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DOES THE LOCATION IN A SCIENCE AND TECHNOLOGY PARK INFLUENCE UNIVERSITY-INDUSTRY RELATIONSHIPS? EVIDENCE FROM A PERIPHERAL REGION

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Abstract

This article investigates the role of firm location and absorptive capacities in university – industry interactions. The study observes firms in Science and Technology Parks (STPs) and other spaces of a regional innovation system. It focuses on the effects that location has in establishing diversified interactions, in comparison with other firm traits usually associated to drawing from universities. The empirical basis for the analysis is a face-to-face survey to 737 firms in Andalusia. Descriptive analysis and regression models have been used in order to detect specific influences coming from the quality of the space and firm traits on five dimensions. The results show that being located in an STP has an influence only on developing informal contacts and human resources training. In contrast, other characteristics of both the location and the firm have an influence on using university services and engaging in R&D collaboration. The study provides evidence on the importance of certain qualities of space, including closeness to universities and existence of specialized institutions.

Keywords: University-Industry Relationships, Science and Technology Parks, Knowledge Transfer, Regional innovation systems, Andalusia

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INTRODUCTION

This paper aims to fill a gap in empirical research on knowledge transfer processes by exploring how both firm features and attributes of the geographical environment affect the different channels of knowledge transfer between firms and universities orpublic research organizations (PROs) in a regional innovation system. As a theoretical background, the paper combines substantive arguments and accumulated evidence on the factors shaping university-industry (U-I) interactions and studies on the effects of Science and Technology Parks (STPs) on innovation.

STPs are conceived as spaces that promote firm innovation by enhancing networking, knowledge transfer and localized spillovers. In particular, it is assumed that STPs facilitate bringing R&D to the economy by creating a bridge between knowledge-based companies, universities and PROs. Agglomeration in a STP may facilitate the creation of close networks and the exchange of useful information between firms and academic research teams. The specific services available in a STP may be useful to get the right contacts and to avoid the transaction costs that firms usually have when looking for research organizations. Therefore, STPs are an important ingredient for policies that try to create regional innovation systems in order to facilitate firm innovation by channeling university knowledge and resources to productive sectors, especially in peripheral regions where innovative firms are scarce and universities have been traditionally oriented to higher education and the production of public knowledge.

However, empirical research on both STPs and knowledge transfer processes show some important gaps in disentangling the specific factors that shape the diversity of U-I interactions. First, there are difficulties for grasping the specific "qualities of space", in addition to proximity and location, that provide advantages for interacting with universities. There may be several influential factors such as the existence of organizations tailored to strengthen the R&D activities of local firms, the presence of Technology Transfer Offices (TTOs) and the circulation of R&D workers and service providers derived from the clustering effects. Second, studies on U-I relationships have shown that important influential factors determining the existence of links with universities are related to the structural characteristics of the firm. Size and productive sector, together with the so called absorptive capacities reflected by the existence of internal R&D and the education of workers, are considered among the more influential. Nevertheless, it is not clear whether interactions with universities are shaped by being located in a STP or by the traits of the firms usually located in these spaces, given that STPs usually try to attract firms related to high-tech or at least knowledge intensive firms. Third, another important gap comes from the empirical information available about the multiple forms of knowledge transfer in contrast to the information provided by universities. While many official registries are based on formal interactions (mainly patent agreements and contract research), other important channels consist on informal interpersonal contacts and links non based on R&D that are not reported and are difficult to gather, especially in peripheral environments.

This article makes a contribution to the field of innovation studies by showing evidence on the factors that shape U-I interactions in STPs and other environments in a regional innovation system. Our results seem counterintuitive to some policies that try to fill STPs mainly with high-tech and R&D intensive firms. We found that location is an important factor that facilitates the links with universities only for specific U-I interactions related to human resources and informal relationships, but not for commercialization and collaborative research. This suggests that location in a STP may create an advantage for the knowledge

transfer processes of the firms that lack certain knowledge capacities, but not for firms that have accumulated absorptive capacities. These observations provide important implications for discussing innovation policies for knowledge transfer in certain regional environments.

The structure of the article is as follows. After this introduction, section two makes a selective account of streams of research related to the multiple channels of U-I interactions and the effects of STPs on knowledge transfer. Section three provides a description of the regional innovation system that is used as a strategic research site. Section four explains the research strategy and the data sources. Section five details the steps of the analysis, including the descriptive accounts of dependent and independent variables and the results of multivariate procedures. Factor analysis on different U-I interactions and regression analysis with variables that influence these interactions are used. The final section makes a summary of the results and discusses the implications for innovation policies in peripheral environments.

BACKGROUND

An important body of research on U-I links has emerged in recent years dealing with several factors that shape the propensity of firms to collaborate with universities. A stream of studies highlights the influences of the structural and behavioral features of the firm. Some authors have found that age influences the existence of U-I links. For instance, in a study focusing on knowledge intensive firms, Cohen et al., (2002) show that start ups are more likely to draw from universities, although others authors find that this pattern is not found in other industrial sectors (Laursen and Salter, 2004). In a similar pace, some studies argue that bigger firms are usually more able to manage complex links and have more financial autonomy to specialize workers on dealing with external sources of knowledge (González and Peña, 2007).

The most influential factors shaping U-I links are considered to be the absorptive capacities of the firm reflected by innovation performance, internal R&D and the level of education of firm workers (Cohen et al., 2002; Carayol, 2003). It is assumed that firms with these traits accumulate cognitive and organizational abilities that increase the possibilities to interact face to face with researchers and also to adapt external knowledge to their productive processes. In addition, the existence of an open innovation strategy is also a predictor for links with external sources of knowledge (D'Este and Patel, 2007).

Another stream of literature that pays special attention to the role of geographical location usually finds evidence on the positive influence of proximity. It has been argued that being close to a university facilitates interactions by diminishing costs and promoting stable personal relationships, although usually the importance of geographical proximity is contingent on the type of the university in the local area (D'Este and Lanmarino, 2010). In some territorial contexts, it has been found that technical universities and universities with excellent research usually attract firms' interests (Laursen et al., 2011). Nevertheless, these results may vary substantially depending on the type of firm and the institutional configuration of the local environment.

Other attributes of the location may influence the existence and the types of U-I links in addition to measures of distance (i.e. numbers of km) or the location of firms in the same region or city of a given university (Fernández-Esquinas and Pinto, 2014). These can be considered as "qualities of space" because of the possibilities given to firms to draw knowledge from external sources. Not only the close presence of technological infrastructures and specialized suppliers facilitate contacts, but also the more intangible elements related to

institutional specialization and agglomeration. Some characteristics of the environment that can influence firm relationships with universities are the presence of services for R&D support, the availability of TTOs and the proximity to other knowledge intensive firms that allow circulation of workers with R&D capabilities.

STPs are considered places that contain many of the aforementioned qualities to facilitate U-I links. The rationale of innovation policies to implement STPs is based on the benefits of such location to promote by means or agglomeration or mediation (APTE, 2007). On the one hand, STPs may create added value to companies by fostering acquaintances and face-to-face contacts among businesses and researchers that are interested in common activities. It is assumed that the proximity to innovative actors and the promotion of common activities increases their capacity to create trust among the potential beneficiaries (EU-DG Regio, 2011). On the other hand, STPs can be seen also as incubators of interactions by locating organizations that promote links (i.e. TTOs, entrepreneurship offices, innovation promotion offices) or by acting itself as intermediaries (i.e. between inside companies and a larger network of different actors such us corporations, public administrations, outside research centers and venture capital groups). Therefore, the science park organizations may play a key role on implementing the functions of the park, especially at initial phases.

A number of empirical studies have investigated the effectiveness of STPs in promoting links (Sherman, 1999; WalkerPeach, 2011; Qiu et al., 2016; Fernández Esquinas et al., 2016), although it is difficult to encompass the possible objectives of the different partners. In UK and US park models, the linkage between commercial enterprises and academic research is essential to innovation policy, although some studies argue that evidence is inconclusive (Albahari et al., 2016). For instance, Quintas et al., (1992) show that experience in the UK does not demonstrate high level of such linkages, while in the US, Links and Scott (2003) state that new technology-based firms (NTBFs) located in a science park have a higher propensity to participate in joint research with universities since many of them are university spin-offs themselves.

An interesting study for disentangling the mechanisms of knowledge transfer functioning in an STP is the survey by Vedovello (1997) to firms in the Surrey Research Park. He examines the links with the local university by looking at three types of links: formal, informal and human resources links. Although he did not observe firms outside this location, he found a low density of formal links, but a higher presence of informal relationships. Other studies that compare new technology-based firms inside and outside STPs in Sweden (Lofsten and Lindelof, 2002) and Spain (Vásquez-Urriago et al., 2016) find that firms located in parks were significantly more likely to have a link with a local university than off park firms. They also evidence the scarcity of links overall. The most common forms of accessing to universities are also “low level” contacts related to the recruitment of university graduates and many informal links not based on R&D. Other studies show that STPs have an important role in developing the innovation output in business networks, especially for spin-off companies (Salvador and Rolfo, 2011), since science parks act as providers of strategic alliances that make it easier to start a new business.

Some critical studies have challenged the catalytic role that a science park would supposedly convey on a region. In their seminal study, Castells and Hall (1994) attributed the low performance of science parks to the low density of firms. Some authors argue that the absence of formal links can be attributed to the view of technology transfer based in the science push

perspective that restricts the necessary articulation and interaction between universities firms in several locations and relevant actors of the local innovation system (Hansson et al,. 2005). More recent analyses conclude that some parks show poor results in terms of cooperation and networking due to low managerial skills of universities regarding technology transfer and NTBFs support (Bakouros et al., 2002; Almeida et al., 2008; Liberati et al., 2016). Other studies attribute these poor results to the misconception of the innovation processes that are more frequent in the science park. Sometimes there is a scarce support in terms of managerial skills to university spin-offs in contrast to the offer of research results (Cao, 2004; McAdam and McAdam, 2008; Berbegal-Mirabent et al., 2015).

The above studies suggest that informal links, human resources circulation and access to tacit knowledge seem to be more important forms of knowledge transfer than high level research collaboration. However, despite the empirical studies on U-I interactions, these forms of links are not frequently studied under the scope of the influences of STPs. It must be added that research on STPs development has not targeted sufficiently lesser developed territories where cooperation with firms based on high level R&D is scarce. In contrast, in these environments the main channels are the advanced services provided by universities, human resource training and exchange of strategic information and tacit knowledge (Perkmann and Walsh, 2007; Larsen, 2011).

In this article we provide an insight based on close observation of the firms collaborating with universities and PROs, in contrast to the behavior of other innovative firms of a region. We take into account the location in the STPs of the region and other locations, together with the main factors that are assumed to shape U-I relationships in specialized research.

THE REGIONAL CONTEXT

Our study focuses on the regional system of innovation in Andalusia. Andalusia is a region located in the South of both Spain and Europe. The region has almost 9 million inhabitants and covers an area of 87,000 square km. In the early 20th century, parameters on wellbeing were similar to those of the rest of the country. Nonetheless, the region differs from others in the country in terms of its lower competitiveness (73.5% of GDP per capita of Spain) (CES, 2014).

Andalusia can be considered as a catch-up innovation system because of the lack of industrial agglomeration and innovative firms. Its indicators are still not equivalent to those of other developed European regions. Investment in R&D is still low by international standards (1.5% of GDP). Only 33% of R&D expenditure of the region is incurred by business (INE, 2015). Family-owned SMEs account for a large proportion of the manufacturing and service sectors. Important industrial sectors are aimed more towards local markets and are dedicated to low- and medium-technology activities and services. Nonetheless, the process of economic modernization promoted by the European Union and regional policies for the creation and diversification of firms has increasingly boosted emerging-technology industries, especially those in the energy, aeronautics and agro-food sectors, and has promoted active innovation policies in place (COTEC, 2000; Junta de Andalucía, 2003; CES, 2008, 2010).

With regard to its public research system, Andalusia currently has nine public universities with some 250,000 students and 17,000 teaching and research staff, in addition to several PROs. Its regional government controls the funding and management of the higher education sector and an important part of innovation policy. Universities account for 45% of R&D expenditure and 61% of researchers in the region are employed by universities (INE, 2015). The experience in

Andalusia in innovation policies is an example of the rapid transition from traditional policies, based on a linear model of innovation, to policies designed to promote interaction between the regional government, universities and industry. For this purpose, several economic incentives have been created for linking firms with universities, and a network of interface organizations has been established to facilitate knowledge transfer and firm innovation, in addition to the TTOs created by universities and PROs (CICE, 2006).

STPs are an important ingredient in this trend. At the moment of launching the survey of this study, there were 7 science and technology parks in operation in Andalusia (other 4 parks were in construction or in the process of selecting firms). The two biggest ones have a longstanding tradition in the region and they are considered as "generalist" , whereas others in the region are rather sector-oriented (e.g. Seville's Aerópolis specializing in the aeronautics industry or Granada's based on health sciences). The other parks are much younger and smaller, and are still in process of development. The location of parks is depicted in Figure 1.

They are run as private corporations with public support and usually led by consortia formed by arrangements of regional governments, city councils, universities and private firms. Regional STPs host business incubators, entrepreneurship support offices and, some of them, public research institutes and university branches. Universities and PROs are important partners. However, there are differences between parks regarding both the presence of the university and the composition of firms. Some parks are located near university campuses, while others are located in urban or industrial areas and host university facilities inside them. Regarding the firms hosted by these parks, all of them include science intensive firms as well as firms with little or no R&D activities. It is important to highlight that the main problem faced by regional parks was attracting potentially innovative firms because of the scarcity of innovative businesses and business angels.

RESEARCH STRATEGY AND DATA SOURCES

Our main research questions are the following:

-What kind of interactions do firms located in a STP maintain with universities, in comparison with companies located in other geographical environments?

-Is the location in a STP more important than the absorptive capacities of the firm for maintaining links with universities? Are other qualities of the space more important than the location in a STP?

-For which kind of U-I interactions (human resources, advanced services, cooperative partnerships and commercialization) is the location more important than absorptive capacities?

Survey and fieldwork

The empirical bases of our analysis is a survey, carried out in 2009, with 737 firms located in Andalusia. The data source for the survey is a public registry of 1.980 innovative firms in the region collected by the regional goverment's network of offices that provide innovation services to businesses. On a total census, 737 were achieved with respect to a sample of 800. The survey was addressed to the manager, company manager or person who occupies the highest level of management in R&D within the organization chart. The protocol followed to contact the survey respondents was double: first, the selected companies were asked to

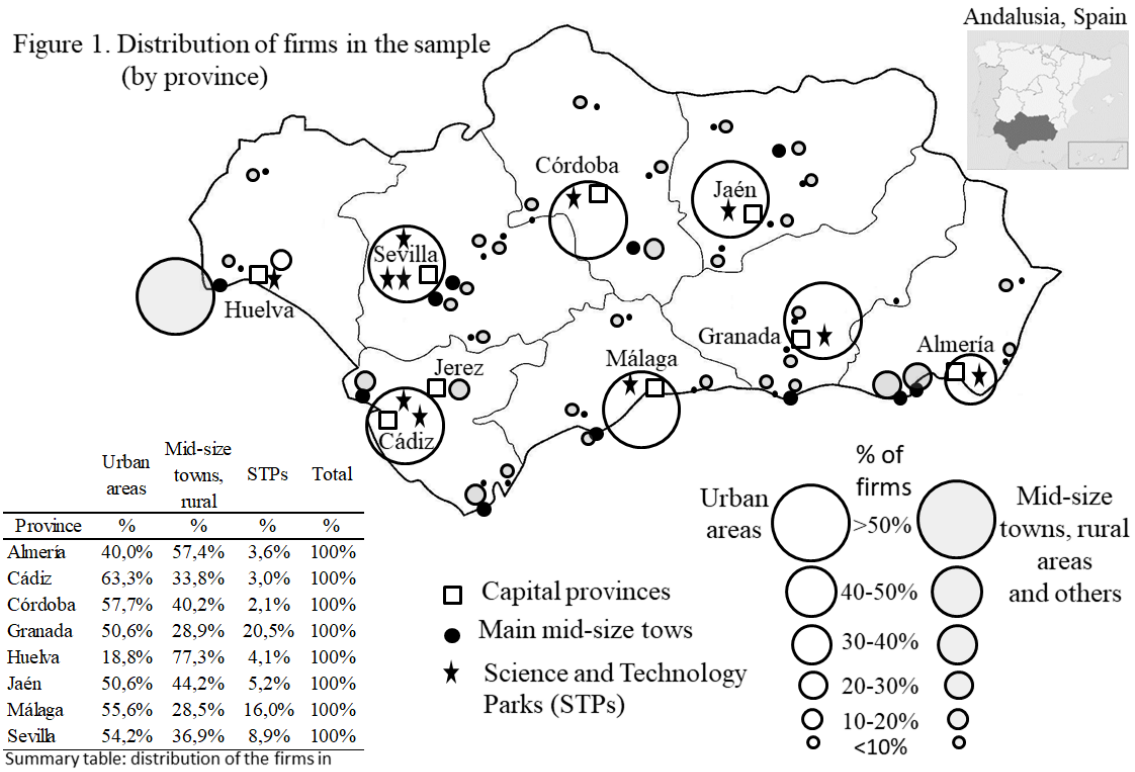
participate in the study by postal letter and later by telephone. Subsequently, an appointment was made to perform the face-to-face survey through semi-structured interviews at the company's headquarters, with an average duration of 39 minutes.

This data source, firstly, incorporates a broad diversity of sizes and turn over, from small family businesses to large firms, although the majority of them are SMEs. Secondly, the sample includes companies with differing innovative capabilities. Manufacturing firms in low-tech sectors and service firms are present, as well as firms conducting highly scientific activities. Thirdly, companies are not concentrated in certain geographical locations, but are dispersed among the diverse urban and rural areas of the region. Regarding science and technology parks, 9% of firms in the sample are located in them, but concentrated in the biggest parks: among the firms located in STPs, 38% are in PTA-Málaga, 28% in Cartuja93-Seville, 28% in Granada Health Park, and the rest are in Aerópolis-Seville and Adesva-Huelva.

The location of the firms in the sample is included in Figure 1. The map reflects the distribution of firms in each province in each type of territory. The distribution is done separately PER (in each) province since the design of the sample is stratified proportionally by province. The size of the blank circles reflects the approximate percentage of firms in urban areas (the areas considered as urban are the capitals of each province, in addition to Jerez de la Frontera in Cádiz province). The size of the grey circles reflects the percentage of firms in the main mid-size towns, rural areas and other areas. The percentage of firms in STPs can be seen in the summary table below the map.

The map shows an important concentration of firms in urban areas, in the main mid-size towns and also in some parts of the coastal side of the region. These areas concentrate a substantial part of the population. They are also the main locations of innovative firms as reflected in the sample. The percentage of innovative firms in STPs is very different in each province because of the size and the age of the parks. The parks in Almeria, Cadiz, Huelva, Jaen and Córdoba are smaller and younger, and they were in process of development at the moment of carrying out the survey. Therefore, they have a smaller number of the innovative firms in their provinces. It is important to notice that in our design for studying the relationships between location and the types of interactions with universities we have not considered the physical distance of firms to a park but the type of territorial location. For instance, the number of Km to a park or to a university is not a significant measure in this region compared to the socioeconomic factors that shape access, including social and institutional relationships. In addition, our preliminary analysis finds that there is NO (not a) selection bias of firms located in STPs because innovative firms in the region are dispersed in different types of location in each province, as shown in the next section.

Figure 1. Distribution of firms in the sample (by province)



Province	Urban areas %	Mid-size towns, rural %	STPs %	Total %
Almería	40,0%	57,4%	3,6%	100%
Cádiz	63,3%	33,8%	3,0%	100%
Córdoba	57,7%	40,2%	2,1%	100%
Granada	50,6%	28,9%	20,5%	100%
Huelva	18,8%	77,3%	4,1%	100%
Jaén	50,6%	44,2%	5,2%	100%
Málaga	55,6%	28,5%	16,0%	100%
Sevilla	54,2%	36,9%	8,9%	100%

Summary table: distribution of the firms in the sample by province and type of territory

Variables and descriptive results for university-firm interactions

The survey includes a set of variables reflecting multiple forms of interactions with universities. After doing several pre-tests for adapting the multiple possibilities to a questionnaire format, twelve possible types of interaction were selected (see Table 1). For each type of interaction, firms were asked if they had had this relationship in the previous five years and how many times. This formulation is aimed at obtaining a detailed descriptive measurement of the 'diversity' of channels for knowledge transfer from a regional university system.

Descriptive results from this set show that the informal relations type yield the highest scores (32% of the firms indicates that they have had this kind of interaction), followed by training of university postgraduates and internships at the firm (27%). The rest of the interactions can be divided into three groups:

• Consulting activities, joint research projects and training of firm workers by the university are carried out by between 15% and 25% of all firms.

• Between 5% and 15% of firms were involved in contracted R&D projects, use of university facilities and personnel exchange.

• Less than 5% of the firms participated in spin-offs or start-ups, licensing or sale of patents and joint ventures.

Other types of collaborative activities –encompassing participation in meetings, seminars, diffusion, publications and so on– are carried out by no more than 2% of firms.

The importance of training contracts and internship is worth noting. This last case is especially relevant since the regional government provides easy access to this kind of training for university postgraduates. Furthermore, for firms this is a common way of recruiting future employees that eliminates the pitfalls of personnel selection processes. Consultancy is also relevant, while exploitation of intellectual property is clearly a minority activity even in those firms considered as the most innovative in the region. Overall, 421 firms (57%) state that they are not involved in any type of collaboration. Only eleven firms declare having strictly informal relations, meaning that this variable shows that informal relations are linked to other activities.

Table 1. Firms that interact with universities and PROs: original set of variables.

Dependent variables	Interactions with universities	NO	YES	N.A.	Total
		Row N %	Row N %	Row N %	N
Advanced services	Consultancy work	78%	22%	0%	737
	Commissioning of R&D projects to universities	86%	14%	0%	737
Cooperative research	Joint R&D projects	78%	22%	0%	737
Commercialization	Use or renting of facilities	92%	8%	0%	737
	Patent exploitation	95%	5%	1%	737
Activities related to human resources	Training of university postgraduates and internships at the firm	72%	28%	0%	737
	Exchange of personnel	93%	7%	0%	737
	Training of firm workers by the university	84%	15%	1%	737
Informal relations	Joint-ventures with universities	96%	4%	0%	737

Participation in spin-offs and start-ups	96%	4%	0%	737
Informal networks	67%	32%	1%	737
Other types of collaborative activities	77%	7%	16%	737

Source for all figures: IESA (2011)

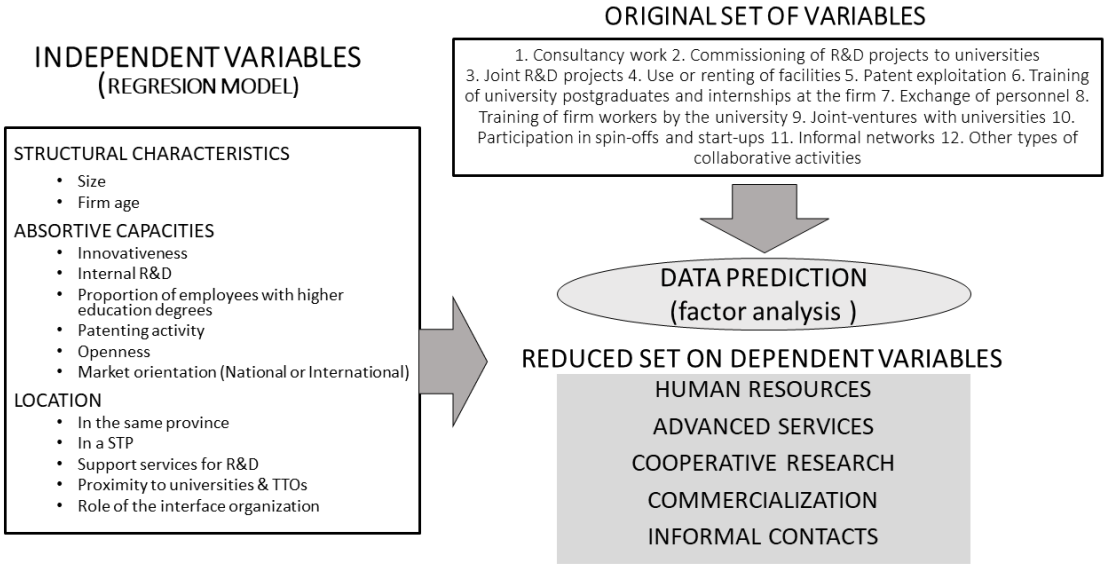
ANALYSIS

Analytical approach

In the first step of the analysis, descriptive procedures have been used to study the different variables included as independent and dependent variables. As a preliminary analysis, a Z-test has been conducted in order to analyze the differences between those companies that cooperate and those firms that have not been involved in any kind of cooperation. This analysis has been replicated to explore the differences between those companies that cooperate and are located in a STP and those that are not, in order to avoid selection biases of firms located in STPs. In the second step, five logistic regression analysis models have been carried out to explore the influences of the characteristics of the firm and location in the development of different interactions with universities. Both independent and dependent variables have been calculated and transformed in order to reflect specific influences.

A summary of the analytical approach containing the sets of variables and the different statistical procedures is showed in Figure 2. The chart on the upper right includes the original set used for constructing the dependent variables formed by 12 types of interactions with universities. With these variables, a reduction has been made by means of a factor analysis, resulting in the 5 dependents finally used in the analysis. They are included in the chart on the lower right. The chart on the left includes the list of independent variables used in the regression models. They are organized in groups of meaningful categories regarding structural characteristics, absorptive capacities and location.

Figure 2. Summary of the research model: sets of variables and relationships between independent and dependent variables



Dependent variables

The dependent variables have been constructed departing from the set of 12 different kinds of interactions with universities indicated above. This set has been reduced to five dimensions . The dependent variables have been coded as "1" for those firms that have maintained at least one kind of interaction within each category and as "0" for those firms that have maintained no interactions.

The five dependent variables reflect the following forms of knowledge transfer:

1. Activities related to human resources (training of postgraduates and internships, exchange of personnel with universities and training of business workers by universities)
2. Advanced services (technological assessment and consultancy, R&D contracts, use of university facilities)
3. Cooperative research (joint R&D projects, joint research centers)
4. Commercialization (joint patents and licensing of university patents, creation of spin-off firms)
5. Informal relationships

It is stressed that over 40% of the companies have participated in some kind of cooperation. As indicated in Table 2, informal relationships obtain the highest value (32%), followed by Human Resources (32%). The other interactions can be divided into two groups: around 25% of the firms engage in advanced services or joint research projects and a 7% of the enterprises have participated in some kind of commercialization activity. It should be highlighted that interaction related to training and personnel, as well as consultancy, carry an important weight. This in contrast with the exploitation of intellectual property rights, that is given less importance even in firms regarded as very innovative in the region.

Table 2. Firms that interact with universities and PROs: reduced set of variables

	No	Yes	Total
Dependent variables	Row N %	Row N %	N
Types of interactions	**59%**	**41%**	**737**
Human Resources (HH.RR.)	68%	32%	737
Advanced Services	74%	26%	737
Cooperative research	77%	23%	737
Commercialization	93%	7%	737
Informal contacts	68%	32%	737

Independent variables

Three sets of independent variables have been used. The first set is related to the main structural characteristics of the firms. Measures of the total number of employees and the age

of the firm have been considered. Both variables are measured as the natural logarithms in order to correct their skewed distribution. In addition, the market orientation of the firm has been used as a dummy variable that indicates whether over 50% of turnover of the firm is made in the national or international market against those companies orientated to the local or regional market.

The second set of variables reflects the absorptive capacity of firms in order to explore the factors that create propensity to interact with universities. The three variables included are related to knowledge utilization in productive processes of the firms. According to previous studies they are likely associated with collaboration with universities. These variables indicate whether the firm develops product innovation for the market, whether the firm develops internal R&D, and the numbers of patents registered by the firm. For measuring human capital level, the proportion of employees with higher education degrees has been included. In addition, another factor usually related to collaboration with universities is the strategy of the firm regarding the willingness to use external actors as sources of knowledge. A measure of the "openness" of the firm has been used departing from a set of questions on the importance given to different sources of information other than the public research sector of the region, including providers, clients, other firms from the same sector, consultants, commercial laboratories, and fairs and dissemination events. The variable has been coded as a dummy variable. A firm is classified as more open when it considers a half or more of the above sources as very important.

The third set of variables is related to the location of the firm. First, as geographical closeness, a dummy variable has been created indicating whether the company is located or not in the same province as the main university group with whom the link is maintained. Second, the allocation of the firm in an STP is also a dummy variable. Third, two binary variables have been defined regarding the institutional environment as proxies of the "quality of space". In particular, they measure whether the company has support services in the surrounding area for promoting R&D and/or technology transfer offices and university services. Fourth, a variable has been added reflecting the role of the interface organizations. This variable indicates if the first contact was initiated by the firm or by one of the interface organizations (TTOs, innovation support offices and incubators). Fifth, other possible aspects of the quality of space may be the characteristics of the industrial tissue. Three variables have been included reflecting the availability of personnel with R&D qualifications, the presence of high-tech companies and the presence of firms of the same sector.

Table 3 shows the main descriptors of the variables for the whole sample. It reflects that most of the firms are located close to a university facility and to other firms of the same sector. Half of the firms declare to have access to R&D personnel in their immediate environment. Around 60% of the firms develop product innovation for the market as well as internal R&D. Table 3 also includes a comparison between the independent variables and a variable which indicates whether the companies have had at least one interaction of any kind with a university or if they have had no interactions. As indicated before, a Z-test has been conducted to compare both columns. Comparison is based on two-sided tests with a significance level of 5%. The superscript indicates that the proportion of both columns is different and these differences are statistically significant. The results show that more than three out of five firms that have interactions with universities are located in the same province as the research group that acts as the main partner. Less than two out of ten companies that have interactions are located in a

STP. The table also shows that the firms that maintain relationships with universities are located in a better environment, meaning that they have more access to resources for promoting R&D. In contrast, there are no differences regarding the closeness to other firms of the same sector or the high industrial activity in the area. The results also suggest that firms with relationships with universities are older, have a higher proportion of employees with a higher education degree and have a higher patenting activity than those that do not interact with universities.

Table 3. Percentage of firms that interact with universities and PROs in each independent variable

Independent variables	**Interactions with universities or PROs**		**Total**
	No	**Yes**	
	Column N %	Column N %	Column N %
Innovativeness	44%	74%[A]	57%
Internal R&D	48%	82%[A]	62%
Openness	17%	25%[A]	20%
National or International market orientation	14%	37%[A]	24%
Location in the same province	4%	63%[A]	28%
Location in an STP	2%	18%[A]	8%
Availability of R&D personnel	37%	66%[A]	49%
Support services for R&D	18%	59%[A]	35%
Proximity to a university TTOs	62%	86%[A]	72%
Proximity to same sector firms	69%	72%	71%
Proximity to high tech companies	29%	46%[A]	36%
High industrial activity in the area	32%	33%	33%
Role of the interface organization in establishing U-	1%	24%[A]	10%
Number of employees (mean)	50	64	56
Firm age (mean)	18	24[A]	21
Proportion of employees with higher education	13%	34%[A]	22%
Patenting activity (mean)	0	2[A]	1

As previously indicated, the Z-test has also been applied to ensure the reliability of the regression analysis. It could be thought that companies interacting with universities and that are allocated in a STP have a higher absorptive capacity than those firms interacting with universities but located outside a STP. This situation could have an impact on the results of the regression analysis. Tables 4 and 5 show that being located in a STP ensures a good regional environment but it does not necessarily imply a higher absorptive capacity. These results assure that the regression analysis is not biased by the characteristics of firms located in a STP in comparison to the other firms of the sample. This outcome suggests that innovative firms in the region are not especially concentrated in STPs. Firms inside STPs are certainly more innovative than the majority of regional firms since STPs do screen the access to certain profiles, although the sample used for this study reflects the broader profile of innovative firms in the region following the classification criteria of the offices for innovation support.

Table 4. Percentage of firms located in a STP in each independent variable: absorptive capacities

Independent variables	Location of the firm in an STP		Total
	No	Yes	
	Column N %	Column N %	Column N %
Innovativeness	71%	91% [A]	74%
Internal R&D	80%	91%	82%
Openness	25%	24%	25%
Proportion of employees with higher education degrees (mean)	30%	53% [A]	34%
Patenting activity (mean)	1	4	2

Table 5. Percentage of firms located in a STP in each independent variable: characteristics of the space

Independent variables	Location of the firm in an STP		
	No	Yes	Total
	Column N %	Column N %	Column N %
Availability of Scientific	63%	81% [A]	66%
Support services for R&D	52%	91% [A]	59%
Proximity to universities & TTOs	84%	98% [A]	86%
Proximity to same sector firms	70%	83% [A]	72%
Proximity to International or HT companies	40%	72% [A]	46%
High industrial activity in the area	33%	37%	33%

Multivariate analysis: The effects of absorptive capacities and location on U-I links

Table 6 examines the factors influencing the development of the five channels of knowledge transfer with universities. At the structural level, the age of the company has a positive impact on the development of any kind of interaction apart from commercialization: the older the firm the more probable it has established a wider range of links. On the other hand, bigger companies are less likely to undertake human resources activities, although the influence of the size disappears when analyzing other activities. The analysis also shows that being oriented to the national or international market has a positive impact on the development of any type of links with the exception of human resources activities.

Regarding the variables related to absorptive capacity, the study shows that most of the variables have a positive influence on establishing all type of links with universities. In particular, the results evidence that companies introducing product innovation for the market and developing internal R&D are more likely to undertake any type of interaction, as well as those firms that employ workers with higher education degrees. A relevant result of the study is that, when distinguishing between different types of interaction, it shows that certain knowledge-based traits influence some interactions with universities, but not others. Thus, for instance, patenting is not related with maintaining links such as commercialization, advanced services or human resources training. In contrast, the likelihood of engaging in cooperative research, as well as having informal contacts, increases for those companies with a higher number of patents. This result suggests that companies that are able to patent neither look for

knowledge already codified by the university nor joint university researchers to develop patents conjointly. They do look, however, for cooperative research and informal links as a way to improve capacities and to have access to relevant information. At the same time, firms with internal R&D do not establish links for commercializing university knowledge, but they do for all the other possibilities. Finally, openness does not seem to be a significant variable for facilitating links with universities, being informal contacts the only exception.

Regarding the location of firms, the study confirms the positive effect of closeness. Companies located in the same province as the local university are more likely to undertake any type of cooperation than firms in different provinces. The exception to this pattern is commercialization activities, which are not influenced by location. This confirms that the use of codified knowledge transcend the territory. Firms that are interested in licensing university patents look for them in any place, regardless of the location. On the other hand, being located in an STP only has an effect on certain types of interactions: those related to human resources training and exchange, and those consisting in informal contacts. Therefore, it can be assumed that being located in a STP increases the probability of developing activities that entail closer interpersonal links and trust. In contrast, being located in a STP is neither related to commercializing university knowledge, nor to the use of university services and infrastructures, nor to participation in collaborative research.

When studying the other characteristics of the space, the analysis shows that the most important elements for cooperation are the availability of support services for R&D in the nearest area and the role of interface organizations. In particular, having support services makes an influence in all channels except those based on human resources. The role of interface organizations has an influence also in all the channels except for commercialization. Interestingly, the proximity to university TTOs only increases the activities related to human resources, but not the others. Finally, other characteristics of the environment related to agglomeration do not show influences in any type of activity.

Table 6. Logistical regression models

		HH.RR.		Advanced Services		Cooperative Research		Commercialization		Informal Contact	
		B	E.T.	B	E.T.	B	E.T.	B	E.T.	B	E.T.
Structural characteristics	Size (ln)	-0,123*	(0,072)	0,031	(0,074)	0,019	(0,076)	0,175	(0,107)	0,016	(0,076)
	Firm age (ln)	0,659***	(0,168)	0,309*	(0,167)	0,341**	(0,166)	-0,09	(0,241)	0,424**	(0,18)
Absorptive capacities	Innovativeness	0,764***	(0,235)	0,65***	(0,25)	0,814***	(0,265)	0,89**	(0,45)	0,548**	(0,255)
	Internal R&D	0,771***	(0,255)	0,933***	(0,285)	0,763***	(0,295)	0,741	(0,494)	0,915***	(0,286)
	Proportion of employees with higher education degrees	0,936**	(0,367)	1,024***	(0,368)	0,93**	(0,377)	1,094**	(0,502)	1,442***	(0,406)
	Patenting activity	0,04	(0,031)	0,047	(0,03)	0,096**	(0,038)	0,013	(0,012)	0,068*	(0,036)
	Openness	0,182	(0,252)	-0,035	(0,261)	0,178	(0,261)	0,113	(0,379)	0,595**	(0,274)
	Market orientation (National or International)	0,256	(0,243)	0,665***	(0,24)	0,961***	(0,24)	0,772**	(0,328)	1,035***	(0,265)
Location	Location in the same province	1,939***	(0,233)	1,477***	(0,236)	0,954***	(0,244)	0,561	(0,358)	2,687***	(0,262)
	Location in a Science or Technological Park	0,692*	(0,414)	0,613	(0,384)	0,38	(0,365)	0,092	(0,433)	1,047**	(0,495)
	Availability of R&D personnel	0,258	(0,247)	0,108	(0,264)	0,109	(0,271)	-0,139	(0,403)	-0,377	(0,28)
	Support services for R&D	0,342	(0,253)	0,822***	(0,259)	0,72***	(0,269)	0,976**	(0,423)	0,471*	(0,28)
	Proximity to universities & TTOs	0,573**	(0,29)	0,368	(0,312)	-0,124	(0,31)	0,085	(0,517)	0,128	(0,307)
	Proximity to same sector firms	-0,31	(0,244)	-0,377	(0,252)	0,015	(0,26)	-0,341	(0,369)	-0,252	(0,268)
	Proximity to International or HT companies	-0,228	(0,252)	-0,069	(0,26)	-0,113	(0,264)	-0,124	(0,372)	0,24	(0,276)
	High industrial activity in the area	0,201	(0,239)	-0,097	(0,251)	-0,23	(0,255)	-0,621	(0,388)	-0,002	(0,268)
	Role of the interface organization	1,114***	(0,361)	0,917***	(0,336)	1,311***	(0,319)	0,571	(0,4)	1,068***	(0,389)
	Pseudo R^2 de Nagelkerke	0,510		0,487		0,433		0,267		0,617	
	% Classified cases	81,1%		81,6%		82,1%		92,5%		84,4%	
	N	737		737		737		737		737	

CONCLUSIONS AND POLICY IMPLICATIONS

The results of this study have several implications for the role of STPs in regional innovation policies regarding the links with universities in peripheral regions. As aimed, the outcomes of this study fill some of the gaps in empirical research on how firm features and attributes of the geographical environment affect different channels of knowledge transfer and cooperation in a regional innovation system. Specifically, the study evidences: 1) firms that maintain relationships with universities are older, have a higher proportion of employees with a higher education degree and have a higher patenting activity that those that do not interact with universities; 2) companies interacting with universities and allocated in a STP do not have a higher absorptive capacity than those firms interacting with universities but located outside a STP; 3) innovative firms in the region are not only concentrated in STPs, although an important amount of firms in STPs can be considered as innovative; 4) companies tend to have more interactions with the university in their own province in any kind of interaction except commercialization activities, independently of the territorial context; 5) being located in a STP only has an effect on certain types of interactions: those related to human resources training and exchange, and those consisting in informal contacts; 6) in contrast, being located in a STP is neither related to commercializing university knowledge, nor to the use of university services and infrastructures, nor to participation in collaborative research; 7) the most important elements for cooperation are the availability of support services for R&D in the nearest area and the role of interface organizations, such as TTOs or entrepreneurial support offices.

These results provide important implications for regional and local innovation policies regarding the kind of firms that are targeted to be located in STPs, and also the services provided by STPs to firms in order to increase knowledge transfer with universities. Firms with higher absorptive capacities, especially innovative firms with internal R&D and a high number of employees with higher education, take care of themselves when they need to use university services of any kind. Firms with patenting activities interact with universities mostly for commercialization activities. They carry out these activities no matter the location. Location may have a positive effect, but our analysis shows that, for these firms, to be inside a STP is not an influential factor in order to increase most kinds of knowledge transfer activities with universities. Location in a STP has a significant influence mainly on increasing collaboration based on the exchange of personnel and services based on human resources, and also on informal contacts. Interestingly, SMEs, firms with lesser absorptive capacities that try to catch up with innovation and spin-off firms may have more opportunities to interact with universities due to location than other bigger and firms with R&D departments.

Services included in SPTs related to knowledge transfer and support services for R&D appears also as an important institutional feature since they increases the chances to interact in universities for any kind of link but commercialization. This suggests that links related to commercialization are subject to a different rationale and depend on specific firms that accumulate capacities to interact with universities on their own.

Universities are the knowledge reservoir of some regions since most of the researchers and science infrastructures are concentrated in the academic sectors. Universities are also the main producers of R&D personnel. In these contexts, parks are important instruments, among others, to get economic value from the knowledge reservoir of universities. Nevertheless, in designing the configuration of STPs, it is necessary to pay attention to the type of firms located

in the parks, to the sources of external knowledge that these firms use and also to the institutional surroundings of these spaces. This is especially important in regional contexts where not all the parks can be filled with NTBFs or high-tech spin-offs coming from universities and business angels. Therefore, regional policies should look carefully the kind of firms they target for their STPs. Sometimes they may prefer companies with a higher R&D profile that may take an advantage of location. However, usually these firms already have the capacity to draw knowledge from universities since they have the resources and the personnel to do that. In contrast, it seems that for some innovative SMEs, for firms that try to catch up with innovation and for certain spin-off firms, being located in a STP can make a difference since they are prone to get engaged firstly in activities related to training, exchange of human resources and informal contacts. They also take an advantage of support services when engaging in advanced services provided by universities, cooperative research and commercialization. This suggests that a "positive discrimination" strategy may be applied for locating some firms with innovation potential but lesser absorptive capacities.

Other implications are related to the diversity of channels for knowledge transfer with local universities. Universities are usually ranked as low sources of innovation for most firms, in comparison to other sources of knowledge such as costumers, workers, competitors and service providers. Very few firms depend on public science for their innovation activities. For innovative SMEs and bigger firms that are not science intensive, research collaboration is scarce. In order to get useful external knowledge, many firms do not require high-level research. Instead, more important sources are business services that incorporate a relevant amount of specialized knowledge. In some regional contexts, the university can be a most affordable way for companies to access services for technological upgrading, testing and laboratory services, technical accreditations and specialized training. Moreover, companies working in high-tech sectors look for inputs other than blue-sky research. Many of them look for technological vigilance. Sometimes they want to have access to partners in order to apply for joint projects funded by public institutions. Other times they want to collaborate as a strategy of visibility. For these companies, informal links, human resources circulation and access to tacit knowledge seem to be as important as commercialization and research collaboration. The results of this study support the diversity of knowledge transfer processes and the importance of including the demand-pull aspects in innovation policies to provide firms with adequate services and contacts.

This diversified approach also has several implications for improving U-I links. First, in some contexts it may be necessary to amplify the role of universities as providers of knowledge-intensive business services, and not only as partners of cooperative research and providers of codified knowledge. This may have consequences for the incentives given to academics to collaborate since these relationships may not be acknowledged in scientific careers. Second, it is important to facilitate informal connections between firms and universities by proximity and agglomeration since it creates the conditions for dense networking and human resources circulation. And third, there are some qualities of the space that are important in addition to proximity in order to promote links with universities. These qualities have to do with the availability in the close environment of the right organizations and infrastructures that facilitate access to a broad range of channels for knowledge transfer. Some of them are TTOs, but other important organizations are the ones that help SMEs to improve their innovation process and to get R&D capabilities. Therefore, further research on the needs of traditional firms, NTBFs and high-tech firms could inform innovation policies when deciding strategies for

knowledge transfer. New and diversified interface organizations in addition to OTTs, adapted to different forms of U-I interactions, should be considered in order to align the role of universities to the flows of knowledge transfer of their local and regional innovation systems.

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