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INNOVATIVE ACTIVITY AND PROPENSITY TO INNOVATE IN EXTREMADURAN KIBS COMPANIES

BEATRIZ CORCHUELO
University of Extremadura, Spain
bcorchue@unex.es

LUÍSA CARVALHO
Institute Polytechnic of Setúbal and CEFAGE
University of Évora, Portugal
luisa.c.carvalho@esce.ips.pt

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Innovation is one of the pillars that sustains the productive dynamism of a company, region or country. This research aims in particular to identify the barriers to innovation that influence the innovative process of Extremaduran knowledge intensive business services (KIBS) companies and their subsequent performance in innovation. Data were obtained from an *ad hoc* questionnaire and sent to managers of Extremaduran companies (Spain). Two waves of data are available: 2011 and 2013. From these, various aspects related to the objective of the work are analysed descriptively and econometrically. Results reveal the existence of obstacles, mainly of a financial and market nature, which hinder innovation in companies. We propose guidelines to encourage public and private entities to formulate measures and policy proposals aimed at improving innovation performance and overcoming barriers to innovation.

Keywords: KIBS companies; innovation; obstacles to innovation; R&D public policies.

Introduction

Innovation is one of the pillars that sustains the productive dynamism of a company, region or country. The OECD (2010) recognises that innovation is a key driver of growth of economies. Consequently, the European 2020 Strategy, agreed by the member states in June 2010, outlines a global plan for Europe, in which innovation is a fundamental growth tool. The promotion of private investment

in innovative activities is, furthermore, a key element in companies' strategies through improved access to innovation financing.

In this sense, one of the principal objectives of public innovation policies in many countries is to promote greater involvement of all kinds of companies in innovative activities in order to achieve increased knowledge which will contribute to an improvement in competitiveness and welfare.

Nevertheless, most government innovation support programs are still designed with the manufacturing company in mind and not companies in the service sector. Despite this, the service sector in the global economy has increased its interest in the dynamics of innovation and how to promote it effectively. Only recently it is seen in specialized literature that efforts are being made an to specify the motivations and characteristics of an innovation policy that takes into account the particularities of the services sector and, specifically, of knowledge-intensive business services (hereafter KIBS) (Aghion *et al.*, 2005; den Hertog *et al.*, 2008; Toivonen, 2006; OECD, 2006; González, 2008; Cruysen and Hollanders, 2008; Therrien *et al.*, 2011; Ettlie and Rosenthal, 2011; Consoli and Elche, 2013).

Some European countries are carrying out programs to support innovation in services (OECD, 2012). Austria, Finland, Germany and Japan have programs dedicated to research and innovation related to the involvement of users or employees in innovation, the development of new business models and the production of services in industrial companies. France has introduced the innovation *voucher* in "green" (environmental) services for small and medium-sized enterprises (SMEs) in the construction sector. Similarly, Ireland has a *voucher* system for SMEs that supports the development of new business models, customer interface or new mechanisms for the provision of services. Denmark has introduced the Service Cluster Denmark program that supports the co-creation, based on R&D, of services by companies and researchers. The United Kingdom has introduced the innovation laboratory in public services to test innovative solutions and provide the possibility of scaling up through the country's public services. Sweden has introduced a public procurement program to promote the acquisition of innovations in the public sector. The Netherlands has extended tax credit to R&D to include the development of software-based services. Sweden has incorporated innovation in services into its new approach to innovation through challenges, which emphasizes co-creation with customers/users and focuses on collaborations between sectors, for example, on sustainable city projects, or the future of health services. In Finland, on both national and regional levels, a pioneering experience is being developed in which public programs support innovation in services through the Server Program executed by the Finnish Agency for Innovation Financing (TEKES), aimed especially at the highly innovative projects

of Finnish KIBS companies that seek to encourage the creation of companies through the establishment of incubators and other types of exclusive centres for this type of company (Vargas, 2016).

González (2008) addressed the problem of incorporating KIBS firms in innovation policy agendas. The need to establish convenient policies in this sector was justified theoretically mainly concerning their link with regional smart specialization (Asheim *et al.*, 2011). Cruysen and Hollanders (2008) indicated some conditioning factors that show cause for a direct intervention in the service sector. Firstly, there is the difficulty of appropriation of the income generated by investment in innovation as well as the risk of imitation. Secondly, the existence of information asymmetries generates problems in the financing of innovation projects due to the high uncertainty and risk that this entails. It has also been observed that in highly concentrated (non-competitive) markets, innovation tends to fall to levels that are further from the competition (Aghion *et al.*, 2005). Systemic market failures are caused by problems in the functioning and coordination between institutions, regulatory deficiencies and poor collaboration among different agents of national innovation systems. González (2008) concluded that strengthening of this sector would be especially important in peripheral areas and for SMEs that have more difficulty accessing this type of service.

In addition to public policies to support innovation, the study of the importance of innovation in services has also been introduced relatively late compared to the manufacturing sector because historically it has had a significant weight in the gross domestic product (GDP). Its study began to be taken into consideration at the end of the 1980s and the 1990s, motivated by the significant increase in spending on innovation in developed countries since the 1980s (Escauriaza *et al.*, 2001). Participation of the services sector in GDP has in fact increased in recent years, reaching an average of 70% in developed countries (European Commission, 2012).

Several factors have contributed to this late study of innovation in this sector. One of these factors is motivated by the varying nature of the innovation. Complications arise when defining innovation due to its dynamic nature when it comes to producing and consuming a service. In this sense, the study of innovation in the service sector is complicated by the lack of a generally accepted theoretical body in the sector, the tools generated to determine innovation in companies, and the heterogeneity of services (Romero and López, 2015). Another factor that complicates the study is the absence of statistical information as well as an inadequate definition of indicators and measures. The way in which they innovate is not widely known because it is not easy to measure services.

In general, the service sector has traditionally been considered as scarcely innovative (Morrar and Gallouj, 2016). This is because of its heterogeneity and

because the knowledge that is generated in some companies cannot be generalized to the entire sector, and it may not even be homogeneous within the same branch at the international level. Innovation in the service sector is different from that in the manufacturing sector, since the success factors are different (Ruíz *et al.*, 2006). There are important differences between the innovation strategies followed by the service and manufacturing companies, which are, in turn, a reflection of the differences that exist at the level of production and the characteristics of the products that both types of companies offer to the market. Services are intangible (Sundbo and Gallouj, 2000; Andrii, 2015), production and consumption happen simultaneously, often there is no clear division between the service provider and the service itself, they cannot be stored, and, in many cases, it is difficult to achieve standardization. Ettlie and Rosenthal (2011) described how service and manufacturing firms are different when it comes to innovation. They found that there appears to be real differences between how manufacturing and services approach the innovation process, primarily because of the way organisations formalise the development of new offerings in these two sectors. While the manufacturing sector is more likely to report the need for new strategies and structures when products are new to the industry or new to the firm, the service sector is more likely to convert novelty into success. These characteristics highlight the market failures that affect innovation activities in the services sector and make it more evident that they receive relatively less financial support for carrying out innovation activities compared to manufacturing (Crespi *et al.*, 2014).

However, despite the heterogeneity of the sector, the services performed by KIBS companies could be defined as a "differentiating group" given that they act as transfer agents, supporters and sources of innovation for other sectors (Bessant and Rush, 1995; den Hertog and Bilderbeek, 1998; Miles *et al.*, 2005; Muller and Doloreux, 2009; Carvalho and Pinto, 2013). These companies help client companies to innovate, generate, transmit and disseminate new knowledge (Zieba, 2013).

All these characteristics are reflected in the definitions given for KIBS companies. Of these, Miles *et al.* (1995, p. 18) define KIBS as "services that involve economic activities that are intended to lead to the creation, accumulation or dissemination of knowledge". The following characteristics of KIBS companies are highlighted: (a) they are based largely on knowledge; (b) they are primary sources of information and knowledge (reports, consultancy, etc.) or they use their knowledge to produce intermediary services of production processes for clients; and (c) they are of competitive importance and they supply mainly to companies. Miles *et al.* (1995) distinguish two types of KIBS companies: the professional knowledge-intensive service companies (p-KIBS) that are users of technology (commercial and management services, legal and accounting, market studies,

management consulting, etc.), and technological knowledge-intensive service companies (t-KIBS) whose activity focuses on information and communication technologies and other technical activities (services related to technological information, engineering, testing and technical analysis, R&D consulting, etc.).

den Hertog and Bilderbeek (1998) define KIBS as a "second knowledge infrastructure" that complements and even merges with traditional infrastructure, made up of universities and public research centres. According to Toivonen (2004, p. 77), KIBS are "services that are provided to other companies or the public sector in which experience plays an especially important role." Muller and Doloreux (2009, p. 9) point out that "they are service companies characterized by providing intensive knowledge services to other companies and organizations, services that are predominantly routine". Finally, Consoli and Elche-Hortelano (2010) define them as intermediary companies specialized in knowledge detection, assessment and professional consulting services. In summary, KIBS companies are characterized by their ability to collect knowledge and external information and transform it, combined with internal knowledge in a customized service product to the requirements of client companies. They are "service companies" that provide services demanded by companies and public organizations; "Knowledge-intensive" both for qualified work and for how transactions between the supplier and the client are carried out by companies in which human capital is the dominant factor.

The special characteristics of KIBS and their contribution to innovative activity have recently aroused interest. The importance they are gaining shows the shift from an industry-based economy to a knowledge-based economy in which their future developments require faster change (Zieba, 2013).

Based on this justification, the main objective of this research is to analyse the innovative activity and the propensity to innovate of KIBS companies in the region of Extremadura (Spain), and the relationship with public policies established to encourage innovative activity. In particular, we aim to identify the barriers to innovation that influence the innovative process of Extremaduran KIBS companies and their subsequent performance in innovation. Within this general objective, the following questions are addressed: what are the characteristics of the KIBS companies? What factors influence consideration of the importance (objectives) of innovation? What are the main obstacles to develop innovation activities detected by companies? What are considered the main benefits of innovation? What public actions are demanded to boost innovative activities? And, how do the obstacles affect the probability to innovate? Thus, the main contributions of the present study are as follows: identification and analysis of the benefits, objectives and main limiting factors to innovation performance focusing on the identification of their nature, origin and importance and the promotion of a better understanding of

these factors, and to pave the way for future studies to identify good practices and overcome the constraints. Additionally, these aspects are linked with public actions that governments could put into effect in order to boost these activities in this sector. In this sense, Madrid-Guijarro *et al.* (2009), and Hidalgo and D'Alvano (2014) argue that understanding the factors that act as barriers to innovation can be useful for developing public policies that encourage innovation and for assisting managers to promote a culture of innovation in firms, as one of the determinants of the survival and success (Perel, 2002; Helmers and Rogers, 2010).

Data were obtained through an *ad hoc* questionnaire sent to managers of Extremaduran companies, from which KIBS companies were selected. Two waves of data are available: 2011 and 2013. From these data, various aspects related to the objective of the work are analysed descriptively and econometrically. The results reveal the existence of obstacles, mainly of a financial and market nature, which make it difficult for companies to innovate.

Our study is original because, to our knowledge, despite abundant literature related to the innovative role of KIBS companies in the economies, there is no study applied to a particular Spanish region. Extremadura has a lower innovative intensity than the national average, so the analysis of innovative activity and the factors that determine the probability of innovation, as well as factors that hinder its development and public policies to develop it, is of interest, and the results obtained and the methodology used could be applied to other sectors and countries.

The study is organized as follows: In the second section, a review of research that has studied the innovative role of KIBS companies as well as their influence on the territory and innovation systems (national and regional) is presented; "Data and Descriptive Study" section explains how the data were obtained, and a descriptive study reveals the main issues analysed in the questionnaire. Following this, the empirical model and estimation method are explained. Next, we present the results and the discussion, and finally, the main limitations of the study, future lines of research and conclusions are outlined.

Background

Studies related to KIBS mainly cover three aspects. The first relates to the definition of KIBS, their characteristics and classification, as well as their relationship with customers. In their activity, KIBS companies bring innovation to companies and are part of the system that creates and generates innovation in countries and regions, producing a positive impact on the economy and contributing to economic development (Vence and González, 2005, for European regions). The second is

based on innovative activity and the role of KIBS in regional and national innovation systems and their contribution (Corrocher and Cusmano, 2014; Doroshenko *et al.*, 2014). The third aspect addresses the determinants and factors connected with the operations of these companies and interactions with the environment (Evangelista *et al.*, 2012), related to sector growth (Koch and Stahlecker, 2006) and associated to spatial proximity and cluster (Shearmur and Doloreux, 2012). In this sense, the study by Drejer and Vinding (2005) for Denmark showed that companies located in large urban areas were twice as likely to collaborate with KIBS companies as those located in peripheral areas, and another study developed in Norway confirms this pattern (Herstad and Ebersberger, 2015).

Focusing on the second aspect, there are several international studies that show the relevant role of KIBS in innovation systems (national and regional) and the economies of the countries, as well as the innovative nature of KIBS and their positive effect on the innovation of the countries.

With regard to this aspect of study, Strambach (1998) performed a pioneering study in analysing the role of KIBS in regional innovative performance and found direct (innovations) and indirect effects (knowledge). In this line of research, are also the studies of Makun and MacPherson (1997) for the three major regions of the State of New York, and Drejer and Vinding (2003) for five large Danish urban areas. Miles (2007) suggested that the presence and use of KIBS in the economy improve the productive performance of other sectors and regions, and a positive relationship was obtained between KIBS companies and innovation. Toivonen (2007) also pointed out the need to link KIBS to innovation systems, particularly at the regional level. Recent studies (Corrocher and Cusmano, 2014) argued that KIBS drive the regional innovation systems because they are key players, particularly in advanced regions where manufacturing competitiveness largely depends on knowledge contents provided by highly specialized suppliers.

For greater geographic scope, Camacho and Rodríguez (2005) highlighted the innovative role of KIBS in the regions through a first empirical approach of the effects associated with the location of KIBS. They used data from 107 European regions. The results indicated that KIBS companies exert a positive impact on regional innovation performance, and that its impact could overflow to the neighbouring regions. Also focusing on European regions, the study by Corrocher and Cusmano (2014) concluded that KIBS companies are fundamental for regions that seek innovation, and that their low growth is a characteristic of low-yield innovation systems. Rodríguez (2014) analysed the role played by KIBS companies in the regional innovation process through the analysis of 240 European regions in 23 countries. Results of this study showed that, on one hand, interregional knowledge flows are a key element in the development of regional innovation, although technological proximity is less important than geographical

proximity, and on the other hand, regions with greater specialization in high technology services (High Tech Services, HTS) or with proximity to regions with a high presence of HTS innovate more because they improve the capacity to transform knowledge into innovation.

Applied to different countries and related to the innovative activity and the role of KIBS companies, Windrum and Tomlinson (1999) carried out a study for England, Holland, Germany and Japan. They concluded that the stronger the links between KIBS companies and the rest of the major industries, the greater are the externalities of innovation and services. Muller and Zenker (2001), for Germany and France, found that KIBS companies not only strengthen and stimulate innovation, but also increase the potential for regional and national innovation, since industrial SMEs that use KIBS tend to spend more on R&D and have close links with universities and research centres. Theter and Hipp (2002) in Germany analysed KIBS companies and other industries (wholesale and retail sales, transport and communications, banks and insurance and other financial services) and found a high probability of development of product innovations, especially in software industries and technical services. In Germany, Koch and Strotmann (2008) reported that access to knowledge through cooperation and networking are determining factors in the innovation of KIBS companies. Ferreira and Quadros (2006) in Brazil, concluded that KIBS companies are important in the creation and distribution of new knowledge and innovation, and that they also promote higher qualification of the workers of the client companies. In Brazil, too, Kubota (2009) showed that KIBS companies contribute positively to the technological innovation of customers, its impact being higher in the case of legal services, accounting and internet solutions. The study by Freel (2006) for the UK compared the innovative behaviour of manufacturers and KIBS companies and highlighted the importance of sources of innovation. Nevertheless, differences between KIBS companies with cooperation with suppliers and customers and KIBS companies dedicated to staff qualification were found. Pires *et al.* (2008) in Portugal, showed differences in the determinants of innovation in product and process of KIBS and manufacturing companies in terms of internal and external R&D; the size of the company matters less in the services than in manufacturing. Young companies are more likely to innovate in KIBS than in manufacturing, although young service companies are less likely to introduce process innovations. Amara *et al.* (2009) for companies in Quebec (Canada) found two relevant factors for all innovations: R&D and knowledge, in the added value of production practices. He and Wong (2009), in Singapore, showed a positive relationship between companies that use KIBS services and innovation, and pointed out that KIBS companies innovate more, although the development of R&D is less likely than in the case of manufacturing companies. The authors also pointed out the importance of human capital and

training. More recently, Doroshenko *et al.* (2014), for Russia, reported that KIBS companies are more prone to innovation and that their degree of impact depends on the industries in which they operate; and Shi *et al.* (2014), in China, concluded that KIBS companies promote innovation, especially in human capital and in the east of the country.

Regarding types of innovation, Leiponen (2005) and Toivonen (2004), in Finland, established that, in terms of innovation, three types are identified: *ad-hoc innovations*, *new fields in knowledge innovations* and *formal innovation*. Corrocher *et al.* (2009), in Lombardy (Italy), identified four innovation modes: *interactive innovation* (cooperation with other companies and customers), *product innovation* (similar to manufacturing) and *techno-organizational innovation* (technology adoption and its impact on relationships with users), and *conservative innovation* (those that do not develop relevant innovation activities). Romero and López (2015) reviewed a number of studies to determine the relevance of KIBS in the generation of product innovation and their role in the national innovation system. Among their conclusions, they emphasized that the influence of KIBS contributes to create and spread innovation in the companies and regions where they operate, so their role in the innovation system and the economy of the countries is relevant.

In the case of Spain, Martínez *et al.* (2005) conducted a study focused on Asturias and concluded that regions with lower KIBS companies supply have a lower competitiveness of companies. The level of innovation is higher in the presence of KIBS companies in the regions. Rodríguez and Camacho (2010) highlighted the innovative nature of KIBS companies and identified four innovation modes: *hard innovators*, companies that apply innovation to obtain mainly product innovations; *soft innovators*, companies that develop process and non-technological innovation; *lonely innovators*, those that do not relate to other agents; and *knowledge diffuser*, companies that spread knowledge by maintaining a close relationship only with other agents of the innovation system, especially universities and research centres.

Studies on obstacles to innovation perceived by KIBS companies and their effect on innovative activity are scarce. Morrar and Abdelhadi (2016) analysed the obstacles of innovation and their influence on innovation capacities in companies (differentiating between product, process, organisational and marketing innovation) of KIBS companies in Palestine. Their results showed that obstacles to innovation hinder the propensity of companies to innovate at different levels. The economic factor (high costs and lack of internal and external financing) was the factor with the greatest negative impact on the types of innovation, followed by the demand barrier reflected in weak competition and uncertainty and the impact of previous innovation. The knowledge factor, on the other hand, had a positive

impact on a number of companies that focus on organisational and marketing innovation, being able to overcome it and address it. In Maldonado-Guzmán *et al.* (2016) *environmental, financial* and *human* external barriers to innovation activities in service SMEs in the State of Aguascaliente (México) were studied. Their results indicated that the three barriers investigated hinder innovation, with the external environmental barrier being the most important. Amara *et al.* (2016) used a sample of Canadian KIBS firms to argue that different obstacles will affect different forms of innovation. The results showed that, overall, financial obstacles are negatively related to product and process innovations, and that knowledge obstacles tend to be negatively associated with delivery, strategic, managerial and marketing innovations. These authors argued that understanding the barriers to innovation improves the theories that explain why some firms do not want to innovate or actively engage in innovation. Carvalho and Sarkar (2018) used a sample for Portuguese KIBS that indicates that managers perceive the existence of important positive relationships between their firms' degree of technological innovation and the level of service innovation, as well as between these and market returns achieved. De Moraes *et al.* (2019) investigated the association between internal barriers to innovation and the propensity of technology-based SMEs to cooperate with universities and research institutes (URIs) in Brazil. They analysed technology-based SMEs and high-tech manufacturing companies and KIBS and found that financial obstacles were shown to be strongly related to the propensity of KIBS to collaborate with URIs.

Finally, the effect of innovation policies on the innovative activity of service companies has also received scarce attention. González (2008) addressed the problem of incorporating KIBS into the agendas of innovation policies. The need to establish convenient policies in this sector was justified theoretically. The author concluded that strengthening of this sector would be especially important in peripheral areas and for SMEs that have more difficulties in accessing this type of services. Busom *et al.* (2015), in Spain, analysed whether service companies follow the same or different patterns of behaviour with respect to policies to stimulate R&D than manufacturing companies and whether it is necessary to design different policies in response to the productive sector. The use of fiscal incentives and direct public support in both sectors was compared together with their association with certain business characteristics. The main results concluded that there is no bias in favour of the manufacturing sector, and that the main differences between companies reside mainly in their capacities for the development of R&D activities, especially human capital and size in certain cases. To the extent that the service sector is more intensive in human capital and its level increases, greater access to public support mechanisms will be observed.

Data and Descriptive Study

Data

An *ad hoc* questionnaire was elaborated focusing mainly on variables related to innovation and other additional aspects. Its design is similar in some respects to the Innovation Survey of Companies elaborated by the National Statistical Institute (NSI) of Spain, although tailored to the needs and objectives of the study that incorporates new questions and issues. The survey was conducted during the months of September 2011 and June 2013.

This questionnaire entitled: *Diagnosis about innovation in business sector of Extremadura* was structured around five blocks of questions: Block I: Characterization data of the company (name of company, location, sector of activity, size, turnover, export activity, types of production processes and characteristics of informant); in Block II: Innovation developed during the last two/three years, type of innovation (product, process, marketing, organisational), types of expenses on technological and non-technological innovation, who develops innovation and how often, types of innovation protection, R&D staff availability and specific department of R&D, way of financing innovation and degree of importance of innovation; in Block III: perception of the importance given to innovation by companies: perception of barriers to innovation, benefits derived from innovation, valuation of the willingness to innovate and valuation of innovation as a key element of competitiveness; Block IV: Knowledge of subsidies and/or tax incentives for R&D activities (financial public support): grade of knowledge and application of direct support (regional, national or international grants) and knowledge and application of R&D fiscal incentives, difficulties for their application and results that reception of these public instruments have generated for companies; and, Block V: Demanded public actions by firms to boost innovative activities. Companies in the sector of manufacturing and KIBS of the Autonomous Community of Extremadura were contacted. For the manufacturing sector, disaggregation into three subsectors or groups of activity was made: Agri-food Industry, Energy and Other industry sector. The final sample was obtained from 777 companies in 2011 and 524 companies in 2013. The methodology was a survey by assisted telephone interview (CATI system). The participation of companies was voluntary (unlike the Innovation Survey of Companies of the NSI). Various statistical tests were carried out to confirm the robustness of the samples during both waves of data: 2011 and 2013.[1]

From the total data, KIBS companies were filtered and selected. The final sample is from 163 companies in 2011 (97 companies in the province of Badajoz

[1]All Tables and Figures are our own elaboration through information obtained from the data.

and 66 companies in the province of Cáceres). For 2013, the final sample is from 67 companies (35 in the province of Badajoz and 32 in the province of Cáceres).

Descriptive study

General characteristics

First, general characteristics of the KIBS companies are analysed. Table 1 shows the distribution of companies, according to company size. The first characteristic observed is that the business size is small: companies with fewer than 10 workers (micro small and medium enterprises-MSMEs).

Export activity is scarce: only 26 companies (16% of total) carry out export activities in 2011 and 11 (16.4%) in 2013.

Second, innovative activity of KIBS companies is analysed. With data from 2011, 80 companies (49.1%) claim to have carried out innovative activities in the last 2/3 years. The number of innovative company increases in 2013 is 45 companies (67.2%) claiming to have carried out innovative activities. Of the innovative companies, 18.8% (15 companies) are, in addition, export companies in 2011; and 11 companies (24.4% of the innovative companies) in 2013. Therefore, export companies in 2013 are, entirely, innovative companies in 2013.

Regarding the type of innovation performed, Fig. 1 shows that it is mainly technological innovation (product and process) although there is also a percentage of companies that claim to carry out non-technological innovations (organisational or marketing).

The type of expenditure on technological innovation is analysed. In Fig. 2, it is seen that, for the two years analysed, the highest expense corresponds to *acquisition of machinery and equipment*, followed by *training in innovation activities* and *internal R&D expenses*.

Regarding expenditures on non-technological innovation, a slight decrease in the number of companies that claim to invest in this in 2013 is shown.

Table 1. KIBS companies' size.

	2011		2013	
Size	Number of firms	% of total firms	Number of firms	% of total firms
< 10 workers	141	86.5	58	86.5
10–49 workers	20	12.3	8	12
50–199 workers	1	0.6	1	1.5
> 200 workers	1	0.6	0	0
Total	163	100	67	100

Fig. 1. Type of innovation (% innovative companies).

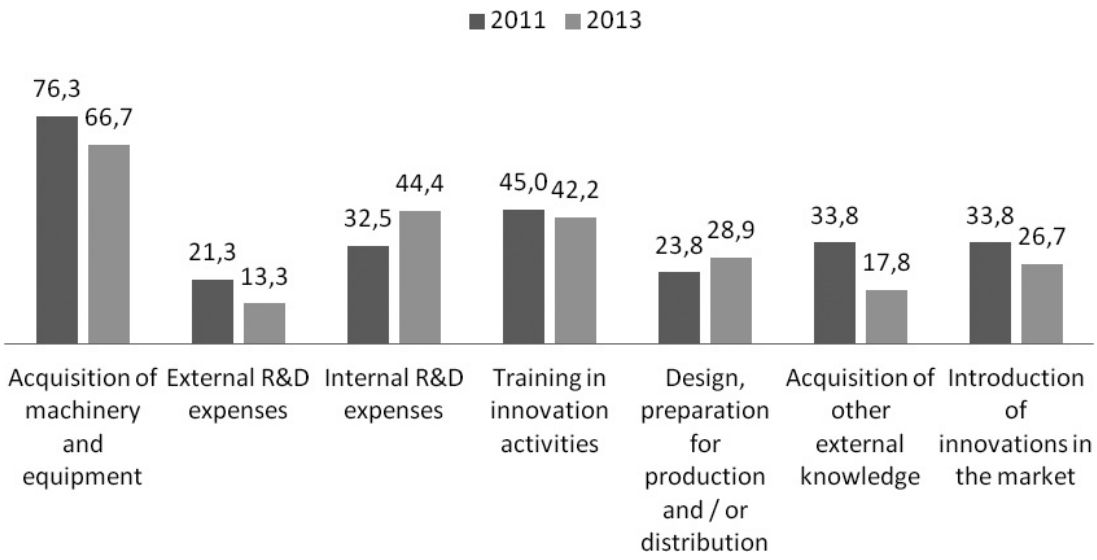


Fig. 2. Expenditures on technological innovation (% innovative companies).

Expenditures are mainly observed in *new business practices in the organization of work or procedures of the company* and *new techniques or channels for product promotion* (Fig. 3).

The way of financing innovations is mainly through the firm's own funds. The number of innovative companies claiming to use funding from subsidies or other direct public financial support, and, especially private funding, is scarce.

Also scarce is the number of companies that claim to protect innovations. Only 31.3% of innovative companies declare that they use some means of protecting innovations in 2011, which increases to 37.8% in 2013. The main ways to protect innovations are trademarks/trade names, followed by patents/ utility models.

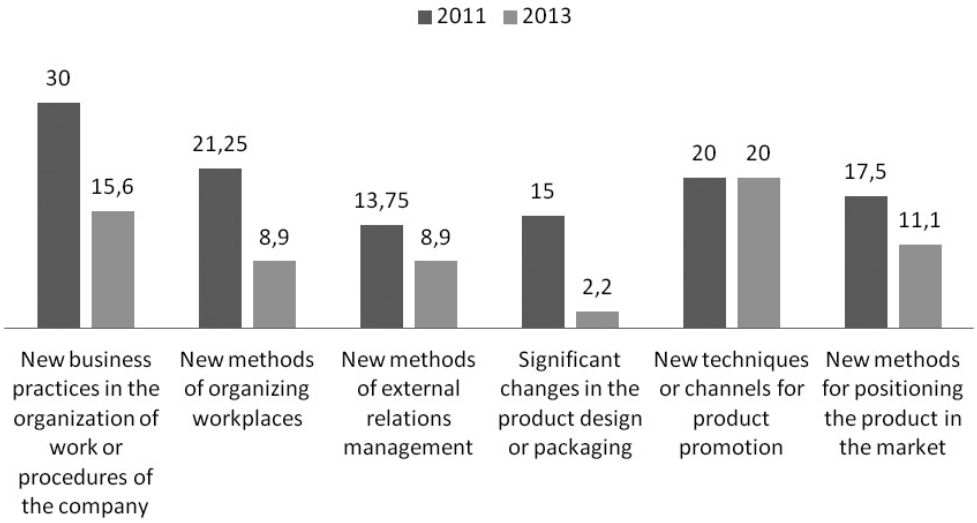


Fig. 3. Expenditures on non-technological innovation (% innovative companies).

Objectives, benefits and obstacles of innovation: Innovative companies

Questions relating to objectives, benefits and obstacles to innovation in innovative companies have also been analysed.[2] The items linked to these blocks of questions are assessed on a Likert scale from 0 (not very important) to 10 (very important). We use a scale of 11 points based on some studies (Churchill and Peter, 1984; Cunnis and Gullom, 2000; OECD, 2013; Bisquerra and Pérez-Escoda, 2015) that recommend the use of more categories on the scales because it increases sensitivity, it can increase reliability and it allows comparison with statistical analysis. The averages of the valuations of these aspects are presented in Figs. 4–6.

First, Fig. 4 shows the average of the evaluation of the *objectives to innovate.* There is a slight variation in the two years analysed, although it is observed that the most valued objectives of innovation for the KIBS companies are to offer a *higher quality of goods and services*, *replacement of outdated products or processes*, and to offer a *wider range of goods and services*. The less valued objectives of innovation are *lower labour costs per unit produced*, *fewer materials per unit produced* and *less energy per unit produced*. Therefore, the innovation objectives are linked to an innovative strategy aimed at differentiation, in order to increase competitiveness in the market, rather than to reduce costs.

Second, we analysed the perceived valuation of *benefits* that innovation brings from the point of view of *intellectual capital* (IC) that make up intangible elements

[2]The analysis focuses on innovative companies in this subsection because the questions were raised only for companies that declare innovative activities in the 2011.

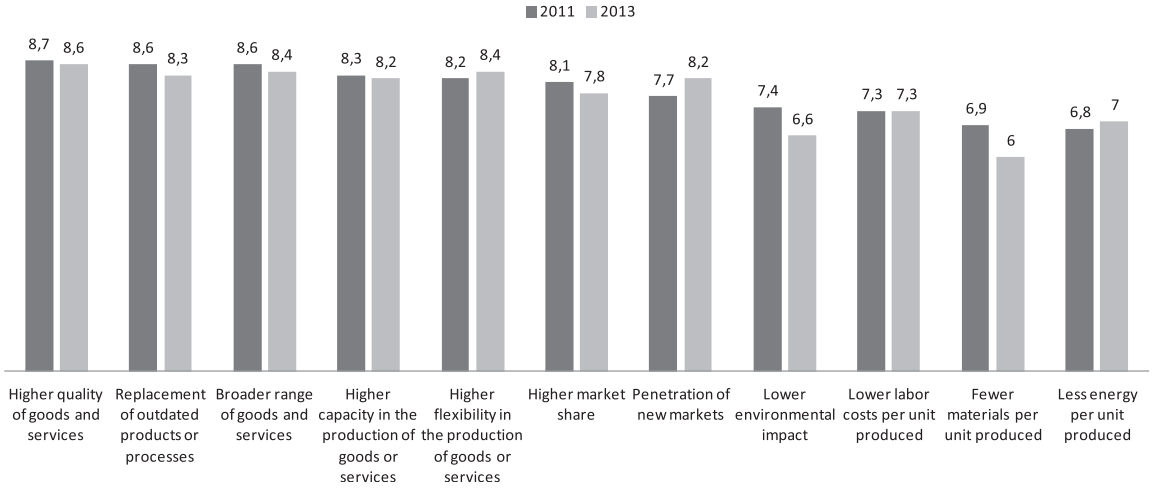


Fig. 4. Objectives to innovate (innovative companies).

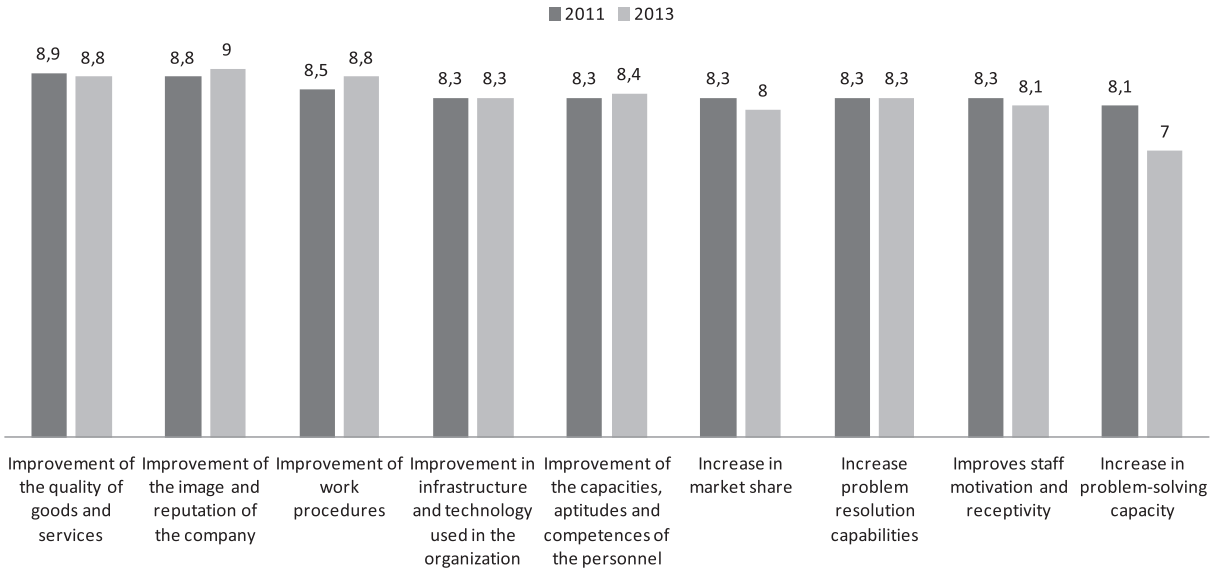
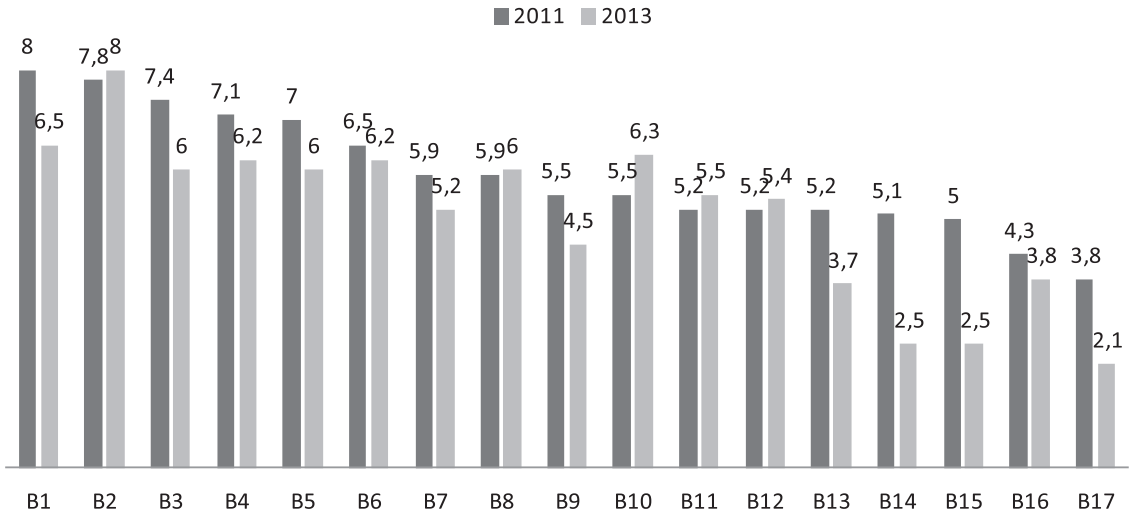


Fig. 5. Benefits of innovation (innovative companies).

in companies (Fig. 5). In general, the most repeated classification in literature identifies three groups of intangibles within IC: those related to *human resources* (human capital), *structure* (structural capital) and *external relations of entity* (relational capital) (Kaufman and Schneider, 2004). Figure 5 shows mean values of innovative companies from data 2011 and 2013. The most valued aspects are those related to *improvement of the quality of goods and services, improvement of work procedures* (both aspects in relation to structural capital of companies), and *improvement of image and reputation of the company* (associated with relational capital). Although the assessment, in general, is high, relatively less importance is given to what is reported by human capital benefits, especially *increase in problem-solving capacity*.



Notes: B1 (lack of external funding); B2 (lack of support from public administrations); B3 (high costs); B4 (high economic risks); B5 (lack of internal funding), B6 (markets dominated by established companies); B7 (market conditions do not imply the need to innovate); B8 (lack of innovation demand by customers); B9 (difficulty in finding cooperation with other companies); B10 (insufficient flexibility of rules and regulations); B11 (absence of innovation mediators); B12 (high imitation risks); B13 (lack of market information); B14 (lack of qualified personnel); B15 (lack of information about technology); B16 (difficulty to protect innovations); B17 (organisational problems of the company).

Fig. 6. Obstacles to innovation (innovative companies).

Finally, the *obstacles* perceived by innovative companies to innovate are evaluated. The questionnaire asks about 17 obstacles that have been classified according to: *financial barriers* (lack of internal and external financing, and high costs), *knowledge barriers* (lack of technological information and lack of market information), *barriers due to lack of resources* (lack of personnel, difficulty in finding cooperation with other companies, lack of innovation mediators, organisational problems), *market barriers* (markets dominated by established companies, high economic risks), *demand barriers* (market conditions do not imply need for innovating, lack of demand for innovation), *difficulty of appropriability* (difficulty in protecting innovations, high imitation risk) and *administrative barriers* (insufficient flexibility of rules and regulations and lack of support from public administrations). In general, for the two years, lack of support from public administrations is seen as the main barrier to innovation, followed by financial and market barriers (Fig. 6).

Willingness to innovate, competitiveness and public policies demanded

Finally, from the descriptive point of view, there are two sets of additional questions not contemplated in national or international innovation surveys. Both sets of questions are analysed for all companies.

Table 2. Willingness to innovate, competitiveness and demanded public actions.

	Innovative firms (mean values)		Non-innovative firms (mean values)	
	2011	2013	2011	2013
Willingness to innovate	7.5	7	4.4	3.4
Competitiveness	8.7	7.5	7.4	5.7
	Innovative firms (%)		Non-innovative firms (%)	
	2011	2013	2011	2013
Personalised advising	50	46.7	43.9	45.5
Direct public funding support (subsidies, soft loans)	51.3	66.7	42.7	72.7
Information seminars	30	20	19.5	31.8
Indirect public funding support (fiscal tax incentives)	51.3	35.6	42.7	59.1
Free training	20	26.7	18.3	22.7

First, companies were asked to rate on a Likert scale 0–10 the perception they have about their *willingness to innovate and take risks derived from innovation* (0: little willingness to 10: high willingness), and whether *innovation is considered as an important element of competitiveness* (0: low consideration at 10: high consideration). Table 2 shows the average valuations for both issues, differentiating between innovative and non-innovative companies. It is interesting to highlight the low average rating of non-innovative companies in willingness to innovate. However, despite the lack of willingness to innovate, innovation is considered as an important element of competitiveness, according to the average ratings obtained by innovative companies.

It is interesting to analyse the reasons that motivate the low willingness to innovate of non-innovative companies, which may be due to the obstacles to innovation detected. In this sense, the last aspect analysed in the questionnaire is about the demands for public action requested by companies in order to boost innovative activity. Table 2 shows the percentages of companies, differentiating between innovative and non-innovative firms. It is observed that, for both innovative and non-innovative companies, higher *public financial support* (direct: subsidies/soft loans, and indirect: fiscal tax incentives) is required, followed by more *personalized advising*.

Empirical Model and Estimation Method

Our goal was to measure the effect of obstacles to innovation on the propensity of Extremaduran KIBS companies to introduce innovations. Obstacles to innovation therefore will be our independent variable, and innovation output is the dependent variable. We use the innovation output index where a firm's innovation output is represented by three dummy variables. Each of these variables is equal to one if the company introduced an innovation (product, process, organisational and/or marketing), differentiating, as well, among product innovation and process innovation (Silva *et al.*, 2008). This taxonomy of innovation is based on the classification of innovation output used in the Oslo Manual (2005). We use data of 2013 because from this year we have information about the perceived obstacles to innovation for innovative and non-innovative companies. Of the total innovative companies, 67.2% reported to have performed innovation activities (product, process, organisational or marketing) in the last 2–3 years; 53.7% reported to have performed only product innovation and 18% only process innovation.

A binary choice probit model was employed to estimate the relationship, i.e., the impact of innovation obstacles on the innovation performance of KIBS companies in Extremadura. The model was run separately for each dependent variable (innovation, product innovation and process innovation). The binary probit model takes the following form:

$$Y_i^* = \alpha_i X_i + \beta_i B_i + \varepsilon_i > 0 \tag{1}$$

whereby the decision of the company "*i*" is a function dependent on a set of the control variables (X) and the barriers to innovation (B). However, the latent variable is not observed. What is observed is the realization of what simply depends on the decision of the firm, so that:

$$Y_i = \begin{cases} 1 & \text{if } y_i^* > 0 \\ 0 & \text{otherwise.} \end{cases} \tag{2}$$

Using this methodology, we analysed, as previously mentioned, three decisions: the company's propensity to perform an innovation (product, process, organisational and/or marketing), the company's propensity to perform a product innovation, and the company's propensity to perform a process innovation. In the first case, the latent variable Y adopts the value 1 when the company performed innovations (product, process, organisational and/or marketing) in the last 2–3 years, and 0 otherwise. In the second decision, the latent variable Y adopts the value 1 when the company performed a product innovation in the last 2–3 years, and 0 otherwise. Finally, in the third decision, the latent variable adopts the value 1

Table 3. Variables.

Dependent variables	
Innovation:	1: the company performed an innovation
Product innovation	1: the company performed a product innovation
Process innovation	1: the company performed a process innovation
Independent variables	
Companies' characteristics:	
Age	1: the company < 10 workers
Micro firm	1: the company < 10 workers
Localisation	1: the company is located in town $> 15{,}000$ inhabitants
Obstacles:	
Lack of internal funding	1: medium-high valuation; lack of internal funding
Lack of external funding	1: medium-high valuation; lack of external funding
High costs	1: medium-high valuation; high costs
Lack of qualified personnel	1: medium-high valuation; lack of qualified personnel
Lack of market information	1: medium-high valuation; lack of market information
Difficulty in finding cooperation with other companies	1: medium-high valuation; difficulty in finding cooperation
High economic risks	1: medium-high valuation; high risks
Markets dominated by established companies	1: medium-high valuation; markets dominated by well-established firms
Insufficient flexibility of rules and regulations	1: medium-high valuation; insufficient flexibility of rules
Difficulty to protect innovations	1: medium-high valuation; difficulty to protect innovations
High imitation risks	1: medium-high valuation; high imitation risks
Lack of support from public administrations	1: medium-high valuation; lack of support from public administrations
Lack of innovation demand by customers	1: medium-high valuation; lack of innovation demand by customers
Absence of innovation mediators	1: medium-high valuation; absence of innovation mediators
Market conditions do not imply the need to innovate	1: medium-high valuation; no necessity of innovations in the market

when the firms performed a process innovation in the last 2–3 years, and 0 otherwise (Table 3).

Obstacles to innovation are our main independent variable (shown in Fig. 6). Barriers to innovation variables have been recoded into dummy variables that have a value of 1 if the company has a medium-high valuation of the obstacle (values 7–10), and value 0 otherwise. In addition to the obstacles of innovation, the model includes a set of control variables: *age* (1: if the company has less than 10 years; 0: otherwise), *micro* firm size (1: if the company has fewer than

10 workers; 0: otherwise), and the size of the locality in which the company is located (1: $>$ 15, 000 inhabitants; 0: otherwise) (*location)*. As we have mentioned previously, Table 1 below shows that 86.5% of companies employ less than 10 employees. This shows that Extremaduran KIBS sector is considered a micro small sector. Most empirical studies find a positive relationship between firm size and innovation performance (Audretsch and Acs, 1991; Fariñas and Huergo, 1999; Shefer and Frenkel, 2005; Barge and López, 2011). Firm age is another control variable which might affect innovation performance of KIBS. Old firms might have more experience and market share that could reflect on financial capabilities and innovation (Hansen, 1992; Koutroumpis *et al.*, 2017). Only 13.4% of the companies have 10 or less than 10 years since their creation, so most of the companies are considered old firms. The variables used in the empirical model are shown in Table 3.

Results and Discussion

Table 4 shows the mean of the marginal effects for each observation (calculated for each value of the independent variables_*dy*/*dx*) and significances which underline the influence these different variables have on the probability. The obstacles that are not significant in all the decisions, i.e., *lack of technology information*, and *problems of organisation of the company,* are not considered.

Different results are observed according to the innovation decision that, in several cases, coincide in terms of sign and significance.

First, barriers due to *high costs* and *high imitation risks* show a positive and significant coefficient in all of the models (columns 2, 3 and 4). There are also positive and significant coefficients in the barriers *difficulty in finding cooperation with companies* and *lack of support from public administrations* in probability to innovate (column 1) and to perform product innovation (column 3). Nevertheless, this latter barrier has a negative impact on probability to perform process innovation (column 4). Likewise, there are positive and significant coefficients in the barriers *lack of innovation demand by customers* and *absence of innovation mediators* in probability to innovate (column 1), although again, the latter has a negative significant coefficient in the probability to perform process innovations (column 4). A positive and significant coefficient is shown in the barrier *lack of qualified personnel* in the probability of obtaining product innovations (column 3) and *insufficient flexibility of rules and regulations* in the probability of obtaining process innovations (column 4). In contrast to the most widespread assumption of the negative impact of innovation obstacles on the ability of firms to perform innovation, there are studies that find a positive impact. Baldwing and Lin (2002)

Table 4. Propensities to innovate.

Variables	Innovation (1) *dy/dx* (s.e.)	Product innovation (2) *dy/dx* (s.e.)	Process innovation (3) *dy/dx* (s.e.)
Obstacles:			
Lack of internal funding	−0.46 (0.124)***	−0.18 (0.241)	−0.19 (0.133)
Lack of external funding	−0.10 (0.089)**	−0.91 (0.083)***	−0.17 (0.143)
High costs	0.29 (0.174)***	0.90 (0.068)***	0.21 (0.110)*
Lack of qualified personnel	0.01 (0.055)	0.78 (0.165)**	0.25 (0.279)
Lack of market information	−0.10 (0.088)**	−0.76 (0.102)***	−0.11 (0.062)
Difficulty in finding cooperation with other companies	0.24 (0.123)***	88 (0.093)***	0.04 (0.121)
High economic risks	−0.04 (0.039)	−0.92 (0.084)**	−0.32 (0.166)**
Markets dominated by established companies	−0.22 (0.144)***	0.36 (0.284)	0.02 (0.146)
Insufficient flexibility of rules and regulations	−0.04 (0.068)	−0.48 (0.260)	0.33 (0.153)**
Difficulty to protect innovations	0.033 (0.041)	0.77 (0.119)***	−0.13 (0.062)**
High imitation risks	0.15 (0.096)	0.56 (0.237)*	0.34 (0.145)**
Lack of support from public administrations	0.93 (0.111)***	0.56 (0.124)***	0.12 (0.077)
Lack of innovation demand by customers	0.18 (0.136)**	0.26 (203)	0.06 (0.086)
Absence of innovation mediators	0.12 (0.097)**	−0.29 (0.267)	−0.25 (0.129)**
Market conditions do not imply the need to innovate	−0.18 (0.120)**	−0.07 (0.194)**	0.05 (0.140)
Companies characteristics:			
Age	−0.21 (0.154)*	−0.68 (0.205)***	−0.19 (0.071)**
Micro firm	−0.10 (0.059)**	−0.61 (0.194)**	−0.15 (0.220)
Localisation	−0.03 (0.040)	−0.80 (0.165)	−0.13 (0.113)
N° Observ.	62	62	62
Log-likelihood	−18.274	−17.369	−15.379

Notes: (1): The dependent variable takes on value 1 if the company has carried out innovation activities in the last 2/3 years (product, process, organisational and/or marketing), and 0 otherwise; (2) the dependent variable takes on value 1 if the company has carried out product innovations, and 0 otherwise; (3) the dependent variable takes on value 1 if the company has carried out process innovations, and 0 otherwise. Each column shows the mean of the estimated marginal effect of the covariates in each probability (*dy/dx*). *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$.

and Tourigny and Le (2004) explained the significant positive coefficient associated with the variable obstacles of innovation. According to these authors, the obstacles to innovation indicate how successfully a firm can overcome these obstacles, which means that the innovation barriers motivate firms to make greater efforts to overcome these barriers and so increase their innovative capabilities. The

latter study concludes that small firms do not face particular impediments which prevent them from becoming innovative, although, in our case, being a small size (fewer than 10 workers) there is a negative impact on innovation development and, especially, product innovations. It is interesting to note that, to our knowledge, there are no studies that reveal the lack of appropriability (*difficulty to protect innovations* and *high risk of imitation*) as a barrier to innovation. This is because, in general, the national innovation surveys do not contemplate the type of barriers that have been taken into account in our questionnaire. The result shows the importance of these types of barriers as a deterrent or incentive barriers depending on the type of innovation. Pellegrino and Savona (2017) found that demand-side factors, particularly concentrated market structure and lack of demand, are as important as financial constraints in determining firms' innovation failures. This evidence redirects attention from financial to non-financial barriers by considering traditional demand, market structure and regulation factors involved in reduced firm innovation performance.

Second, there are obstacles that, conversely, have a negative and significant effect on innovative decisions of KIBS companies. The barrier *lack of internal and external funding* makes it difficult to innovate (column 2). However, there are differences according to the type of innovation: *lack of internal funding* has a negative and significant effect on the probability of performing process innovation (column 4), while *lack of external funding* reduces the probability to carry out product innovation (column 2). There are numerous studies that detect these obstacles and their influence on innovation probability and other decisions applied to companies from different countries, such as Hadjimanolis (1999) for companies from Cyprus; Savignac (2008) in France; Silva *et al.* (2008) and Silva *et al.* (2017) for Portuguese firms; McCann (2010) for United Kingdom; and Demirbas *et al.* (2011) for Turkish firms. The study by Amara *et al.* (2016) for Canadian firms, Maldonado-Guzmán *et al.* (2016) for Mexican companies, and Morrar and Abdelhadi (2016) for Palestinian companies, also conclude that financial obstacles are negatively related to innovation in these cases in KIBS companies.

The obstacle *lack of market information* has a negative and significant effect on the probability to innovate (column 2) and the probability of performing product innovation (column 3) but has no significant effect on the probability of process innovation. Canales and Álvarez (2017) analyse the impact of knowledge-obstacles on the probability of introducing innovations, concluding that these types of barriers reduce by approximately 26% innovation probability in Chilean firms.

A negative and significant effect of the barrier *high economic risks* is also observed in the propensity to perform product and process innovation (columns 3 and 4). Obstacles linked with *high economic risks* are shown in some studies such

as Comtesse *et al.* (2002) in Switzerland; McCann (2010) in the UK; or Necadová and Scholleova (2011) in the Czech Republic.

Finally, barriers due to market conditions (*markets dominated by established companies* and *market conditions do not imply the need to innovate*) have a negative and significant effect on the general propensity to innovate. The study by D'Este *et al.* (2012) points to market conditions as an important barrier to innovation. Sipos *et al.* (2014) analysed the impact of hampering innovation factors on innovative performance both within innovative and non-innovative firms. They group the European surveyed countries into four main categories and reported that *market dominated by established companies* was a highly important hampering innovation factor only for a relatively small share of innovative companies belonging to countries with high innovative performance.

With regard to the control variables, being a newly created company has a negative and significant effect in all of the models (columns 2, 3 and 4), thus showing that older companies with more experience and market share have higher financial and innovation capacities.

In summary, it can be observed that *lack of financing* is presented as the main barrier to innovation. The following also have a negative effect on the probability of innovating in a different way: *lack of information about markets*, *high economic risks*, *markets dominated by established companies*, *market conditions do not imply the need to innovate* and the *difficulty to protect innovations*. Public actions demanded by KIBS companies can contribute to reduce the perception of these barriers to innovation, especially financial and lack of information so that attention must be paid to them in order to stimulate innovative activity in the sector.

Conclusion

This research especially aims to identify the barriers to innovation that influence the innovative process of Extremaduran KIBS companies and their subsequent performance in innovation. Other aspects such as objectives and benefits of innovation are also descriptively analysed.

In terms of the contributions of this research, the results obtained allow us to propose guidelines to encourage public and private entities to formulate measures and policy proposals that are aimed at improving innovation performance and overcoming barriers to innovation. These policies must, first of all, ensure the process of creating knowledge based on research, an aspect that constitutes the essence of KIBS companies. Likewise, they should encompass to a greater extent the non-technological aspects that characterize innovation in services and in particular in KIBS. It is necessary, therefore, to adopt a broader concept of innovation

that takes into account the importance of both technological (product and process) and non-technological (especially organisational) innovations. It would also be necessary to adopt financial incentives for both technological and non-technological aspects to permit their access to the KIBS companies. Policies that stimulate demand for KBIS can also stimulate supply and quality. These measures are particularly important, given that Extremaduran KIBS businesses consist mainly of micro and small companies. As the study by González (2008) concluded, these measures take on special significance, especially in the case of peripheral regions and SMEs.

The authors are aware that this study has some limitations. First, there was the difficulty of obtaining data (the questionnaire was not compulsory for companies), although in the end, we achieved a fairly representative sample of Extremaduran KIBS business reality. It is also important to point out that, unlike official data offered by the NSI in Spain, the available data from the questionnaire are from companies with fewer than 10 workers which, as has been analysed, constitutes the principal size of the Extremaduran business structure.

The second limitation is that we have information about only two periods (2011 and 2013). The Spanish national and regional economic crisis must be taken into account in these periods of time. Data obtained come from a recessionary environment, which could also be related to higher or lower willingness to innovate.

Despite these important limitations, we consider that this study could be a framework for future research in this field. We consider that, despite the time elapsed between the sample data (2011 and 2013) and the present date, the recommended measures indicated in the previous paragraphs should be taken into account in order to increase the perception of the advantages that innovation brings to companies in terms of competitiveness, and to design specific public policies that would reduce the perception of obstacles and encourage innovation in this type of companies.

These limitations also provide us with the basis for further studies in the following directions:

(1) Firstly, it would be of great interest to use the available data to delve further into the specific innovative characteristics and barriers to innovation that are perceived by Extremaduran KIBS companies. Specifically, it would be convenient to have access to continuous variables such as number of employees, turnover, export volume, R&D expenditures, personnel dedicated to R&D, etc. These continuous variables would allow more detailed results to be obtained.
(2) It would also be of interest to extend analysis of the factors that can influence unwillingness to firms to innovate, especially in non-innovative firms: age of

companies, occurrence of small and non-competitive markets, limited availability of financing, etc., and to expand the available information to other years.

(3) The methodology and analysis could be applied to other Spanish regions and, in particular, a comparative analysis could be made with Portugal.

It is our intention to improve all these aspects by enlarging the range of future data, reviewing those variables of the questionnaire for which there was no adequate answer and analysing in greater depth those barriers perceived by companies to innovate. Also of interest would be to determine what type of public policy actions can be recommended to promote and stimulate innovative activity, with the particular aim of increasing willingness to innovate, considering that innovation brings competitive advantages to companies as well as enhanced growth and wellness in the region.

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