient use of open innovation may be hindering SMEs from reaping the benefits of openness. As with most processes, open innovation is likely to become more efficient as firms gain experience, which would explain why large firms are benefiting more from openness. Both managers and policy makers may thus want to engage in initiatives that accelerate the experience curve for open innovation in SMEs. As Spanish firms engage relatively little in open innovation (Guimón and Salazar-Elena, 2015), firms in some other countries may be at a more advanced stage on this experience curve. Both regions and firms could consider their previous experience with collaborating in innovative activities in order to become more efficient. Companies may want to start taking small steps toward engaging in open innovation, to gain experience and to find out if and how they might benefit from such collaborations. As the field of open innovation is maturing, courses, and other learning materials are becoming available for managers to learn how to engage efficiently in open innovation. Since our research underlines the importance of efficient open innovation and a correct coupling of open innovation and IPR, managers are encouraged to seek training in this respect.

We would not go so far as to say SMEs should not patent, but they may be well advised to employ other forms of IP protection if they cannot patent efficiently. Similarly, the

long-term negative effects of using trademarks call for caution when using this form of protection. A more targeted use of copyrights may be useful because of the low costs and ease of formal application, these options can also be applied by small companies. However, potentially high costs of legal enforcement of such rights should be taken into consideration, and that also competitors might be abreast of the new development. Overall, each IPR has its advantages and disadvantages, which should encourage also SMEs to learn about these factors to use IPRs strategically.

For policy makers, supporting more efficient patenting and trademark processes in SMEs would be a way to improve the efficiency of innovation in general, and of open innovation in particular. For instance, the costs of filing and maintaining IPRs should be more distinctive for small or big companies. In many countries such initiatives are already in place, so company leaders should carefully take such options of support into consideration.

Finally, it is worth mentioning that external collaborations, such as open innovation activities, need to be embedded in an overall strategy for acquiring external knowledge. For this reason, research suggests using decision support frameworks as proposed by Howells *et al.* (2004).

Limitations and further research

To the best of our knowledge, this study is the first to focus on most available IPRs, namely, patents, industrial designs, trademarks, and copyrights, in relationship with open innovation and firm performance in an SME context. Beyond this newness there are also some important limitations to face.

A main limitation of this paper is that we do not take the appropriability paradox of IP protection into consideration, which is highlighted in earlier research as a critical factor (Laursen and Salter, 2004). We acknowledge that it is important to consider legal and strategic aspects of appropriability regimes. As mentioned earlier, we refer to other publications that address this issue in depth, which we think is necessary to cover this paradox in its full scope. Regarding this issue, we analyze only the IPR activity itself, and not its impact. For instance, a company, despite a limited number of IPRs, may have defined an industry standard with these few rights, called dominant designs (Brem *et al.*, 2016). Such research might also be a potential track for new projects.

A further limitation of this study is the focus on Spain, even though there are several good reasons why our analysis regarding companies of this country makes sense (e.g. EASME, 2016). However, since markets and policies within the European Union are diverse, the results cannot easily be transferred to other countries and regions. This offers a starting point for future research, which should follow our analysis in other countries, especially in the EU.

A key limitation of this paper is the fact that SMEs rely in many cases on protection forms which cannot be measured by IP data, namely, trade secrets (Almeling, 2012), secrecy and speed to market (Leiponen and Byma, 2009). Hence, we suggest that future research should also include specific questions to analyze relationships between the use of secrecy, speed to market, and other IP regimes.

Another limitation is measuring IP with four binary variables, a choice linked to our focus on contrasting the four types of IP use. The focus on contrasting the four types of IP use limits the depth in which we investigate each construct. The degree of use of each type, e.g. the number of patents, as well as the reasons for choosing a certain type of IP when engaging in open innovation would be fruitful avenues of further study.

Moreover, IP is also related to high transaction costs (Bogers *et al.*, 2012). Future research should take this further into consideration. Another key aspect is the usage of the term SME. Given that our results indicate rather diverse results depending on the category according to the EU (2015) definition, we recommend undertaking more studies which focus on each

subcategory to analyze effects for each industry class. In addition, this study did not distinguish between the different sub-types of open innovation, like coupled processes. As these processes are supposed to have an impact on protecting collaborative innovation activities, future studies should consider them (Bogers *et al.*, 2012). Hence, future research might want to break the definition of open innovation down to its components: e.g. collaborations focused on knowledge gain (outside-in) or knowledge sharing or commercialization (inside-out). Another avenue for research could be the area of competitive intelligence: if and how do SMEs use, e.g. patent documents as sources of innovations (Kalanje, 2006).

An interesting direction that has not been contemplated in this study is the relationship between family-run SMEs and open innovation, focusing on IP activities. Future studies could analyze the management behavior of IP practices and decision-making processes in family-run SMEs, and compare it to other SMEs or large firms. We also encourage future research with other industry samples, including different countries in Europe, Asia and the USA. Finally, we would like to mention that we did not discuss explicit IPR strategies, but the use of commonly available IPRs in SMEs. Future research might also want to include several strategic approaches in using IPR in corporate strategy.

In conclusion, SMEs do not yet efficiently engage in open innovation. Amongst other initiatives that could help accelerate the path of SMEs toward benefiting from open innovation are more efficient patenting processes. Meanwhile, SMEs tend to be better off relying on IPRs such as trademarks or industrial designs to protect IP in open innovation, where applicable.

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