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Knowledge Transfer in the Mirror: Reflections on the Determinants of Research Groups and Companies Collaborative Patterns within Andalusia's Regional Innovation System

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Abstract:

Knowledge transfer is a crucial aspect for the new paradigm of science-industry cooperation. The new role of universities and the relevance of external knowledge to firm's competitiveness brought a huge attention to this process both in analytical and decision-making terms. Commonly, formal mechanisms as intellectual property rights licensing, research contracts and spinning-off are the focus of the policy interventions and studies but the role of informality is being underlined by several recent research results. This article explores the crucial factors that induce science and industry collaborations in Andalusia, a catching-up region in Spanish and European context. The study uses limited dependent and count data regression analysis based in a survey applied in parallel to research groups and firms. The estimated regressions create a mirror image between these two institutional spheres stressing aspects that are more relevant in each reality to stimulate the existence, number, diversity and informality of knowledge transfer. The results give relevant insights for policies to stimulate knowledge transfer in technology moderate intensive South European regions.

Key-words: Knowledge transfer, Research Groups, Companies, Regression

1. Introduction

The debate about university-industry relations is today very active. The relevance of knowledge transfer is being underlined in the last two decades by a stream of innovation-related literature that stresses the crucial role of scientific knowledge to economic development. The notions of Triple Helix (Etzkowitz and Leydesdorff, 1997), a new mode of knowledge production (Gibbons et al, 1994) or Innovation Systems (Lundvall,1992) have compatible visions of the contemporary science world were a interaction of several actors is required. An evident linkage is between universities, here understood as higher education institutions and research units with activity in education activities, that are seen as producers of knowledge and the companies, that use knowledge to implement new solutions, diffuse innovations in the market and contribute to economic growth with added-value and employment. The analyses (and also the policies) are in this way how universities create channels for transfer knowledge to companies. Nevertheless there are several different formal and informal mechanisms it is evident that the practice and the research of these phenomena have a limited vision focusing the activities that directly connected with commercialization of science, protection and licensing of intellectual property rights (IPR), the creation of new advanced firms, usually known as spinning-off, and the development of research contracts.

This narrow approach to what is knowledge transfer, to the diversity of third-stream of activities that include additional channels as extension activities and informal contacts (Molas-Gallart et al, 2002) created new tensions to the university. Commercialization activities have important impacts upon the mertonian principles of science (Merton, 1942). Even if the scientist never really followed completely these ideas of communalism, universalism, disinterestedness and organized skepticism they were important benchmarks to the scientific career. Today science faces different tensions, the science is supposed to create new knowledge, but also to transfer (probably sell is a more precise word) and often to try to create by their own direct economic benefits for the universities. This situation pressured universities for commercialization practices, creating TTOs (technology transfer offices) and establishing internal regulations for these activities. This movement began in the US in the late seventies but was transformed to a global trend today.

It is well-know by the companies that they require technical knowledge to market relevant products. The existence of a level of absorptive capacity (Cohen and Levinthal, 1990) facilitates the interconnections between both worlds. The connection of medium-high technology firms to scientific knowledge is more or less evident even if the big multinationals carry out independently their applied research. In regions were the economic base is not knowledge intensive it is not so evident the need and the possibility to create university-industry linkages. In fact, even this industrial focus, implicit in the common way to phrase this topic, is contested because services are accepted as having a central role for innovation today but are even more complex to understand due to the intangible character of the majority of the innovations.

These worlds of science and business are separated. In the daily routine practice of intermediate actors like TTOs is evident that companies and research groups are different collectives with different styles of thought (Pinto, 2009a). In university-industry relations studies is common to depart from one of the sides, or using the company or using the research group, often the analysis are at the researcher level, chosen as statistical units. It is then frequent to see econometric explanations of the factors that induce innovation activities in firms, usually through limited dependent models estimates, and factors that impact in knowledge transfer interactions, a common proxy is patent numbers, through count models.

This article has the ambition to underline the main factors that impact in several aspects of the knowledge transfer process in the vision of companies and research groups. For this purpose we will confront four dependent variables, the existence of knowledge transfer relations, the number of knowledge transfer relations, the importance of informality in knowledge transfer, and the diversity of transfer channels used. Using a large survey to companies and research groups in the Spanish region of Andalusia in 2008 it is possible to study in parallel a series of common control variables and, of course, specific variables for firms and science. The case of Andalusia is particularly relevant, it is bigger in population and territorial scale than the smaller EU countries, from one of the poorest regions of Spain, Andalusia has today grown considerably in economic terms and structuring a relevant network of innovation actors. The results facilitate a direct comparison of what are the factors that impact more deeply in these dimensions of knowledge transfer and originate important policy implications.

2. Knowledge Transfer from Research and Company's Perspective

The attention to knowledge transfer is often connected to the Bay-Dole Act in the US that permitted to universities to exploit commercially publicly-funded research. This act had a crucial institutional impact by signaling to research actors the potential benefits of theses activities (Berman, 2008). The Bayh-Dole created different models for university inventions and inspired several policies that changed the commercialization routines of scientists (Aldridge and Audretsch, 2010). But its main consequence was the rise of protection of intellectual property, in particular patents (Kenney and Patton, 2009) with the ambition of obtaining extraordinary revenues from this additional source. Van Zeebroeck et al (2009) paid recently particular attention to the determinants for the growing number of patents.

This dramatic rise in university patenting was often accompanied by a narrowing of the other types of knowledge flows (Rosell and Agrawal, 2009). Thursby et al (2009) showed that a proportion of university researcher's patents are not IPR from the universities but from companies that cooperate with them. The rising of patent numbers and science commercialization has impacts in research productivity and in several other scientific life aspects (Czarnitzki et al, 2009; Buenstorf, 2009). In parallel the increase of patent numbers was accompanied by a fall in its quality (Colyvas et al, 2002) and researchers begin patenting for the sake of patenting (Pinto and Pereira, NDa). Knowledge transfer need to be managed by researchers that create specific approaches based in the complementarities found in different activities (Landry et al, 2010).

Several studies tried to understand the factors to explain cooperation with companies in research groups. The personal profile of the scientist, experience, scientific area, age, reputation, gender, the institutional factors like the incentives to cooperate, the existence of TTOs, internal schemes, valorization of these activities by their peers, increase the cooperation activities. Several studies using econometric applications have focused the academic inventors and industry involvement (Boardman, 2009), academics as brokers (Lissoni, 2010), the valuable university-industry linkages (Giuliani and Arza, 2009), the reasons of why researchers spin-off (Krabel and Mueller, 2009), the success of scientists in commercialization (Link and Scott, 2010), collaboration practices of universities with industry (Ponomariov and Boardman, 2009; Giuliani et al, 2010).

Arundel and Geuna (2004) use firm specific variables and territorial specific variables to understand the university-industry interactions. Regional markets, the use of informal channels and tacit knowledge are crucial. D'Este and Iammarino (2010) studied the distance of collaborations, quality of the department, the investment and revenue in R&D, type of centre, the scientific area and the age of the research group as drivers for knowledge transfer intensity. Audretsch and Aldridge (2010) analyze the type of researcher that engages commercialization activities focusing the intensity of research, the reputation of the scientists and the location. D'Este and Patel (2007) focus explanation of the varieties of U-I interactions underlying the role of informal mechanisms. Østergaard (2009) also underlines the relevance of informal channels for network creation.

Focusing the company’s side, the firm growth is determined by its capacity to innovate and to absorb and apply new knowledge (Lee, 2010). This is an idea in fashion since the often-cited article of Cohen and Levinthal (1990) that introduced the relevance of the knowledge base in a company to understand and benefit from technological advancements that are done in its external environment. The absorptive capacity is a topic that is commonly studied through knowledge production function estimation at firm-level (O’Mahony and Vecchi, 2009). The absorptive capacity is particularly relevant to study in less knowledge-intensive regions to underline the aspects that may impact in the creation of innovative dynamics.[1] For example, the case of Spain was focused by several authors (Escribano et al, 2009; Gomez and Vargas, 2009; and Artés, 2009). But this framework is also useful to explain the processes in high-tech sectors like biotech and pharmaceutical firms (Fabrizio, 2009) or the market competition and the investment in R&D (Lee, 2009). Other empirical questions like the relation of absorptive capacity and distance to collaboration (De Jong and Freel, 2010) or the relevance of SME networks (Kirkels and Duysters, 2010) or the determinants of corporate and non-corporate R&D performance (Wang, 2010; Moncada-Paternò-Castello et al, 2010) are being tested with similar approaches. Innovation in firms impacts strongly in macro-economic growth (Evangelista et al, 2010). In fact, there is a global nexus between innovation and growth (Hasan et al, 2010).

It is relevant to underline a recent study of Bruneel et al (2010). It focuses a particular aspect of this issue: the factors that diminish U-I collaboration. These authors selected several variables: absorptive capacity (percentage of qualified human resources), firm size (number of workers), nature of the firm (belonging to a group or not), inter-industry differences, doctoral degree of the respondent and degree of trust to explain the breadth of interactions (variety of used channels), education-based interactions (related with courses and classes) and contract-based interactions (contracts of research or IPR).

These interactions between science and companies are complex and create different national and regional profiles that impact in the efficiency of knowledge transfer (Pinto and Pereira, NDa), patenting (Fu and Yang, 2009), distance and research collaboration (Hoekman et al, 2010). An example is the diversity of typologies of regional innovation systems that emerge in a European level analysis (Pinto, 2009; Buesa et al, 2010).

3. Insights for the Knowledge Transfer Process

3.1. Presentation of the Study

The focus of this study is knowledge transfer. This notion is used in a broad sense to include the common types of mechanisms (spinning-out, IPR and research contracts) but stressing also the importance of other channels and informality.

[1] Research Policy 38(3) is an issue completely dedicated to "Innovation in Low and Medium Technology Industries".

In this study knowledge transfer activities includes technological consulting, collaborative research projects, contracted research, share of infrastructures, exploitation of patents, internships, exchange of staff, training, participation in the creation of technological centre, spin-off creation, informal relations and a variable that included other channels not specified. In the case of research groups these activities are added with science communication activities. The goal is to understand the variables that impact in the process of knowledge transfer with the possibility to compare the relevance of several aspects to companies and research groups and controlling by several dimensions that are often referred as being crucial to engage this kind of activities.

Our analysis focuses the Spanish region of Andalusia. It is a large region in terms of territory and in terms of population. Andalusia is the Spanish region further south, considered the gateway between Europe and Africa. The region is large, more than seven million people, eighteen percent of the population of Spain, and almost ninety thousand square kilometers. Andalusia autonomous community consists of eight provinces: Huelva, Seville, Almeria, Cadiz, Cordoba, Granada, Málaga and Jaén. Agriculture and tourism are very relevant in the regional economy but other sectors such as chemicals, automotive sector complementary industries, electronics, telecommunications and food processing are also important. In recent years, economic growth has been intense. Currently the region has surpassed the 75% EU average of GDPpc, which placed the region as "convergence" in the race for EU structural funds,. From one of the poorest European Union regions, Andalusia was able to structure an interesting network of innovation actors (Pinto et al, ND). Despite its economic convergence process it remains one disadvantaged regions of Spain and Europe regarding innovation (Pinto, 2009), even if several excellence poles like Seville and Malaga do exist.

The study includes only cases from the provinces from this particular region, its conclusions are coherent with other analysis and have potential to enlighten specially regions with a similar scientific, technological and innovative profile. The study benefits from the research project implemented by IESA-CSIC named *"Condiciones de generación y uso de la investigación científica en los sistemas de I+D"*. The fieldwork and data collection was in 2008. The sample includes 737 companies and 765 research groups. The data was not suitable for a direct regression analysis and it was necessary to perform several transformations to achieve adequate variable to include in such a methodological approach. The variables included in the study are explained and linked with the research objectives in tables 1 and 2.

Variable	Description	Research objectives
KT	Binary variable that assumes value 1 if company has engaged in knowledge transfer activities and 0 if not.	Understand what conditions the decision of engaging or not in knowledge transfer with universities
NUMKT	Count variable with the total number of knowledge transfer relations	Understand the crucial variables to increase number of knowledge transfer with universities
INF	A ratio variable between the number of informal relations and total number of KT relations. Percentages were transformed in integers to facilitate Count model estimation.	Discuss the importance of informal relationships in total KT relations and the contrast with other dependent variables.
DIVKT	A count variable with the number of channels of knowledge transfer used.	Study the diversity of utilization of KT mechanisms.
IND	Dummy variable that assumes value 1 if company is from the Industry sector and 0 if not	Verify the idea that industrial companies are focused in a process approach and innovate and try to connect with universities more often
GROUP	Dummy variable that assumes the value 1 if company belongs to a Group of companies	Verify the possibility of groups engaging more in KT activities
AGE	Count variable with the age of the company in years	Study the impact of age of company in KT
EMP	Count variable with the total number of employees in the company	Study the impact of company size in KT activities
EMPQ	Ratio variable with the employees with Higher Education and the total	Create a measure of absorptive capacity in the firm and verify the impact of qualified human resources
EXP	Ratio variable of percentage of exports from total sales	Verify the relevance of export intensity to engage KT
RDDEP	Dummy variable that assumes value 1 if company has an internal R&D department and 0 if not	Create another measure of absorptive capacity in the firm and verify the impact of existence of internal R&D department
FORM	Dummy variable that assumes value 1 if company has invested in training activities for its employees	Create another measure of absorptive capacity in the firm and verify the impact of existence of technical qualification of employees
INOVACT	Dummy variable that assumes value 1 if company has developed innovative activities and 0 if not	Verify the impact of investing in the acquisition of external R&D, machinery and equipment, external knowledge, introduction of innovations, biotechnology activities, or industrial design in KT
PAT	Dummy variable that assumes value 1 if company has at least a registered national patent	Understand the relation of IPR protection in companies and KT activities
KTEXP	Count variable that with the number of years since the first contact with a research organization	Verify the impact of experience in KT activities to further instigate more KT
PREVREL	Dummy variable that assumes the value 1 if the company respondent supports that the existence of previous relation is the crucial factor to engage KT activities between companies and research groups	Understand the relevance of trust and mutual knowledge for KT activities
KTO	Score variable that is created with the sum of three dummy variables, one that assumes 1 if the initiative for the KT activities was from the KTO, other that assumes 1 if the KTO helped during all the process and another one if the KTO was considered the central intermediary to KT, multiplied by the valuation of the effectiveness of the KTO (0 to 4)	Understand the importance of KTOs to KT in the perspective of company's side
KTEXT	Dummy variable that assumes value 1 if company cooperates with research groups outside its region	Verify the importance to overall KT activities if the company has relations with external research groups
KTVAL	Score variable with the valorization of the respondent of the importance of KT to the competitiveness of the company (0-4)	Understand the connections between the valorization of KT and the actual enrolment of the companies in these activities
STP	Dummy variable that assumes the value 1 if it locates is a Science & Technology Park	Verify if companies in this kind of complex are more willing to engage KT
PROXUNIV	Dummy variable that assumes the value 1 if the company is geographically close to a university	Understand the importance of physical distance to KT
PROXHTMNE	Dummy variable that assumes the value 1 if the company is close to high-tech multinational companies	Verify the relevance of physical proximity to multinationals to engage KT activities with research groups
CLUST	Dummy variable that assumes value 1 if company is integrated in a territorial cluster and 0 if not	Understand if the participation in a cluster, defined as the cumulative availability of qualified personnel, R&D services and competencies, proximity to other related companies and high industrial activity, increases the KT activities

Table 1: Variables used in Companies Analysis

Source: Personal elaboration

Variable	Description	Research objectives
KT	Binary variable that assumes value 1 if research group has engaged in knowledge transfer activities and 0 if not.	Understand what conditions the decision of engaging or not in knowledge transfer with companies
NUMKT	Count variable with the total number of knowledge transfer relations	Understand the crucial variables to increase number of knowledge transfer with companies
INF	A ratio variable between the number of informal relations and total number of KT relations. Percentages were transformed in integers to facilitate Count model estimation.	Discuss the importance of informal relationships in total KT relations and the contrast with other dependent variables.
DIVKT	A count variable with the number of channels of knowledge transfer used.	Study the diversity of utilization of KT mechanisms.
NATLIFE	Dummy variable that assumes value 1 if research group focus Natural Sciences and Life Sciences	Verify the propensity to KT in this scientific domains
EXPTECH	Dummy variable that assumes value 1 if research group focus Exact and Experimental Sciences and Technologies	Verify the propensity to KT in this scientific domain
SOCHUM	Dummy variable that assumes value 1 if research group focus Humanities and Social Sciences	Verify the propensity to KT in this scientific domain
AGE	Count variable with the age of the research group in years	Study the impact of age of research group in KT
MEMB	Count variable with the total number of researchers in the group	Study the impact of group's size in KT activities
MEMQ	Ratio variable with the researchers currently holding a PhD from the total	Verify the qualification, specialization and life cycle of the group researchers as inducer of KT activities
DIR	Dummy variable that assumes value 1 if strategic decisions are completely centralized in a Director	Understand the impact of assertive leadership in KT activities
LIBER	Dummy variable that assumes value 1 if decision-making process is based in the individual decision of each researcher	Verify the impact of research freedom to engage KT
IDTOTAL	Count variable of total R&D expenditure in thousands Euros	Understand the effect of budget size for R&D in engaging KT activities
IDPRIV	Ratio variable between the budget from R&D coming from private sources from total expenditure	Verify the importance of R&D funded by private funds to engage KT activities
FOCUSKT	Score variable that is the product of the sum of two dummies, first main activity focused on knowledge transfer or diffusion of science, second the orientation of research activities towards companies with a self-assessment of ability to transfer knowledge (1-5)	Verify the importance knowledge transfer activities as main objective of research group activities for actual KT
KTEXP	Count variable that with the number of years since the first contact with a company	Verify the impact of experience in KT activities to further instigate more KT
PREVREL	Dummy variable that assumes the value 1 if the research group respondent supports that the existence of previous relation is the crucial factor to engage KT activities between companies and research groups	Understand the relevance of trust and mutual knowledge for KT activities
KTO	Score variable that is created with the sum of three dummy variables, one that assumes 1 if the initiative for the KT activities was from the KTO, other that assumes 1 if the KTO helped during all the process and another one if the KTO was considered the central intermediary to KT, multiplied by the valuation of the effectiveness of the KTO (0 to 4)	Understand the importance of KTOs to KT in the perspective of research group's side
KTEXT	Dummy variable that assumes value 1 if research group cooperates with companies outside its region	Verify the importance to overall KT activities if the research group has relations with external companies
KTLARGECOMP	Ratio variable that ensures the percentage of KT activities with large firms from total number	Understand the impact of collaborating in KT with large companies to KT activities
KTVAL	Score variable with the valorization of the respondent of the importance of KT to the competitiveness of the research group (0-4)	Understand the connections between the valorization of KT and the actual enrolment of research groups in these activities

Table 2: Variables used in Research Groups Analysis

Source: Personal elaboration

In table 3, the descriptive statistics (mean, standard deviation, minimum and maximum) are presented for all the variables concerning companies.

Variable	Mean	Standard deviation	Mininum	Maximum
kt	.4029851	.4908309	0	1
numkt	6.949796	17.62329	0	187
inf	.0833514	.2084454	0	1
divkt	1.290366	2.030.963	0	10
ind	.265943	.4421341	0	1
group	.2279512	.4197958	0	1
age	17.7862	21.33341	0	338
emp	55.9212	238.468	1	3580
empq	.3544369	.384179	0	2.89
exp	7.050204	17.86655	0	100
rddep	.2510176	.4338931	0	1
form	.7991859	.4008814	0	1
inovact	3.370421	1.888133	0	7
pat	.2075984	.405863	0	1
ktexp	8.132972	4.549691	1	48
prevrel	.1940299	.3957205	0	1
kto	.7449118	1.822282	0	9
ktext	.0841248	.2777634	0	1
ktval	1.427408	1.702925	0	4
stp	.082768	.2757183	0	1
proxuniv	.7191316	.4497285	0	1
proxhtmne	.358209	.4797996	0	1
clust	.0909091	.287675	0	1

Table 3: Descriptive Statistics Variables used in Companies Analysis

Source: Personal elaboration

In table 4, the descriptive statistics (mean, standard deviation, minimum and maximum) are presented for all the variables concerning research groups.

Variable	Mean	Standard deviation	Mininum	Maximum
kt	.551634	.4976522	0	1
numkt	12.50327	38.19126	0	882
inf	.1137909	.2163748	0	1
divkt	2.504575	2.882797	0	11
natlife	.3647059	.4816625	0	1
exptech	.2130719	.4097459	0	1
sochum	.4222222	.4942367	0	1
age	14.14784	7.037167	0	61
memb	12.44052	8.620758	2	88
memq	.6754248	.2091963	.1	1
dir	.1137255	.3176853	0	1
liber	.0588235	.2354481	0	1
idtotal	40642.98	50373.31	0	1030000
idpriv	.1102222	.2117351	0	1
focuskt	.5490196	1.490551	0	10
ktexp	1.16732	4.93632	1	37
prevrel	.324183	.468375	0	1
kto	.9699346	1.891808	0	12
ktext	.2810458	.4498039	0	1
ktlargecomp	.2078562	.3661271	0	1
ktval	1.878431	1.739476	0	4

Table 4: Descriptive Statistics Variables used in Research Groups Analysis

Source: Personal elaboration

The interest in studying these four dependent variables is because, although they are connected, they are not illustrative of the exactly same process. An example is the figure 1.

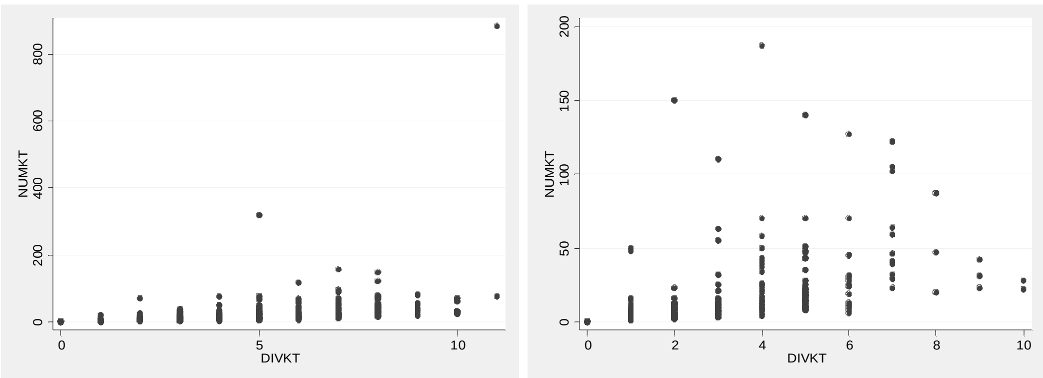

Figure 1: Relation of Number of Knowledge transfer activities and Diversity of channels

Source: Personal elaboration based in data of IESA (2009a) and IESA (2009b)

The illustration underlines the relation between the number of knowledge transfer and activities and the diversity of channels used. The correlation analysis evidences a positive association between the variables but the graphical analysis suggests that there is a common positive movement until a certain degree of specialization. After this point the utilization of more diversity of channels does not seem to impact positively in the number of knowledge transfer activities engaged. The inclusion of these four dependent variables tries to comprehend specific aspects of knowledge transfer.

Commonly ordinary least squares estimator is the best linear unbiased estimator. But with the characteristics of the dependent variables the efficiency of the estimates of this estimator is poor compared with alternative methods.

In the case of variable KT, a limited dependent variable that assumes the values 1 or 0 it was used PROBIT estimation. In the case of NUMKT, INF and DIVKT, dependent variables that are count of scores non negative integers from zero to many, a count model approach was used. The problem of over-dispersion required the comparison of a Poisson model with a Negative binomial (Cameron and Trivedi, 1998). Negative binomial representation was always superior to a Poisson model for the available data. Because of the high number of zeros in the observations the zero-inflated model was also compared with a Negative binomial using the Vuong test available in Stata[2]. In general the Negative binomial was the estimator that better suited the data. Negative binomial estimator is widely used in count models in innovation studies since at least since the influential study using patent data of Hausman et al (1984). In the case of INF, as this variable was not a true count data variable but a transformation, a TOBIT specification was also performed as a confirmatory method. Nevertheless the OLS estimates were also presented because are good indicators to check the overall robustness of the results by supporting the analysis of the correct signal of the coefficient.

The estimated models[3] were analyzed in terms of its general capacity to explain the processes, the significance of the coefficients, characteristics of the residuals and autocorrelation. It is difficult to overcome the endogeneity limitations, a common problem in this type of estimation, where the variables are simultaneously causes and consequences of the dependent variables in circular causation processes.

[2] Vuong (1989) developed non-nested model tests that were adapted by Greene (1994) in a test that has been implemented in this software. The z-value not significant, the Vuong test shows that the zero-inflated negative binomial is not a better fit than the standard negative binomial. This statistic has a standard normal distribution with large positive values favoring the zero-inflated model and with large negative values favoring the nonzero-inflated version (negative binomial in this case). Values close to zero in absolute value favor neither model (Long, 1997).

[3] The complete estimation results can be found at Pinto et al (ND). The econometric package used was Stata 10.0.

3.2. Econometric Evidence

The results are synthesized in the following tables. The table 5 (KT), table 6 (NUMKT), table 7 (INF) and table 8 (DIVKT) regard the comparison of the independent variables that are common both to companies and research groups facilitating a direct comparison of the aspects that impact with more intensity in knowledge transfer dynamics and in this way should be targeted with specific and oriented policies. Table 9 focus control variables that are specific to companies and table 10 to research groups. The interpretation of the tables is to be done as follows [- non significant negative coefficient; -- significant negative coefficient at 0,1; --- significant negative coefficient at 0,05; ---- significant negative coefficient at 0,01; + non significant positive coefficient; ++ significant positive coefficient at 0,1; +++ significant positive coefficient at 0,05; ++++ significant positive coefficient at 0,01].

	KT			
	Companies		Research groups	
	OLS	Probit	OLS	Probit
AGE	+	+	+++	+++
EMP/MEMB	-	-	+	+
EMPQ/MEMBQ	++++	++++	-	-
KTEXP	-	-	-	-
PREVREL	++++	++++	++++	+
KTO	+	+	++++	++++
KTEXT	++++	ND	++++	+++
KTVAL	++++	++++	++++	++++

Table 5: Comparison of Importance of Companies and Research Groups Analysis Common Variables to Engaging or not in Knowledge transfer activities

Source: Personal elaboration

In general, the analysis supports other results found in the literature but in this case some contrasts can be found. Age is a significant variable to research groups engage KT activities (table 5) but not to firms. The quality of the employees and the previous experience are crucial dimensions for the company’s side. The role of the KTO is substantially more important to research groups than to firms engage KT. The knowledge transfer with external organizations to the region and the valorization of this activities are important inducers of engaging or not KT for both groups.

	NUMKT					
	Companies			Research Groups		
	OLS	Nbin	ZINbin	OLS	Nbin	ZINbin
AGE	+	+	+	-	++++	++++
EMP/MEMB	-	-	-	+	++	++
EMPQ/MEMBQ	+	++++	++++	--	-	-
KTEXP	+++	++++	++++	++++	-	-
PREVREL	+	++++	++++	+	++++	++++
KTO	+	++++	++++	+	++++	++++
KTEXT	+++	+	+	+	++	+++
KTVAL	++++	++++	++++	++++	++++	++++

Table 6: Comparison of Importance of Companies and Research Groups Analysis Common Variables to Number of Knowledge transfer activities

Source: Personal elaboration

Regarding the number of knowledge transfer collaborations (table 6) they follow in general the same behavior of engaging or not in knowledge transfer. For the total number, the dimension of the research group becomes more relevant. Knowledge transfer experience is a significant variable for companies. Valorization of knowledge transfer is crucial for the number of occurrences.

	INF							
	Companies				Research Groups			
	OLS	Nbin	ZINbin	Tobit	OLS	Nbin	ZINbin	Tobit
AGE	-	-	-	-	-	++++	+	-
EMP/MEMB	-	-	++	-	----	---	----	----
EMPQ/MEMBQ	++++	+	-	++++	-	+	+	-
KTEXP	-	-	-	-	----	----	-	----
PREVREL	+	++++	-	+	+++	++++	+	+++
KTO	-	-	----	-	-	++++	----	-
KTEXT	---	----	----	----	+	++++	-	+
KTVAL	++++	++++	+	++++	++++	++++	---	++++

Table 7: Comparison of Importance of Companies and Research Groups Analysis Common Variables to Importance of Informality in Knowledge transfer activities

Source: Personal elaboration

The variable INF (table 7) was very difficult to model and it is the only estimation where substantial differences appear with the different estimators. Very significant for both companies and research groups to the weight of informality in the total of KT relations was the fact that existing previous relations. Knowledge transfer valorization seems to be an inducer for the increased importance of informality in the total of relations.

	DIVKT					
	Companies			Research Groups		
	OLS	Nbin	ZINbin	OLS	Nbin	ZINbin
AGE	+	+	+	-	-	-
EMP/MEMB	-	-	-	++++	++++	++++
EMPQ/MEMBQ	++++	++++	++++	---	-	-
KTEXP	+	+	+	++++	+++	++++
PREVREL	++++	++++	++++	+	++++	++++
KTO	++++	++++	++++	++++	++++	++++
KTEXT	++++	++++	++++	++++	++++	++++
KTVAL	++++	++++	++++	++++	++++	++++

Table 8: Comparison of Importance of Companies and Research Groups Analysis Common Variables to Diversity of Knowledge transfer channels used

Source: Personal elaboration

Previous relations, the knowledge transfer office importance, the existence of relevant external collaborations and the valorization of theses activities are crucial aspects for the diversity of KT channels used (table 8). The numbers of members in research groups and the quality of the members in companies also have positive impacts in the variety of channels used.

Companies	**KT**		**NUMKT**			**INF**				**DIVKT**		
	OLS	Probit	OLS	Nbin	ZINbin	OLS	Nbin	ZINbin	Tobit	OLS	Nbin	ZINbin
ind	+	-	---	-	-	+	-	+	+	-	+	+
group	+	-	-	+	+	+	-	+	+	--	-	+
exp	+	+	+++	+++	++++	+	+	--	+	++	+++	+++
rddep	+	+	+	++	++	-	+	-	-	+++	+	+
Form	-	-	++++	+	+	-	---	--	-	+	+	+
inovact	+	+	+	++++	++++	-	+	--	-	++	++++	++++
pat	-	-	-	---	---	+	+	-	+	+	+	+
stp	+	+++	+	+++	+++	+	+	-	+	++++	+	+
proxuniv	+	+	-	+	+	+	-	+	+	-	+	+
proxhtmne	-	-	-	-	-	-	+	-	-	+	-	-
clust	+	+	+	+	+	+	-	-	+	+	+	+

Table 9: Importance of Specific Company Variables

Source: Personal elaboration

Specifically for companies (table 9), the localization in a Science & Technology park is statistically significant for engaging knowledge transfer activities. The export intensity, the investment in innovative activities and the localization in S&T parks are significant for the number of KT relations. The only specific variable that seems to have a statistical significant coefficient in informality of the relations is the investment in training of the employees that have a negative impact in the degree of informality. A broader utilization of the diversity of KT channels is positively related with export capacity and innovative activities in firms.

Research groups	**KT**		**NUMKT**			**INF**				**DIVKT**		
	OLS	Probit	OLS	Nbin	ZINbin	OLS	Nbin	ZINbin	Tobit	OLS	Nbin	ZINbin
natlife	++++	+	+	+	+	++	+	-	-	++++	++	++
exptech	+	ND	+	ND	ND	+++	ND	ND	ND	++++	ND	ND
sochum	ND	---	ND	+	+	ND	----	+	---	ND	----	----
dir	+	+	---	-	-	+	++	+	+	-	-	-
liber	+++	++++	+	++++	++++	+	++++	-	+	+	++	+
idtotal	-	-	-	+	+	-	-	-	-	+	-	-
idpriv	-	-	++++	++++	++++	---	+	-	---	++++	+	++
focuskt	+	+	+	+	+	--	--	-	--	+	+	+
ktlargecomp	+	+	-	-	-	+	++	++++	+	---	-	--

Table 10: Importance of Specific Research Group Variables

Source: Personal elaboration

In research groups (table 10) the engagement in KT activities seems to be related with the liberty of the decision making. Like Heinze et al (2009) underlined, complementarities of competencies and leadership in research are knowledge transfer determinants to pay attention to. In this case, there is statistical evidence of the liberty to be important not only to the engagement in knowledge transfer, but also to increase the number of relations and the degree of informality in these relations. There is some evidence that groups from natural and life sciences have more propensity to knowledge transfer that other scientific areas. The number of KT and diversity of channels are influenced positively by the proportion of the R&D budget coming from private sources.

5. Conclusions and Policy Implications

Knowledge transfer is a crucial domain for current university-industry interactions. A diversity of mechanisms and activities that try to stimulate the acquisition of advanced capabilities is having attention from research and company's side. In this article, the visions of research groups and companies were compared regarding the factors that induce the existence of knowledge transfer, the number, informality and diversity of these relations.

The estimated models confirm that are significant differences between the variables that impact in knowledge transfer in the perspective of a company and a research group. The age of the company is not relevant to engage or not in knowledge transfer but is crucial for research groups, being an indicator of its maturity. The dimension of the company or research group is not significant, having only impact for the diversity of channels that a specific research group uses. Qualification of employees is critical to knowledge transfer occurrences but it can be counterproductive in the case of research units' over-qualification. Other factors like the valorization of knowledge transfer activities are important for both sides. Informality is stimulated specially for the existence of previous relations.

To companies, the export intensity, the innovation activities and the location in a Science and Technology park contribute positively for knowledge transfer engagement. For research groups, the fact that the R&D investment provides from private sources is a catalyst for further relations with industry. It was found evidence of the positive impact that autonomy of decision in individual researchers with the group increases interest and relations for knowledge transfer.

Departing from the case of the Spanish region of Andalusia, these results cannot be fully generalized to all contexts because knowledge transfer is a process that is highly dependent on capabilities available for companies and research groups but also on institutional architectures and territorial resources. But we can accept with confidence that the general conclusions are appropriate for the majority of cases of regions with similar socio-economic profiles. To conclude, it is important to underline that the development of specific instruments to stimulate these activities from each side are required. Current policy instruments address knowledge transfer as a homogeneous subject when in fact the approach and the determinants of relations depend if one is analyzing in the perspective of a company or a research group.

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