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THE ROLE OF TRIPLE HELIX ORGANIZATIONS IN UNIVERSITY-INDUSTRY RELATIONSHIPS

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Introduction

Triple Helix dynamics have emerged together with a group of specialized organizations aimed at creating networking and consensus spaces for different actors. Technology transfer offices (TTO), science and technology parks and governmental innovation agencies are some of the main Tripe Helix (TH) organizations to promote and channel university-industry relationships. Although the importance of these 'interface' organizations is widely acknowledged, it is difficult to obtain empirical evidence of the influence they have in shaping the interactions between firms, universities and other public research bodies. Most of the empirical research focuses on the role played by specific structures using available data related to formalized links or codified knowledge. Usually it is not possible to compare their relative importance taking into account the different channels of knowledge transfer.

This paper studies the role played by TH organizations in the existing relationships between university and industry in a regional university system, using a methodology developed for the purpose. Our main goal is to identify the degree to which they are involved in the innovation dynamics of firms in a region as well as the functions they play whitin the multiple forms of relationships that firms establish with universities. We departure from two research questions for studying this issue: a) what kind of firms use TH organizations, and for what kind of purposes? b) Do different TH organizations have a specific role depending of the kind of university-industry relationship?

The empirical basis for our analysis resides in a face-to-face survey to 737 firms conducted in 2008 and 2009 that allows us to answer these questions. The research site is Andalusia, the biggest region of Spain in terms of population. This regional innovation system is characterized for having and extensive public university sector, a traditional industrial tissue and a set of innovation policies that are trying to catch-up with more developed regions. Our sample of firms reflects the diversity of sectors, sizes and innovative profiles of firms in the region. The survey includes two set of variables reflecting both the intervention of TH organizations in establishing links with universities and the importance attributed to them by firms. The survey also measures an extensive set of university-industry relationships, ranging from projects and patents, to consultancy and human resources training.

In the first step of the analysis, we use descriptive procedures to show the role played by different TH organizations and the importance attributed to them by firms. In the second step, we build up dependent variables reflecting the effectiveness attributed to three of them: technology transfer offices in universities (TTO), business support institutions (science parks and incubators) and financial support institution. In the third step, we use regression analysis to detect what factors shape the role of these organizations in a regional university system.

Empirical evidence shows firstly the importance that personal contacts and networks in the surrounding environment have for maintaining most types of relationships between firms and university. Then, the findings from the multivariate analysis show that TH organizations have different importance depending on some absorptive capacities, mostly internal R&D, but not on the structural characteristics of firms. Moreover, we find that the main influences on the role of TH organizations come from the kind of links that firms establish with universities. The results of the study highlight the contributions for refining the TH framework from a micro-level point of view and provide implications for university policy in catch-up regional university systems.

Background

Hybrid organizations are one of the main micro-components of TH institutional arrangements. They function as boundary spaces that allow practices from different domains to operate, and eventually to overcome cultural barriers. Research in this field usually highlight their growing importance, the conditions for promoting interactions and effective alliances, as well as the problems associated with merging different cultures and practices.

There are several strands of literature focusing on the role and the outcomes of specific organizations. The main amount of research is dedicated to technology transfer offices, reflecting the importance that these organizations have reached in university environments. The emphasis on commercialization of research since the 1980s has resulted in the emergence of specialized units for identifying the market and business needs and also for managing arrangements with commercial users. Technology transfer offices have therefore became in central agents to get into practice university research in research intensive universities (Colyvas et al., 2002; O'Gorman et al., 2008). The diffusion of these structures to a wide range of university systems has resulted in a significant variety, although most of the studies highlight their function for managing intellectual property rights and the creation of academic spin-offs, as well as to market university inventions (Rothaermel et al., 2007). Other important strand of literature specifies science parks as locations that directly influence academic entrepreneurship and attract hight tech firms and knowledge providers (Lee and Osteryoung, 2004; Lindelöf and Löfsten, 2003; Lindelöf and Löfsten, 2004; Löfsten and Lindelöf, 2005; Siegel et al., 2003; Löfsten and Lindelöf, 2002; McAdam and McAdam, 2008; Lindelöf and Löfsten, 2006). Moreover, a third strand focuses on institutions specialized in providing business support, specially the innovation agencies. These institutions along with government funding agencies are significant actors in the institutional spheres of University, Industry and Government, acting as promoter of knowledge-based innovation systems (Etzkowitz, 2002; Etzkowitz, 2003; Etzkowitz and Klofsten, 2005).

Nevertheless, research on this topic has difficulties in showing the real importance of hybrid organizations for the innovative firms of specific innovation systems. On the one hand, empirical studies face the problems of using data reported by universities, especially from TTO registries. These data usually portrays the firms that reach to establish some formal relationships. Official surveys do not observe neither all the specific links maintained with universities, nor they address the value attributed by firms to TH organizations. Most of the empirical observations do not capture the different knowledge flows that exist in a regular university system, for instance, the consulting activities, the activities related to human resources or the importance of informal relationships. On the other hand, it is claimed the highly biased nature of many approaches when analyzing both the real performance and the outputs of TH organizations, especially of TTOs. There are some useful studies that observe the commercialization of academic research as a function of the productivity of these agents. Factors related to the organizational structure, such as resources, networks, the degree of autonomy and independence from the parent organization, have influences on the TTO performance (Bercovitz et al., 2001; Feldman et al., 2002). In addition, other studies provide evidence about the difficulties for the collaboration between universities and industry related to TTOs rules and expectations (Clarysse et al., 2007) or the conflicts with intellectual property rights (Bruneel et al., 2010). Therefore, it is difficult to determine what kind of firms, in a given environment, really value TH organizations and for what kind of relationships.

The triple helix approach provides a useful heuristic for grounding theoretically empirical observations on the role of different organizations. According to (Etzkowitz and Ranga, 2010), there are no universally-applicable models for knowledge-based regional development. One combination of components, interactions and functions which is successful in one region not necessarily is benefit to another one. It is necessary to adapt the structure defined in the Triple Helix System to the regional context and study which is the hybrid organization more important and convenience in each moment of the knowledge

transfer process between university and industry. In that sense, analysing the importance and the role of hybrid organizations taking into account a specific regional context provides better understanding of the interactions between the elements defined by Triple Helix System approach. The concept of knowledge spaces is especially useful for our purposes because it highlights some of the elements that should be taking into account in a regional innovation system.

Research focus

The two general research questions that we use as a point of departure are subject to important discussions in innovation literature and policy practices. The background assumptions of most of theoretical approaches reflect the importance of links and interactive learning for effective innovation, and therefore the significant role of interface organizations in enhancing relationships. Nevertheless, the answer to the questions about what different links and what actor is better for an innovation system is far from straightforward.

It is commonly assumed that effective links produce circulation of workers, ideas and capacities, and in turn may enhance creativity and breakthrough innovations if complementary actors and technologies are put together. In policy terms, more links means usually an expectation of better firm performance. The role of specific hybrid organizations promoted by governments and publicly owned academic organizations is aimed at avoiding the so called "systemic failures", specially the barriers that avoid interconnections between the main actors of an innovation system.

Actually, what we find in most innovation systems is that governments, universities and other organizations establish specialized bodies to accomplish their specific goals. In general terms, these interface structures try to overcome systemic failures. But in real terms they may have very different roles. This diversity is especially important in catch-up systems where high-tech businesses do not represent a significant part of the industrial tissue, or where not all universities have reached an international level of research excellence. In these settings, interface organizations may have different aims. Some of them try to enhance the basic absorptive capacities of firms and their cognitive distance to universities. Others try to promote trust between actors from different cultural domains. And some others are oriented to provide effective mechanism to avoid the transactions cost between competent firms and researchers with solid schemes of basic research. Some organizations 'modulate' their specific targets. But other times the goals overlap due to coordination problems or because some organizations have the capacities to act independently.

Given the complex situation that can be found in any regional context, our two general research questions focus specifically on the organizational structure and dynamics that shape an innovation system where different capacities, and therefore different kinds of knowledge flows, can be found. Our research focuses for our original questions are the following:

a) For studying the importance of TH organizations, we focus on three of them. First, we consider the network of University TTO since they are organizations specifically designed to promote and manage university-industry relationships. Second, we take into account the research parks usually build around university campus. These parks are specific facilities designed as knowledge spaces to provide circulation of ideas and capacities between agents. And third, we consider the role of an innovation agency in charge of the most important and incubators facilities and financial aid for innovation, including the aid for collaborating with universities. Given that these organizations can have overlapping and burred roles, we have tried to get straightforward answers from firms using questions about their effectiveness for enhancing relationships with universities and public research institutes.

b) For studying the specific role of TH organizations on university-industry relationships, we assume that the links between industry, academia and governments are diverse and context specific. Observations of the success of these structures have tended to focus on easy to measure outcomes, such us licensing, patenting or standardized organizational forms (Siegel et. al 2003). Although these are important forms for knowledge transfer, non codified and informal channels should be taking into account. They are expected to be of major importance, especially in catch up innovation systems due the different levels of absorptive capacities of firms, and different kind of incentive coming form government and academic structures. Therefore, we focus on the real kinds of university-industry relationship that firms maintain with the public research system. Specifically, we consider the influence that several types of links have on the role attributed to the TH organizations.

Our case study

Our empirical context is the regional system of innovation in Andalusia1, a region of Southern Spain traditionally characterized by its weak industrial fabric and a changing but yet detached university system that is representative of a considerable number of European regions. Those specific regional characteristics make this kind of analysis especially interesting because of the possible implications for similar regions with low-intensity R&D systems. Understanding the particular strategies firms follow with different TH organizations for their innovation processes can contribute to improve policies that take into account those interactions.

It is noticeable the composition of the business fabric in the Andalusian region since family-owned SMEs account for a large portion of the production sector. This firm structure implies that important industry sectors are oriented towards local markets and dedicated to low and medium technology activities (only 33% of R&D expenditure of the region is made by the firms) (INE, 2006). Nonetheless, regional firms are becoming increasingly heterogeneous as a result of the process of economic modernization promoted by the European Union and regional policies for the creation and diversification of firms (Junta de Andalucía, 2003).

In terms of its innovation system, Andalusia can be considered a catch-up region because its indicators are still not on a par, from a convergence standpoint, with those of developed European countries. Figures for investment in R&D are still low by international standards (1.5% of GDP) and are concentrated in the public sector (65%). As mentioned, the productive environment is formed largely by small and medium-sized services firms or traditional manufacturing ones. As a result, the industrial sector generally still has little capacity for investment in R&D (CICE, 2006; COTEC, 1998). Nevertheless, the region has emerging industries, especially in the new energy, aeronautics and agrofood sectors, as well as increasingly active innovation policies (CES, 2008). All the above make Andalusia a strategic region for studying the wide variety of relationships between industry and different actors in a catch-up environment.

Regional Government is in charge of funding and management of the Higher Education Sector2. The growth of the university system has resulted in an organizational model traditionally centred on teaching and academic research. Investment in the acquisition of scientific capacity in recent years has led to the concentration in universities of a large part of regional R&D resources (universities account for 45% of R&D expenditure, while 61% of the researchers in the region are employed by universities) (INE, 2006). An important change has occurred in recent years as a result of the reorganization of both R&D and higher education policies in 2004. Andalusia is an example of the rapid transition from traditional policies based on a linear model of innovation to TH policies3 aimed at interaction between the regional government, universities and industry (CICE, 2006).

Consequently, TH organizations have expanded in the last decade. Some of them are new structures, and other are the results of adapting other public organization to aims related more directly with innovation. Currently there are 20 TTO in the regional innovation system. Most of them are located and owned by universities, but others are located in hospitals and some public research organizations, such as CSIC. The network of TTO was promoted by both the central and regional government as a tool for enhancing university-industry links, and also for managing the traditional activities of academics carried out in a decentralized manner. There are also 10 research parks4, most of them located in the surrounding of a university. These parks are usually the result of partnerships between different institutions –such us universities, city councils, the regional government and some private firms- and have services to assist firms to promote their location in the park or to provide links with other firms or university units. All of

[1] Andalusia is a region located at the South of both Spain and Europe. The region has almost 9 million inhabitants and covers an area of 87,000 square km. It is geographically diverse with large rural enclaves and several metropolitan areas. A traditionally less developed region, Andalusia has undergone a rapid process of change, bringing it practically on a par with European standards. 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 the per capita GDP of Spain in 2001) (CES (2008) Informe sobre la situación socioeconómica de Andalucía, Consejo Económico y Social de Andalucía, Sevilla..

[2] Andalusia currently has nine public universities with some 250,000 students and 17,000 teaching and research staff.

[3] A useful example of the more interactive polices is the RETA network of the regional government that provides innovation support and collects information from the firms that have been used in this study.

[4] Each of these science parks are specialized in a specific economic sectors, from aerospace industry to the food industry, biomedical and information technology and communication.

them also locate a firm incubator centre. Finally, the most important institution for financial support is the Agency for Regional Innovation (Agencia IDEA). The former agency for industrial policy and the restructuring of old industrial conglomerates, it was reoriented toward innovation policy. Now is in charge of the regional funds directed to firm innovation, some of them linked directly with entrepreneurship and joint projects with universities. It also develops an extensive program for advising activities related to firm innovation.

Methodology

Data source

This study uses a directory of firms located in the Autonomous Community of Andalusia. The directory was developed by a regional government agency that provides innovation assessment (CITANDALUCÍA). The main purpose of this data set is to identify the technology resources of the region, regarding possible innovative firms for getting them involved in networks with other firms as well as in regional innovation programs. The directory contains data of 1898 firms that have received some type of public financial support for innovation during the 2000-2006 period, including:

- Subsidies for modernization and innovation from the Regional Innovation Agency.
- Subsidies from the Regional R&D Plan and other R&D programs developed by regional institutions.
- Subsidies and tax deductions from the central government for participation in innovation activities (generally through the National Center for Technological Development-CDTI).
- Subsidies from the EU Framework Program (1998-2002) or any other European Union program related to innovation.

In addition, CITANDALUCÍA has added to their data set those firms that have been identified as more prone to innovation due to the activities they develop or because the positive feedback they show when contacted by the local offices.

The data source used for the study has a series of advantages and drawbacks related to the typical dilemma between "representativity" and "specificity" that often arises in studies of this kind. For example, one of the key decisions to be taken when defining our population of firms is whether observations should be made of all the existing firms in the region or only firms with specific characteristics, namely those with a potential for innovation. A limitation of our data source is that it does not represent all of the firms in the region, but only those with a more innovative profile. Thus our data source is biased with respect to the entire population of firms. Nonetheless, this source permits us to conduct analyses aimed at examining the characteristics of cooperation. If we were to use a sample of firms chosen randomly from among all of those registered in the region, we would obtain only a very small percentage of them that have had some type of relationships with universities or TH organizations. It would therefore be pointless to ask about the different forms of interaction and we would encounter a similar situation to that which occurs with more general innovation surveys. By choosing our data in this way, we obtain an "operational population" that fits in with the objectives of our study as it represents the portion of the production sector that is more prone to collaboration.

On the other hand, the use of this data source provides additional advantages. Firstly, it includes firms with varying innovation capacities that have obtained different types of financial support. There are firms that have obtained non-R&D related aid for innovation (e.g. a computer network or a web marketing system) as well as firms that engage in highly scientific activities (e.g. R&D projects conducted by aeronautic firms). This also means that only some of them have a department specifically dedicated to R&D. Secondly, the sample includes a wide range of business activities and sizes ranging from SMEs to large companies. Thirdly, the firms studied are not only concentrated in industrial areas or in technology parks near universities, but dispersed geographically throughout urban and rural areas of the region. In short, our data source is appropriate for observing the different patterns of interaction and the possible factors that operate in them.

Sample, fieldwork and questionnaire

Using this population, we have designed a sample of 737 enterprises. Selection was random, with a proportional distribution between strata formed by the sector of activity and the province where the enterprise is located. The fieldwork was conducted through personal interviews in the headquarters or offices of the firms. The fieldwork was carried out in the following sequence. The enterprises that were selected in the initial phase were contacted first by post mail and later by telephone to request their participation in the study. If the enterprise accepted, the appropriate person employed by the firm was chosen to respond the questionnaire. An appointment was then arranged and a professional survey taker travelled to the firm's headquarters to conduct the survey.

For the firms that refused to answer the survey, a randomly selected substitution sample was used following the same criteria. The acceptance rate in the first wave was 76%, while in the second wave it was 72%. A total sample of 737 enterprises was obtained. The main characteristics of the firms included in the sample can be found in Table I of the appendix. The firms are chiefly independent, with less than one-fourth belonging to a business group. The number of employees reflects the size of the enterprises in the region: 52% employ ten workers or less, while only 14 % have more than 50 workers. A large part of the firms can be considered start-ups: 18% were created after the year 2000. Their geographical location varies throughout the region, as does their sector of activity. As regards innovation capacity, 21.3% have an R&D department on the premises, while 3.8% have off-site R&D departments.

The information collected has been grouped into three main categories: a) characteristics of the firm and geographical location, b) interaction with the university sector and c) the role of the TTO organizations.

Special importance was given in the survey to section b). Decisions regarding survey design were inspired in recent specific studies (Cohen et al., 2002) as well as in the report on third stream indicators by Molas-Gallart et al. (2002). Nonetheless, in this last case the indicators were not designed in an operational manner, making it necessary to develop a specific measurement system. Moreover, the indicators were adapted to the context of the region where the firms are located. The indicator set was developed using an activity-based approach. In other words, the survey focused on what the enterprises do in relation to the universities, rather than on the impact that this interaction may have in economic terms. The set of indicators includes twelve possibilities for interaction, ranging from R&D contract and consultancy to training and mobility of personnel, including also commercialization of IPR-related activities (see Table II of the annex). For each of these items, the respondent was asked if the firm had engaged in such activities during the 2000-2006 period and the number of times they occurred.

Indicators related to TH organizations are divided in two parts. First, the questionnaire asks for the specific role of different agents in establishing the relationships with universities. The question we have used asks for the main actor for initiating the relationship. It considers both personal contacts and TH organizations. Second, other set of indicators reflects the importance attributed to three kinds of TH organizations and firms: technology transfer offices in universities (TTO), business support institutions (science parks and incubators) and financial support institution. We use a 4-item scale for each of them. It asks for the effectiveness of each organization in establishing relationships, ranging from non to very effective. We have decided to use these answers as proxy indicators of the effective, and not the actual role of each of them. This decision is because sometimes are compulsory for some university professors to use the TTO or similar office for managing the activities they carry out with firms.

Strategy of analysis

After providing a descriptive account of the above indicators, our strategy of analysis is as follows. We have carried out three regression analysis models aimed at studying the influences for each of the TH organizations. With these models we are able to identify the specific role of each organization depending on the characteristics of the firms and the forms of relationships they have maintained with universities. Model 1 uses as a dependent variable the importance attributed to TTO. Models 2 and 3 use respectively research parks and the innovation agency as dependent variables. The observation values that we have used for each of the variables in the model are the firms answering the two higher items of the scale. That is, if they consider their role for establishing relationships with universities effective or very effective.

For each model we have used two sets of independent variables. The first set is related with the main characteristics of firms. On the one hand, we have considered the size and the sector of activity as

structural variables. On the other hand, we have used two variables as indicators of absorptive capacity: the existence of a R&D department on the premises of the firm and the innovative activity measured as the existence of internal R&D. We also have used the contract of external R&D as an indicator of the open strategy to innovation. The second set reflects the channel for knowledge transfer that firms predominantly use in their interactions with the universities. We have distinguished a wide range of formal relationships with universities. Specifically, we have considered 5 different forms of collaboration: (1) activities of human resources (training of postgraduated and internships, exchange of personnel with universities and training of business workers by universities), (2) R&D project and consulting from universities, (3) use of universities patents, (4) participation in spin-offs and start-ups, (5) participation in joint research centres. Moreover, we have included a variable that measures if the firm has informal relationships with a university. Such variables of forms of collaborations and informal relationships are dummy variables: we have coded as 1 the firms that have maintained at least once each king of interaction.

Findings

Descriptive results

Table 1 includes the answers for questions which specifically ask for the agent that acts in establishing the firms contact and the contract. The results show that the main channel are personal contacts in opposite of the different TH Organizations. Table 2 shows the descriptive results of the effectiveness attributed to the three organizations. It can be showed that both science parks and financial institutions are given high importance, with approximately 44%. On the other hand, TTO are valued as highly effective only by 22% of all firms.

Table II of the appendix includes the different interactions that firms have with universities. It should be noted that informal relationships obtain the highest value (32% of the firms stated that they engaged in this type of interaction), followed by training of university personnel inside the firm (27.5%). This last case is especially significant due to regional government programs to promote the training of university postgraduates in enterprises (CICE, 2006). Moreover, this is a common mechanism for identifying future employees and lowering the risks involved in the selection of personnel. The rest of the interactions can be divided into three groups: 15%-25% of the firms engage in consultancy, joint research projects and university training programs for their employees. 5%-15% of the firms contract R&D projects, lease or use university facilities and engaged in the exchange of personnel. Less than 5% of the enterprises have participated in the creation of spin-offs or start-ups, the sale or transfer of patents and joint ventures. It should be highlighted that interaction related to training and personnel as well as consultancy carry an important weight, while the exploitation of intellectual property rights is given less importance even in firms regarded as being the most innovative in the region. To give an overview of the results, 421 firms (57% of the sample) stated that they engaged in no type of collaboration, while 305 (41%) stated that they engaged in some type of collaboration in addition to informal relations.

Table 1. Mechanism of starting the relationship

Mechanism	**Percent**
Through the TTO	21.7
Through a financial support institution	4.7
Through a Business support institutions	8.5
Through a informal relationship	65.1

Table 2. Dependent variable

Dependet Variables	Percent
Effectiveness of Technology transfer offices (TTO)	26.3
Effectiveness of Business support institutions (science parks)	42.2
Effectiveness of Financial support institution	42.9

Table 3. Independent variable (%)

Independent Variables		Percent	Mean	S.D.	Min	Max	N
Size		0	56	239	1	3580	737
Activity Sector	Medium-High Tech	5.7	-	-	-	-	737
	Low Tech	31.8	-	-	-	-	737
	Services	51.6	-	-	-	-	737
	Others	10.9	-	-	-	-	737
Absorptive Capacity	R&D Department	25.2	-	-	-	-	737
Innovation Activity	Internal R&D	62.1	-	-	-	-	737
Open innovation	External R&D	43.4	-	-	-	-	737
Human resources		32.2	-	-	-	-	737
Joint research projects & consultancy		28.6	-	-	-	-	737
Patents		4.6	-	-	-	-	737
Spin-off		3.9	-	-	-	-	737
Joint research centers		3.7	-	-	-	-	737
Informal relationship		32.2	-	-	-	-	737

Main influences on the role of TH organizations

Table 4 shows the results of the logistical regressions for the hybrid organization. Previous tables set out descriptive statistics of the variables included in the analysis (see Table 2 and 3).

Table 4: Logistical regressions

			Technology transfer offices (TTO)		Business support institutions (SCIENCE PARKS)		Financial support institution (IDEA Agency)	
			Coefficient	Std.E.	Coefficient	Std.E.	Coefficient	Std.E.
Characteristics of firms	Size		0,000	0,000	0,000	0,000	0,000	0,000
	Activity Sector	Medium-High Tech.						
		Low Tech.	-0,269	0,414	-0,449	0,356	0,399	0,384
		Services	-0,183	0,402	0,307	0,341	0,497	0,374
		Others	0,222	0,461	0,582	0,400	1,154***	0,436
	Absorptive Capacity	R&D Department	0,213	0,222	0,085	0,176	-0,088	0,181
	Innovation Activity	Internal R&D	0,096	0,226	0,395**	0,182	0,522***	0,186
	Open innovation	External R&D	0,019	0,207	-0,121	0,174	0,063	0,179
Type of collaboration with universities	Human resources		0,873***	0,240	-0,061	0,223	0,176	0,224
	Joint research projects & consultancy		1,097***	0,277	-0,372	0,265	-0,125	0,266
	Patents		-0,470	0,406	-0,130	0,408	0,737	0,479
	Spin off		0,850*	0,468	0,500	0,443	1,542**	0,645
	Joint research centers		0,198	0,458	0,848*	0,462	0,681	0,548
	Informal relationship		0,056	0,283	0,536**	0,256	0,775***	0,256
Nagelkerke pseudo R^2			0,236		0,086		0,169	
% Cases classified			76		59,7		65,5	
N			737		737		737	

The analysis shows that the role of hybrid organizations does not differ in response to some structural and organizational characteristics of firms. Activity sector and size do not show significant differences when attributing importance to TH organizations. Internal R&D is the only relevant variable related to research parks and the innovation agency. But interestingly, this variable does not show significant value when used in the model related to TTO.

We find most of the differences when attending to the type of activities carried out in cooperation with universities. As we can see in table 4, the TTO stands as an interface body for the activities related to the exchange, training and recruitment of human resources, as well as joint research projects and the implementation of technology consulting. These activities are not related with research parks and the innovation agency since these organizations are more oriented to activities related to projects and more direct commercial aims. However, business support institutions, such as science parks, acquire greater relevance in the creation of joints research centers. This means that the research parks are especially useful for establishing long term relationships and new kind of public-private partnerships, such us the joint centers that we asked for in the questionnaire. Firms located in these parks usually have more capacities and are able to establish new kind of hybrid centers in cooperation with universities.

When the mechanism of knowledge transfer is the creation of spin offs the analysis shows that the TTO along with the government agencies are more important for the firms studied. This confirms the role that literature usually attributes to these agents. Academic entrepreneurship is commonly facilitated through a combination of capacities of academics with financial aid, such as free credits, where both structures seem to play an important role. Finally, as shown in the independent variables descriptive table (Table 2), 32.2% of companies claim to keep some kind of informal contact with the university. These companies grant an important role to both science parks and financial support institutions in establishing a link with the university.

Conclusions and implications

The analysis shows that different organizations have indeed different roles in the relationships that firms maintain with universities in a regional innovation system. Overall, the descriptives show that research parks and innovation agencies are given greater effectiveness than TTO, as shown in table 2. Others descriptives aimed to observing specifically the role of possible channels showing that personal relationships are important. TTO are also part of the networking activities, but together with other agents. Personal contacts are the main channel for initiating the relationships.

These roles are context dependent because of the institutional arrangements that are found in the regional university system. For most of academics it is compulsory to channel their collaborative activities through the TTO when financial exchanges are made. University professors establish their links independently, and afterwards they have to use the formalized procedures of universities when economic transactions exist. This suggests that the compulsory role sometimes is not considered efficient. Nevertheless, this does not mean that TTO are not relevant agents.

Moreover, regression analysis shows that the structure of influences is shaped by the type of relationships. Actually, our data show that TTO are specially valued by firms that have used non codified knowledge, especially activities involving training and exchange of human resources, whereas significant influences are not seen with other organizations. Interestingly, the structural characteristics of firms do not have a significant influence, except for the internal R&D, and only in relation with research parks and innovation agencies.

These results are only a first tentative analysis of our data that needs to be reshaped and complemented with other variables. However, we can extract both theoretical and policy implications. First, the finding may be relevant for refining analytical approaches to the role of TH organizations, taking into account that different organizations assume different roles depending on the specific institutional and productive contexts. In catch-up innovation systems the valuable role of universities is maybe the opposite that the mainstream literature assumes, focused mostly on patents and projects with high scientific content. Second, policy implications can be suggested since it is not possible to assess the performance of all TH organizations based on the same set of standardized indicators, especially on easy to measure outputs related to codified knowledge. The type of relationships maintained may be a critical component for the effectiveness of each organization.

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APPENDIX

Table I: Characteristics of the firms in the sample

		Frequency	Percent
Belongs to a corporate group	Yes	168	22.8
	No	567	76.9
	No answer	2	0.3
Number of workers	From 1 to 5	225	30.5
	From 6 to 10	162	22.0
	From 11 to 25	174	23.6
	From 26 to 50	73	9.9
	More than 50	101	13.7
	No answer	2	0.3
	Mean	56	
	Std. Deviation	239	
Firm age	Fewer than 7 years	133	18.0
	More than 7 years	599	81.3
	Do not know / No answer	5	0.7
	Mean	18	
	Std. Deviation	21	
Activity sector (PITEC)	Agriculture, livestock farming, forestry and fishing	46	6.2
	Oil industry	3	0.4
	Manufacture industry	196	26.6
	Energy and water	26	3.5
	Building industry	47	6.4
	Services	419	56.9
Geographic environment	Science or technology park	61	8.3
	Industrial park	209	28.4
	Urban area	398	54.0
	Rural area	60	8.1
	Others	6	0.8
	Do not know / No answer	3	0.4
R&D department	Yes, in this location	157	21.3
	Yes, in a different location	28	3.8
	No	551	74.8
	No Answer	1	0.1
Num. of workers in the R&D department	Fewer than 5 workers	102	55.1
	From 5 to 9 workers	34	18.4
	10 or more workers	38	20.5
	Do not know / No answer	11	5.9
	Not applicable	552	
TOTAL		**737**	

Table II: Types of interactions with universities

	% answering "yes" in each type of interaction	% Do not know / No answer	Collaborative intensity (number of interactions)					
			N[1]	Max	Mean[1]	Std. Deviation[1]	Mean[2]	Std. Deviation[2]
Consultancy work	21.8%	0,10%	124	80	7,1	11	1,3	5,4
Commissioning of R&D projects to universities	14.0%	0,00%	87	20	3,6	3,5	0,4	1,7
Joint R&D projects	22.1%	0.0%	145	33	3.8	4.8	0.8	2.6
Use or renting of facilities	8.1%	0.1%	48	48	4.6	7.3	0.3	2.2
Patent exploitation	4.6%	0.5%	28	8	2.5	2.5	0.1	0.7
Training of university postgraduates and internships at the firm	27.5%	0.1%	158	147	8.1	16.0	1.8	8.4
Exchange of personnel	7.1%	0.1%	40	20	4.3	4.5	0.2	1.4
Training of firm workers by the university	15.2%	0.5%	93	40	4.1	5.0	0.5	2.3
Joint-ventures with universities	3.7%	0.1%	22	2	1.1	0.3	0.0	0.2
Participation in spin-offs and start-ups	3.9%	0.3%	27	100	5.4	19.0	0.2	3.7
Informal networks	32.2%	0.8%	147	100	8.2	14.5	1.9	7.7
Other types of collaborative Activities	1.9%	15.8%						

[1]Base: Firms displaying at least one type of interaction

[2] Base: Total of firms