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Access to universities' public knowledge: Who's more regionalist?

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Abstract:

1. Introduction

Codified university knowledge such as patenting and scientific publications may have an influence on innovation in regions because of the flow of technological knowledge between universities and firms. This flow of knowledge can take place through a variety of interaction channels between academics and firms (by reading the patent and or a scientific paper, or via direct conversation or informal meetings with the academic inventors/researcher, through the hiring of graduate or doctorate students, etc.). However, sometimes there is a mismatch between the university codified knowledge produced in the region and the firms' acquisition of that knowledge. This paper explores the causes explaining why firms use the inward regional university knowledge and why they acquire that knowledge elsewhere outside the region.

Our interest for this topic is motivated for several facts. First, the regional focus for analysing the acquisition of knowledge from universities is suitable given the growing role of policies at regional level to achieve the European Research Area (ERA). It is well known that the program to develop the ERA is primarily a partnership between the European Commission and the member states; but the Commission, the Council and the Committee of the Regions all see a role for the regions in the ERA, as a result of a greater involvement of the regions in research

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and innovation policies (Charles et al., 2009). Second, some regions generate scientific and technological knowledge in their universities, but sometimes regions producing that codified knowledge are unable to fully absorb it or exploit it (Caragliu and Nijkamp, 2012). Third, despite the importance of knowing what explains the acquisition of university knowledge outside or inside the region for regional policy, only a few recent papers have analyzed this topic. For example, Acosta et al. (2011b), study the outside dimension of research collaboration patterns; Abramo (2010) addresses both dimensions for a single country; and Azagra (2012) takes a large number of countries and years to analyze the national patterns of accessing public knowledge. None of this previous research centres on a regional perspective for EU27.

Particularly, two groups of hypotheses are tested about the role of absorptive capacity for academic knowledge, and the importance of the regional presence of regional scientific/ technological opportunities on the firms' acquisition of university knowledge. For this purpose we draw on a regional sample of 20,630 university references (both patents and papers) contained in 15,433 firms' patents across EU27 regions for 1990-2007. The econometric results show a significant role of the university opportunities to increase the acquisition of inward university knowledge, while the firm absorptive capacity is not relevant in explaining the use of knowledge by the firms located in the same region where the knowledge is produced. However, the outward acquisition of knowledge is explained for the absorptive capacity and the regional opportunities for spillovers is not relevant.

The paper is organized as follows. Section 2 reviews the literature relevant to this paper and establishes the hypothesis. Section 3 discusses the empirical framework. Section 4 explains the data and provides summary statistics. Section IV presents the empirical results. We briefly summarize the conclusions, policy implications, and discuss future research in the final Section.

2. Literature review and hypotheses

The process of incorporating new knowledge into firms from other institutions such as universities has been recently discussed in the frame of the open innovation paradigm. According to the open innovation model, firms incorporate external as well as internal ideas, and internal and external paths to market, as they look to advance their technology (Chesbrough, 2003, 2006). Since Chesbrough's seminal work, a considerable number of papers have analysed the open innovation process at various levels, including at firm, industry and region levels (see van de Vrande et al., 2009 for a review), and new trends and directions have been identified (see, for example, Gassmann et al., 2010).

The open innovation ideas assume acquiring knowledge from different sources. Dahlander and Gann (2010) developed an analytical framework by structuring the process of open innovation in two dimensions: inbound/outbound (see also Chesbrough, 2006, Gassmann and Enkel, 2004) and pecuniary/non-pecuniary. Inbound open innovation is an outside-inwards process and involves opening the innovation process to knowledge exploration. External knowledge exploration refers to the acquisition of knowledge from external sources. By contrast, outbound open innovation is an inside-outwards process and includes opening the innovation process to knowledge exploitation (Lichtenthaler, 2011). According to this literature, the firms' acquisition of knowledge from university outputs such as patents open to public and scientific papers is a kind of inbound and non-pecuniary process of innovation. From a spatial perspective, regions exhibit similar patterns to firms; innovative success might depend on the appropriate combination of knowledge inputs from local and regional as well as national and global sources of knowledge (Kratke, 2010); moreover as pointed by Cooke et al., (2000) and Cooke (2005), it is impossible to discuss innovation processes and policies without reference to the interactions of local–regional, national and global actors and institutions.

The empirical evidence on businesses' external knowledge sourcing through university spillovers has revealed two facts: First, there is a geographical dimension in the external process of knowledge acquisition from universities. The relevant role of distance has been tested largely by a long list of empirical papers on university spillovers (e.g. Anselin et al. 1997, 2000; Feldman and Florida 1994; Fischer and Varga 2003; Jaffe 1989; Varga 1998). The main finding of these studies is that knowledge spillovers from universities are localized and contribute to higher rates of corporate patents or innovations in geographically bound areas. Moreover, knowledge spillovers are usually "confined largely to the region in which the research takes place" (Hewitt-Dundas, 2011). Second, spillovers from neighbouring sources of knowledge inside the region or other ways of acquisition of knowledge outside the region do not occur automatically. A certain degree of "absorptive capacity" (Cohen and Levinthal, 1990) is necessary; that is, firms must have the ability to recognise the value of new, external information, assimilate it, and apply it" (Cohen and Levinthal, 1990). Using the terminology of the open innovation paradigm, absorptive capacity is "a pre-condition for organising inbound open innovation activities" (Spithoven, 2011).

In the light of the above arguments, the open innovation paradigm suggests that firms incorporate external as well as internal ideas to advance their technology. These ideas include knowledge from external institutions such as universities inside and outside the region where the firm is located, but a certain degree of absorptive capacity for university knowledge seems to be one of the main requirements for firms to absorb university knowledge through spillovers.

As pointed out above, one of the main findings of empirical university spillover literature is that distance is a relevant factor for explaining the use by firms of academic knowledge produce in the same area or region where firms are located. However, several papers suggest that knowledge sourcing occurs at a variety of different spatial scales such as supra-regional and global connections that might be equally important to those in the region in order to get access to external knowledge sources (Arndt and Sternberg, 2000; Kaufmann and Todtling, 2001; Bathelt et al., 2004). Davenport (2005) reports some research that has analysed how many firms do not acquire their knowledge from within geographically proximate areas, concluding that there are some factors that may work against geographically proximate knowledge-acquisition activities such as the role of foreign firms and multi-nationals, or firms working on some specific kind of technologies. Boschma (2005) argues that although geographical proximity facilitates interaction and cooperation for acquisition of knowledge, it is neither a prerequisite nor a sufficient condition for interactive learning to take place; other forms of proximity may frequently substitute for geographical proximity. Cargliu and Nijkamp (2012) recently explore the relationship between outward knowledge spillovers (measured as total factor productivity) and regional absorptive capacity for a sample of European regions, concluding that lower regional absorptive capacity increases knowledge spillovers towards surrounding areas, hampering the regions' capability to decode and efficiently exploit new knowledge, both locally produced and originating from outside. One of the main reasons explaining why some firms relies on proximity rather than in long distance sources of knowledge seems to be the grade of absorptive capacity: when firms' absorptive capacity is low, geographically proximate collaborations may be their only option. In contrast, high absorptive capacity enabling firms to collaborate for innovation at greater geographical distance (Drejer and Vinding, 2007; De Jong and Freel, 2010).

This literature suggests two important conclusions: first, distance is not an obstacle for many firms with high absorptive capacity to acquire knowledge from other regions. Second, the acquisition of knowledge from surrounding areas is easier for firms with lower absorptive capacity. This discussion leads to the following two hypotheses. Both hypotheses concern the influence of the absorptive capacity on the use of university knowledge produced inside and outside the region:

Hypothesis 1: The acquisition of codified knowledge in form of patents and papers produced by universities inside the region is negatively related to the absorptive capacity for academic knowledge of firms in the region.

Hypothesis 2: The acquisition of codified knowledge in form of patents and papers produced by universities outside the region is positively related to the absorptive capacity for academic knowledge of firms in the region.

The above hypotheses concern the firm capacity to acquire university knowledge, but academic knowledge is a flow; we need to take into account the other party in the game: universities. The question is to what extent the availability, quality or characteristics of the knowledge produced in universities stimulate or hinder the acquisition of inward and outward regional academic knowledge? In this respect, some empirical research has stressed the role of universities to encourage the flow of knowledge between universities and firms at regional level. Audrestch and Feldman (1996) find a positive relationship between ''local university research funding'' and ''local industry value-added'' at the state level. Their results indicate the relative economic importance of new knowledge to the location and concentration of industrial production. Zucker et al. (2002) relate the input "number of local research stars" to the output "number of new local biotech firms" and examine the variance in this relationship across geographic space at the economic region level. They find that the number of local stars and their collaborators is a strong predictor of the geographic distribution of US biotech firms in 1990. Branstetter (2001) identifies a positive relationship between ‘‘scientific publications from the University of California’’ and ‘‘patents that cite those papers’’, also at the state level. In another more recent paper Branstetter (2005) points out that the more rapid growth in the intensity with which U.S. patents cite academic science suggests a response to new technological opportunities created by academic research.

Other related literature on firm formation/location also suggests the importance of the characteristics of the academic knowledge for the spillovers to take place in the region. For example, Audretsch et al. (2004) focused on whether knowledge spillovers are homogeneous with respect to different scientific fields. They found that the firms locational decision is shaped not only by the output of universities (for instance, students and research), but also by the nature of that output (that is, the specialized nature of scientific knowledge). Audretsch and Lehmann (2005) concluded that universities in regions with greater knowledge capacity and higher knowledge output also generate a larger number of technology start-ups. Several empirical papers in different spatial contexts point to the potential positive relationship between local university R&D expenditures and the number of newly created high technology firms (e.g. Harhoff, 1999 for Germany; Woodward et al., 2006 for US; Abramovsky et al., 2007, provide evidence on the extent business sector R&D activity is located near high quality university research departments in Great Britain; Acosta et al. 2011a found a significant relationship between some university ouputs and new firm formation for the case of Spain).

According to this literature, we expect that a firm in a territorial environment with a well-established university presence increases the opportunities for the company to access and absorb relevant new scientific knowledge more easily, in comparison with other companies located in regions with weak university capacities. At the same time, firms in regions with low technological and scientific opportunities created by universities will acquire academic knowledge elsewhere outside the region. This reasoning leads to the following two hypotheses:

Hypothesis 3: The acquisition of codified knowledge in form of patents and papers produced by universities inside the region is positively related to the university capacity to produce scientific and technological knowledge in the region.

Hypothesis 4: The acquisition of codified knowledge in form of patents and papers produced by universities outside the region is negatively related to the university capacity to produce scientific and technological knowledge in the region.

3. Model and variables

The basic model for testing our hypotheses relates the acquisition of university knowledge (UKA) by firms in region to two main explanatory factors: the absorptive capacity (AC) and the availability of university knowledge in the region (U). The regional function is given in general form as:
$UKA_{it} = f(AC_{it}, U_{it})$ for $i = 1, 2, \ldots, N$, Where the subscripts “i” and “t” refer to region i and time t, respectively. We may call this equation the University Knowledge

Acquisition Function (UKAF), and concerns the activity in which firms in a region capture knowledge from inward and outward regional university knowledge; that is, university knowledge produced in universities located in the region or elsewhere. To fully explain the knowledge acquisition we have extended this function in two ways:

- The model should control for the technological specialization. Although -to our knowledge- there is not empirical research on the effects of technological diversification (or specialization) on the acquisition of university knowledge, regions specialized in high technology might rely on external knowledge rather than on regional internal knowledge. For example, some authors (E.g. Klevorick, 1995, Acosta and Coronado, 2003, Laursen and Salter, 2004) suggest that in some industrial sectors, the relationship between universities and industrial innovation appears to be a tight one, such as in biotechnology, while in others such as textiles it appears to be weaker.

- Regions are grouped in countries, therefore some correlation is expected across regions of the same country. For example, national innovative measures, incentives -or more general firms' policies- influencing the regions of the whole country. The presence of higher-order hierarchical structures with different characteristics (region are grouped in countries) point to the multilevel nature of the factors influencing the acquisition of university knowledge.

We may reformulate the initial model by including these additional factors in an extended UKAF:

$$UKA_{git} = f(AC_{git}, U_{git}, S_{git}, Z_{git}, \varepsilon_{gt}) \text{ for } i = 1,2,\ldots,N \quad g = 1,2,\ldots,G$$

Where g indexes the group or cluster. S controls for the technological specialization of the region and Z for its size. ε is an unobserved cluster effect capturing the regional influences of the group (country) on the regional acquisition of inward and outward knowledge.

For correctly estimating the UKAF, the empirical equation should have to consider both the nature of the dependent variable (citations to university references in patents are count data) and the fact that the units of observations (regions) are grouped in countries. To take into account both requirements and allow for overdispersion, we opted for framework of a negative binomial model with grouped data with the following conditional mean:

$$E(UKA_{git}) = \exp(\alpha AC_{git-2} + \beta U_{git-2} + \varphi S_{git-2} + \varphi \ln GDP_{git-2}, u_{git} + \varepsilon_{gt}) \text{ for } i = 1,2,\ldots,N \quad g = 1,2,\ldots,G$$

Where α, ß φ and φ represent the effects of the absorptive capacity AC, regional opportunities U, and the control variables S and Z, respectively. u is an idiosyncratic error term and ε captures the unobserved heterogeneity of the group's (country) influences.

The following paragraphs explain how we have measured each variable.

Dependent variables. We consider two dependent variables in two separate models:

- The acquisition or use of inward regional university knowledge is captured by the number of citations in firms' patents to universities located in the same region where the firm is established.

- The acquisition or use of outward regional university knowledge is captured by the number of citations in firms' patents to universities located outside the region where the firm is established.

Independent variables:

- Absorptive capacity (AC). The empirical literature on absorptive capacity has to a large extent limited itself to the amount of R&D expenditures or presence of an R&D unit as a measure of absorptive capacity both at firm and at regional level. Other popular indicators of absorptive capacity include human resources, and networks. In this paper we use R&D efforts for a viable proxy of absorptive capacity (firms' R&D as percentage of GDP -gross domestic product-). The original paper by Cohen and Levinthal (1990) used firm-based R&D data as proxies for absorptive capacity in the empirical section of their paper. Subsequent extensive evidence has use firm R&D to analyse the firms' capability to access knowledge from external sources (e.g. seminal papers such as Kim, 1997, and Kodama, 1995, stress the crucial role of a firm's internal R&D in determining its ability for the acquisition and assimilation of external knowledge).

- Presence in the region of university technological opportunities (U). We capture the capacity of universities in each region to produce quality patents using regional 'Higher Education R&D' expenditure as percentage of regional GDP. This is a resource variable to proxy for the strength of the university system to produce outputs. We expect that greater effort in university R&D should lead to more university outputs that could increase the opportunities for firms to acquire and exploit this knowledge.

- To control for the regional specialization (S) we calculate a similar measure to the revealed technological advantage index (Soete and Wyatt, 1983): TAI= $\frac{P_{ij} / \sum_{s=1}^{S} P_{is}}{\sum_{i=1}^{N} P_{is} / \sum_{i=1}^{N} \sum_{s=1}^{S} P_{is}}$, where $P_{is} / \sum_{s=1}^{S} P_{is}$ is the number of patents of region i in sector j over the number of patents of region i in all sectors; $\sum_{s=1}^{N} P_{is} / \sum_{i=1}^{N} \sum_{s=1}^{S} P_{is}$ is the number of patents of all regions in sector s over the total number of patents. To construct the index we use eight sections of the International Patent Clasification (IPC) (see the bottom of Table 2).

For the estimation of the models, we employ a conditional fixed and random effects negative binomial estimator in which we assume that units (regions) are positively correlated within clusters (countries). Then, the econometric estimations are in the framework of cluster count data models. The decision to use a two-level hierarchical analysis (regions clusters in countries) has two main objectives: (a) to evaluate the unobserved heterogeneity—along with the fixed effects—of the regional acquisition of knowledge; the inclusion of random effects in the model considers that there is natural heterogeneity across regions of the same country; (b) to correctly estimate the confidence intervals, taking into account the intra regional correlation of regions in of the same country. Failures to take into account the clustering of data result in serious biases (see, for example, Moulton, 1990; Antweiler, 2001; Wooldridge, 2003, 2006).

4. Data

4.1 Data and sources

The data collection process was designed by the Institute for Prospective Technological Studies (IPTS) in 2009. An international consortium of researchers from the University of Newcastle, Incentim and the Centre for Science and Technology Studies (CWTS) were responsible for implementing the data collection. The EPO Worldwide Patent Statistical Database (PATSTAT) database was used to compile a dataset of 649,156 direct EPO patents applied for in the period 1990-2007. These 649,156 patents involved 1,938,818 references, equating to an average of 3 references per patent (cf Criscuolo and Verspagen 2008 and Sapsalis et al. 2007). The team then identified which were university references. The strategy used differed depending on whether it was references to patent literature or to non-patent literature.

These matching procedures for the distribution of references by institutional sector resulted in 82% non-university references, 17% references of unknown institutional origin and 1% university references. As explained above, this 1% is an underestimation due to the single-author criterion. This 1%, or 20,630 university references (contained in 15,433 patents), is the basis for our analysis. These references were classified by applicant for EU27 NUTs II regions. In the case of multiple regions, fractional counts were applied, i.e. if a patent application involved two different regions, each scored 0.5 patents. Based on our classification by region applicants we are able to check whether there is a match between applicant region and region of a citation from a university.

{Figure 1 and Figure 2 around here}

4.2 Descriptive statistics

5. Results

5.1. Baseline results

In order to analyze the acquisition of codified knowledge in form of patents and papers produced by universities inside and outside the region, we have estimated two models, both using fixed and random effects estimations (Table 2):

Model I shows that the absorptive capacity of firms in the region does not play any role in determining the use of scientific and technological university knowledge generated in the same region of the firm's location, i.e. there is no evidence in favour of Hypothesis 1.

Model II shows that the firms' absorptive capacity of the region determines the use of outward university knowledge. That is, regions with greater effort in private R&D have a greater absorption of scientific and technological university knowledge from outside the region (from other countries or other regions in the same country). Hence, Hypothesis 2 is confirmed.

Concerning the influence of the university capacity of the region to produce spillovers, Model I shows that the use of scientific and technological university knowledge by firms from the same region is positively related with the university capacity of the region. This means that the greater the R&D effort in the universities of the region, the larger the use of scientific and technological knowledge from the own regional universities, i.e. the evidence supports Hypothesis 3.

Hypothesis 4, not confirmed.

Effects of technological specialization

Table 2

Negative binomial models for grouped data. Estimation Results. Dependent Variable: UKA (University knowledge Acquisition)								
	I. Acquisition of inward regional knowledge				II. Acquisition of outward regional knowledge			
	FE		RE		FE		RE	
cons	-18.103		-22.711		-2.225	**	-2.253	**
A=Firms' R&D/GDP	-0.259		-0.258		0.191	**	0.191	**
U=Universities' R&D/GDP	2.668	**	2.334	**	0.158		0.242	
GDP	0.001	**	0.001	**	0.001	**	0.001	**
speA (1)	0.564	*	0.687	*	0.378	**	0.385	**
speB	0.214		0.238		0.056		0.063	
speC	1.011	**	0.935	**	0.585	**	0.584	**
speD	-0.029		-0.018		-0.025		-0.009	
speE	0.129		0.128		0.039		0.043	*
speF	0.227		0.136		0.072	*	0.064	*
speG	0.369		0.329		0.466	**	0.468	**
speH	0.374		0.383		0.135	**	0.164	**
Ln_r			2.321				1.829	
Ln_s			1.157				3.126	
Number of obs	460		499		495		499	
Number of groups	9		22		18		22	
Wald chi2	109.22	**	115.29	**	2390.51	**	2404.48	**
Loglikelihood	-197.86		-233.27		-1511.75		-1615.7	
LR Test Panel vs Pooled			7.24	**			93.97	**

Notes:
(1) IPC Sections to construct the specialization indexes (spe): A Human Necessities; B Performing Operations; Transporting; C Chemistry; Metallurgy; D Textiles; Paper; E Fixed Constructions; F — Mechanical Engineering; Lighting; Heating; Weapons; Blasting: G Physics; H Electricity.
- **, * denote that the coefficients are statistically different from zero at the 1% and 5% and levels, respectively.
- Both models include year dummies for 1997 to 2006.
- Poisson models presents overdispersion. Negative Binomial models are preferred to Poisson models
- VIF suggests no signs of multicollinearity.
- We cannot compute Hausman test because the different number of observations. With the same observations RE are preferred to FE.

5.2. Robustness I: Robust standard errors

The robustness of our results can be checked estimating other econometric specifications. The most suitable alternative models to contrast our hypothesis, given the nature of our sample, are the zero inflated negative binomial model (ZINB) and the negative binomial model (NB), both with cluster robust standard errors (according to a country variable). The estimations provides the following results:

- For the acquisition of inward university knowledge, according to the Vuong statistic, the ZINB model is preferred to the NB model. This is not surprising, given the great number of zeros in the sample used to explain the acquisition of inward knowledge. [1,2]

- For the acquisition of outward university knowledge, the Vuong statistic is not conclusive in selecting ZINB or NB model.

Table 3 presents the proffered estimations. From this Table, we can conclude that, comparing with the baseline models in Table 2, these coefficients are similar and significance levels do not change.

Table 3

Robustness. NB and ZINB models for grouped data Dependent Variable: UKA (University knowledge Acquisition)				
	I. Acquisition of inward regional knowledge		II. Acquisition of outward regional knowledge	
	ZIP Robust Std Err Adjusted (country)		NB Robust Std Err Adjusted (country)	
cons	-19.400	**	-1.378	**
A=Firms' R&D/GDP	-0.079		0.210	**
U=Universities' R&D/GDP	2.499	**	0.539	
GDP	0.001	**	0.001	**
speA (1)	1.729	**	0.572	**
speB	0.389	*	0.091	**
speC	0.607		0.918	**
speD	0.160		-0.004	

[1] Vuong statistic has been calculated in all models without the cluster option.
[2] Poisson model with robust standard errors adjusted for clusters present overdispersion in all cases.

speE	0.078		0.102	*
speF	-0.090		0.141	*
speG	0.511	*	0.634	**
speH	-0.004		0.381	**
Inflation model (logit)				
cons	-2.067			
speA (1)	2.430			
speB	-0.040			
speC	-1.315			
speD	0.205			
speE	-0.403			
speF	-0.930			
speG	1.680			
speH	-3.108			
Number of obs	499		499	
Number of clusters	22		22	
Log pseudoikelihood	-227.05		-1553.91	

Notes:
(1) IPC Sections to construct the specialization indexes (spe): A Human Necessities; B Performing Operations; Transporting; C Chemistry; Metallurgy; D Textiles; Paper; E Fixed Constructions; F — Mechanical Engineering; Lighting; Heating; Weapons; Blasting: G Physics; H Electricity.
- **, * denote that the coefficients are statistically different from zero at the 1% and 5% and levels, respectively.
- Both models include year dummies for 1997 to 2006.
- Poisson models presents overdisperssion. Negative Binomial models are preferred to Poisson models
- VIF suggests no signs of multicollinearity.
- Vuong statistics favours ZIP against ZINB.

5.3. Robustness II: All institutions (not only firms)

Table 4

Negative binomial models for grouped data. Estimation Results. Dependent Variable: UKA (University knowledge Acquisition)								
	I. Acquisition of inward regional knowledge				II. Acquisition of outward regional knowledge			
	FE		RE		FE		RE	
cons	-6.414	**	-6.159	**	-1.968	**	-1.948	**
A=Firms’ R&D/GDP	-0.147		-0.177		0.176	**	0.178	**
U=Universities’ R&D/GDP	2.065	**	1.657	**	0.183		0.136	
speA (1)	0.748	**	0.746	**	0.415	**	0.412	**
speB	0.303	*	0.274	*	0.158	**	0.151	**
speC	1.245	**	1.209	**	0.647	**	0.661	**
speD	0.016		0.018		0.018		0.018	
speE	0.142	*	0.126		0.054	*	0.054	*
speF	0.225	**	0.174	*	0.084	**	0.081	**
speG	0.535	**	0.522	**	0.422	**	0.427	**
speH	0.460	**	0.497	**	0.303	**	0.303	**
Ln_r			2.193				1.796	
Ln_s			3.374				4.231	
Number of obs	570		570		570		570	
Number of groups	12		12		12		12	
Wald chi2	105.14	**	105.6	**	292.77	**	297.97	**
Loglikelihood	-429.5		-477.2		-1921.5		-1997.6	
LR Test Panel vs Pooled			3.2	*			53.16	**

Notes: (1) IPC Sections to construct the specialization indexes (spe): A Human Necessities; B Performing Operations; Transporting; C Chemistry; Metallurgy; D Textiles; Paper; E Fixed Constructions; F — Mechanical Engineering; Lighting; Heating; Weapons; Blasting: G Physics; H Electricity. - **, * denote that the coefficients are statistically different from zero at the 1% and 5% and levels, respectively. - Both models include year dummies for 1997 to 2006. - Poisson models presents overdispersion. Negative Binomial models are preferred to Poisson models - VIF suggests no signs of multicollinearity. - FE and RE coefficients are similar but Hausman test suggests RE are preferred to FE.

Table 5

Robustness. NB and ZINB models for grouped data Dependent Variable: UKA (University knowledge Acquisition)				
	I. Acquisition of outward regional knowledge		II. Acquisition of inward regional knowledge	
	NB Robust Std Err Adjusted (country)		ZINB Robust Std Err Adjusted (country)	
cons	-0.796	**	-6.841	**
A=Firms' R&D/GDP	0.306	**	-0.111	
U=Universities' R&D/GDP	0.162		2.210	**
speA (1)	0.704	**	1.070	**
speB	0.126	**	0.362	**
speC	1.122	**	1.515	**
speD	-0.001		0.050	
speE	0.146	**	0.126	
speF	0.126		0.260	
speG	0.609	**	0.470	**
speH	0.632	*	0.827	**
Inflation model (logit)				
cons			-26.123	**
Number of obs	570		570	
Number of clusters	12		12	
Log pseudoikelihood	-1829.8		-467.3	
Vuong test ZINB vs NB	0.26		-0.001	
Notes: (1) IPC Sections to construct the specialization indexes (spe): A Human Necessities; B Performing Operations; Transporting; C Chemistry; Metallurgy; D Textiles; Paper; E Fixed Constructions; F — Mechanical Engineering; Lighting; Heating; Weapons; Blasting: G Physics; H Electricity. - **, * denote that the coefficients are statistically different from zero at the 1% and 5% and levels, respectively. - Both models include year dummies for 1997 to 2006. - Poisson models presents overdispersion. Negative Binomial models are preferred to Poisson models - VIF suggests no signs of multicollinearity. - FE and RE coefficients are similar but Hausman test suggests RE are preferred to FE.				

6. Conclusions

In this paper we argue that the knowledge that firms in a region can acquire from university spillovers is a function of both the absorptive capacity of the firms developed by investing in knowledge, and the opportunities for university spillover. To test our hypotheses we put forward an external knowledge acquisition function which explains the factors affecting the regional inward and outward acquisition of university knowledge by firms.

Our models yield to reject the hypothesis H1 and H4. Hypotheses H2 and H3. are not rejected. According to these findings, absorptive capacity is not relevant in explaining the acquisition of inward scientific and technological university knowledge; however, regional absorptive capacity plays a relevant positive effect in the acquisition of outward university knowledge. Regarding the other relevant variable in the models, university opportunities for spillovers in the region have a positive effect on the acquisition of local knowledge by firms from the same region, but does not have any influence in the acquisition of outward university regional knowledge.

This findings have some relevant policy implications. Considering the objective of policy makers, we can divide implications into two types:

-If the objective of regional government is encouraging the use of university knowledge produced in the region (by firms established in the region), our results suggest that the only way is the stimulation of the supply side, that is the investment in university scientific and technological knowledge to produce regional opportunities.

- If the objective is improving the competitiveness of local firms (in the sense that they could understand and incorporate university knowledge from elsewhere), our results suggest that absorptive capacity is the variable to spur.

Limitations...

Future research...

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Figure 1
EPO patents in 1990-2007 from Patstat

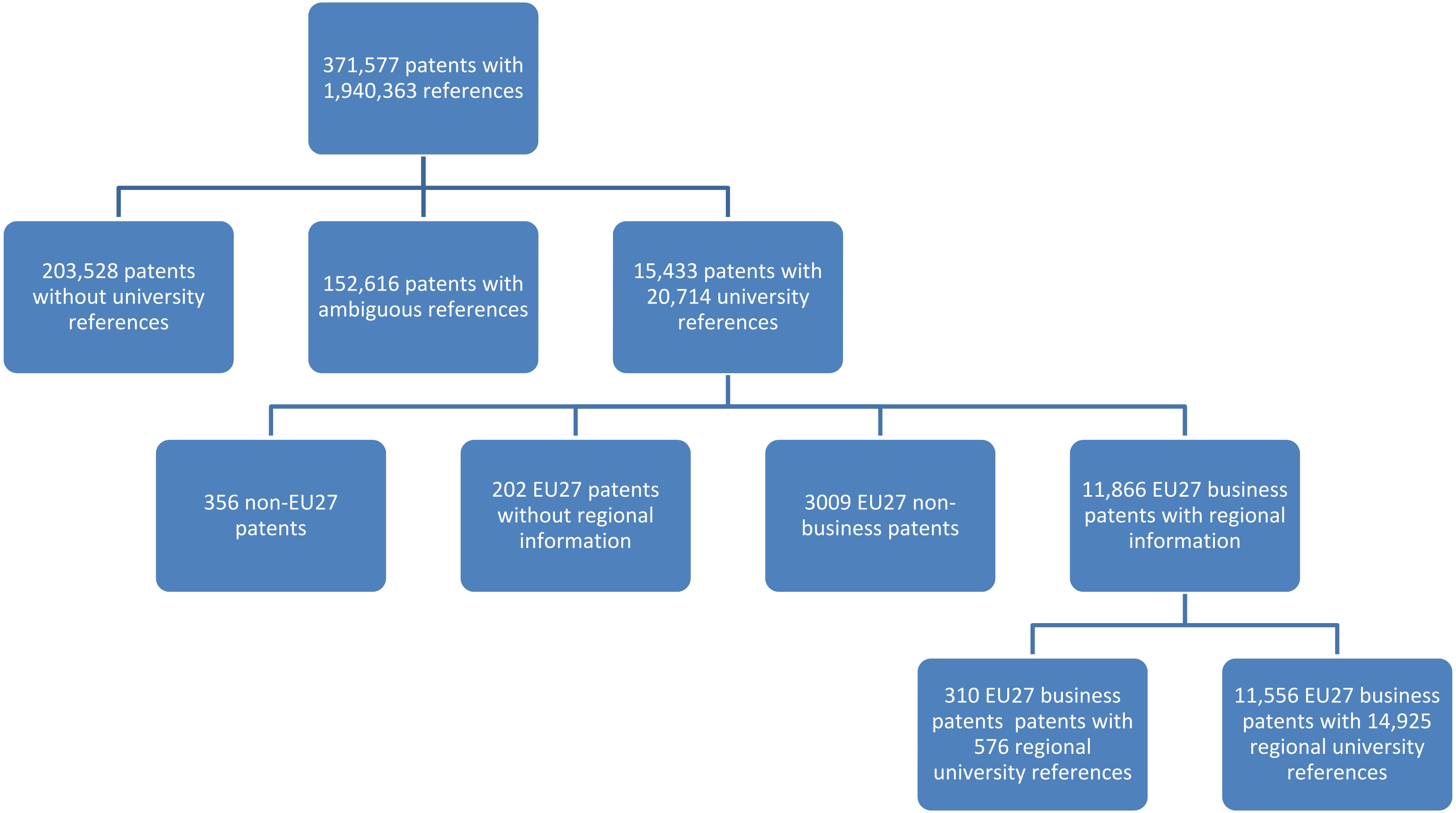

Figure 2
The panel